Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes − ENSIAS

Centre d'Etudes Doctorales en Sciences des Technologies de l'Information et de l'Ingénieur − ST2I

THESE DE DOCTORAT

A NEW DECISION AID FRAMEWORK FOR ORGANIZATIONS' SUSTAINABILITY-DRIVEN GROWTH STRATEGY

Présentée le 28 Décembre 2017 par

FADWA CHAKER

Formation Doctorale : Informatique

Equipe de Recherche : Technologies d'Information et Management d'Entreprises (TIME)

Composition du Jury :

Président du Jury :	**M. M. EL KOUTBI, PES, ENSIAS**
Directeur de Thèse :	**M. A. EL MANOUAR, PES, ENSIAS**
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Invité :	**M. M. K. EL GHAIB, PhD, Social Innovation & Sustainability Institute, ESCA Ecole de Management**

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Année : 2017

Pour mes parents

**  **

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ABSTRACT

Sustainability is no longer a luxury, it has become a source of competitive advantage, and sometimes the only option companies are left with to survive in highly unstable environments. Yet defining a proper sustainability strategy is still a challenge that most firms are faced with. In this regard, one of the commonly accepted decision making approaches is the Sustainability Balanced Scorecard (SBSC).

After showing the importance of sustainability-alignedapproaches to decision making over Corporate Social Responsibility (CSR) based ones, this research work satisfies three objectives: First, making a critical evaluation of existing literature works in SBSC architecture design methodologies proposed over the past fifteen years. Second, building upon the review findings and proposing a robust design methodology based on combining technical and systemic decision-aid approaches. Third, experimenting the framework via System Dynamics simulation with a real case study on a MNC in the consumer packaged goods industry.

From a conceptual perspective, the proposed framework surpasses the rigidity of the traditional BSC −and its multiple sustainability colored versions− by enabling total adaptation to organizational contexts thanks to a methodological combination of Fuzzy DEMATEL and AHP, which results in sporadically varying, yet technically vindicated structures. In addition, the Adaptive SBSC (ASBSC) is reinforced by a time-bound simulation modeling method using System Dynamics, which leads to the Dynamic ASBSC (ADSBSC). Thus, the ADSBSC brings a systematic answer to the long-debated SBSC architecture design methods in a dynamic perspective that reduces mental models biases and offers a more realistic conceptualization of reality.

From an empirical perspective, the ADSBSC helps organizations comfort their strategic choices pertaining to sustainability management with respect to both investment and implementation. It can serve indeed as a novel and effective tool for sustainability management, on which both business managers and policy makers can rely to assess current performance and build future strategies.

Keywords:

Sustainability decision making; decision aid frameworks; balanced scorecard; system dynamics; DEMATEL.

RESUME

Le développement durable est aujourd'hui une exigence planétaire. Les firmes y voient une source d'avantage concurrentiel, voire même parfois le seul moyen de subsistance dans un marché globalisé fortement compétitif. Cependant, il relève encore du défi de proprement définir des stratégies de durabilité efficaces. Dans ce sens, le SBSC(SustainabilityBalancedScorecard)s'avère l'une des approches managériales d'aide à la décision les plus largement acceptées.

Après avoir explicité l'intérêt d'aligner l'approche de prise de décision davantage sur les principes du développement durable que sur l'angle plus restreint de la Responsabilité Sociale d'Entreprise (RSE), cette recherche vise trois objectifs: premièrement, l'élaboration d'une revue critique de la littérature autour des architectures et modèles conceptuels du SBSC sur les quinze dernières années. Deuxièmement, la proposition d'un framework robuste basé sur la combinaison de méthodes analytiques et d'approches systémiques. Troisièmement, l'expérimentation du framework proposé à travers une étude de cas élaborée au sein d'une multinationale dans le domaine de la grande consommation.

D'un point de vue conceptuel, le modèle proposé surpasse la rigidité longtemps imposée par le BSC traditionnel −avec ses versions multiples à la couleur développement durable. Ceci est assuré par une forte adaptabilité aux différents contextes managériaux grâce à une combinaison des méthodes Fuzzy DEMATEL et AHP, donnant ainsi naissance à des structures de SBSC à la fois variées et techniquement précises. En outre, cet ASBSC (Adaptive SBSC) est renforcé par une modélisation temporelle permettant sa simulation dans une approche de System Dynamics, aboutissant à l'ADSBSC (Adaptive Dynamic ASBSC). L'ADSBSC apporte ainsi une réponse systématique au débat longuement entretenu sur la construction du SBSC dans une optique dynamique qui réduit l'influence intuitionniste des modèles mentaux dans la conceptualisation de la décision.

D'un point de vue empirique, l'ADSBSC conforte les organismes dans leurs choix stratégiques inhérents au développement durable, et ce aussi bien au niveau du choix d'investissement que de la mise en œuvre de la stratégie. Il est en effet traduisible en un véritable outil d'aide à la décision stratégique en développement durable aussi bien dans les milieux des affaires que dans le domaine des politiques publiques.

Mots-clés:

Sustainability decision making; decision aid frameworks; balanced scorecard; system dynamics; DEMATEL.

INTRODUCTION

Globalization has shaped every piece of the modern history of mankind. Since the great voyages and transatlantic trade, through the industrial revolution, to imperialism and today's free market capitalism, man has experienced all facets of growth and prosperity. Yet, the economic, technological, medical and scientific breakthroughs have also come with unprecedented wealth disparity, social fracture and ecological disasters. In the midst of political economics and conflicts of interest, corporations have played a crucial role in this course of events.

From daily functional decisions to strategic investment choices, companies shape the direction of the world, and our future with it. It is no surprise that some milestone global conventions have been designed and ratified to ensure corporations and nations adopt responsible and sustainable behavior along the growth way. In 1992, the Rio Summit defined a broad map for sustainable development, followed two years later with the Climate Change Convention which led in 1997 to the Kyoto Protocol. The United Nations Global Compact, adopted in 2000, was another cornerstone achievement that paved the way, fifteen years later, to the Paris Agreement and the United Nations Sustainable Development Goals.

With the rise of guiding principles for more responsible enterprise, decision makers embarked on a more inclusive stakeholder approach technically backed up with a series of certifications, reporting initiatives and social responsibility labeling. This movement has also been accompanied with the surge of analytical decision-aid methods combining mathematics, engineering and management sciences to help company executives make sound and sustainability-aware decisions.

More particularly, scientific research literature shows that the largest portion of studies in sustainability decision making has addressed operational decision-aid frameworks and tools that aim to solve specific CSR related questions, including multi-criteria/multi-objective decision aid techniques, sustainability performance measurement systems and indices, etc. Most literature works focus, indeed, on such problems as selection, prioritization or outranking of green supply chain components or CSR programs.

In contrast, few studies have addressed the more encompassing system thinking approaches such as feedback systems and emergent self-organization (Williams, Kennedy, Philipp, & Whiteman, 2017). This discrepancy is even more alarming when we realize that effective sustainability management at both the corporate and state levels requires a systemic view where economic, social, political, and environmental considerations are simultaneously taken into account. Scientists have contended that "*a mature understanding of sustainability management requires studies to adopt a multi-disciplinary*

systemic lens capable of appreciating the interconnectivity of economic, political, social and ecological issues across temporal and spatial dimensions" (Williams et al., 2017).

Achieving this interconnectivity can only come about if we, as managers, researchers, and decision makers, rid our thinking of the narrow, transactional, and almost weary concept of CSR −and the often short-sighted value accrued from its literal application− in order to embrace wholeheartedly the more holistic concept of sustainability. Achieving this interconnectivity can only happen if we devise the right decision making systems and tools so as to build long term growth strategies that are deeply and equally rooted in economic, social and environmental welfare.

This thesis makes a contribution to the development and expansion of the systemic management of sustainability through decision sciences engineering. In this work, we propose an encompassing sustainability decision-aid system based on a framework combining fuzzy multi-criteria decision making, the Balanced Scorecard and System Dynamics. We solve for and quantify the complex causal relationships in an organization using mathematical decision-aid techniques; we address ad-hoc interactions and time delays using System Dynamics simulation, and tackle the imprecision pertaining to human judgment with fuzzy logic. We reinforce this framework with an analysis of the computerization process and eventual deployment architectures that can support the whole information system. The result is a comprehensive decision aid system that companies and non-profit institutions are able to use to analyze the existing state of the art, and, most importantly, to build long-term strategies capable of maximizing both growth and societal impact.

Practically, this thesis is organized as follows. In the **Ist Chapter**, a historical overview of the concepts of CSR and sustainability is presented, with a note on the necessary transition we need to operate from the first to the second. **Chapter II** takes us next to the major decision making frameworks used in CSR and sustainability management and their distribution by area and focus (operational vs. systemic). A critical synthesis of the literature is conducted and the attention is shifted towards a few of the system thinking approaches that present interesting research avenues. In **Chapter III**, and based on the critical evaluation presented in the previous chapter, a new decision-aid framework is proposed using a methodological combination of operational decision making techniques, system dynamics and the sustainability balanced scorecard. The framework is denoted the Adaptive Dynamic Sustainability Balanced Scorecard (ADSBSC). The automation of this system is also investigated. Last, **Chapter IV** presents an application of the ADSBSC system to a real case study of a multinational corporation in the consumer goods industry. The model is then validated, results are confronted with reality, and recommendations are drawn.

CHAPTER I:

FROM CORPORATE SOCIAL RESPONSIBILITY (CSR) TO SUSTAINABILITY:

STATE OF THE ART

CHAPTER 1. FROM CORPORATE SOCIAL RESPONSIBILITY (CSR) TO SUSTAINABILITY: STATE OF THE ART

1.1 Historical Evolution and Brief Review of the Literature

The roots of the social responsibility of business trace back to the early years of the Cold War where some alert activists use this concept as a means of aligning business interests with the defense of free-market capitalism against what was depicted as the clear-and-present danger of Soviet Communism (Spector, 2008). The 1950s witness a scant exchange of ideas on the concept of responsible business among scholars and business leaders, marked essentially by the publication in 1953 of Bowen's pivotal book *Social Responsibilities of the Businessman*(Bowen, 2013)(2013 Edition) where the author expands the benefits accrued by businesses in adopting a socially responsible approach and which is perceived to be markedly ahead of its time. The debate is reignited a few years later with Theodore Levitt and his work *The Dangers of Social Responsibility*(Levitt, 1958) where it is argued that business's job is to 'take care of the more material aspects of welfare' and that social welfare is instead the strict responsibility of governments, or as he plainly put it: "Government's job is not business, and business's job is not government" (p. 47) . Although intense, Levitt's work does not curb the rising movement for social responsibility which rises essentially in the US in the wake of the various social movements of the 1960s including civil rights, women's rights, consumers' rights and the environmental movement. Amidst social activists' claims and scholarly debates, business leaders turn increasingly receptive of the changes shaping society, and soon more inclined to gradually integrate social responsibility discussions in boardroom meetings.

CSR research expands significantly during this period of the 1960s and various definitions of the concept emerge. Keith Davis, one of the first and main contributors to this growth, defines social responsibility in the management context as the "businessmen's decisions and actions taken for reasons at least partially beyond the firm's direct economic or technical interest"(Davis, 1960). Moreover, Davis gains increased recognition thanks to the link he establishes between social responsibility and business power, or what is renowned as the "Iron Law of Responsibility", and where he states that "social responsibilities of businessmen need to be commensurate with their power" (p.71). In that sense, Davis (1960) asserts that, if business power and social responsibility are considered to be of relative equal weights "then the avoidance of social responsibility leads to gradual erosion of social power" (p.73) on the side of businesses.

Another influential writer of that period is William C. Frederick (1960)who alleges that "the economy's means of production should be employed in such a way that production and distribution should enhance total socio-economic welfare" (p. 60). Frederick clarifies his view by setting forth the following description of social responsibility as "a public posture toward society's economic and human resources and a willingness to see that those resources are used for broad social ends and not simply for the narrowly circumscribed interests of private persons and firms"(Frederick, 1960).

Joseph W. McGuire is another key researcher in the field of social responsibility in that period. He takes the construct a step further in his book *Business and Society*(1963) and asserts that corporations must be concerned about the whole social world around them and take interest in politics, education, the welfare of community and "happiness" of its employees, and should, therefore, act "justly" as a proper citizen should (p. 144).

While other authors continue to enrich the debate on social responsibility of businesses, Keith Davis closes out this decade by adding the ethics component atop his definition of the concept. In a paper where he addresses the question of what businessmen owe to society, Davis (1968) declares "the substance of social responsibility arises from concern for the ethical consequences of one's acts as they might affect the interests of others" (p.46).

The 1970s witness what Carroll (1999) refers to as the proliferation of CSR definitions. Authors like H. L. Johnson (1971), George Steiner (1971), and Gordon Fitch (1976) provide various definitions of the social responsibility of business. While Johnson hints at the stakeholder approach by using the term "multiplicity of interests" of a firm's managerial staff, Steiner delves into the spheres and conditions under which CSR might be applied. On his side, Fitch (1976) defines CSR as "the serious attempt to solve social problems caused wholly or in part by the corporation" (p. 38). Preston and Post (1975)prefer to introduce the term "public responsibility" to stress the importance of linking corporate social concern with the firm's host environment and the public policies and processes that shape that environment.

During the same period, several studies attempt to understand more closely the concept of CSR and what it really means to executives (Abbott & Monsen, 1979; Bowman, 1975; Holmes, 1976), and the term gets increasingly popular in business and academic areas. But Levitt's skeptical publications of the two decades before continue to nurture the passion of some enthusiasts of Adam Smith's fundamental principles of capitalism. In 1970, Milton Friedman presents a confrontational discourse against the social responsibility of business.Friedman (1962)had already contended in his famous book *Capitalism and freedom* that "few trends could so thoroughly undermine the very foundations of our free society as the acceptance by corporate officials of a social responsibility other than to make as much money for their stockholders as possible" (p. 133). Returning back to charge in 1970, the writer relates

CSR to some form of disguised feudalism. To put it in his own words, "the use of the cloak of social responsibility, and the nonsense spoken in its name by influential and prestigious businessmen, does clearly harm the foundations of a free society. [...] The difficulty of exercising "social responsibility" illustrates, of course, the great virtue of private competitive enterprise--it forces people to be responsible for their own actions and makes it difficult for them to "exploit" other people for either selfish or unselfish purposes. They can do good--but only at their own expense", concluding with his widely renowned argument: "there is one and only one social responsibility of business--to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud"(Friedman, 1970). Davis (1973) responds back to Friedman employing a quote from distinguished economist Paul Samuelson who maintains that "a large corporation these days not only may engage in social responsibility, it had damn well better try to do so" (p.24)(Samuelson, 1971).

The 1980s are characterized by less work on the definitions of CSR and more research into alternative concepts and frameworks. Such concepts as corporate social responsiveness, business ethics, stakeholder theory and public policy take form and arouse increased scholarly interest. Mechanisms for assessing CSR are presented such as the one found in the work conducted by Tuzzolino and Armandi (1981)where the authors use Maslow's (1970) need hierarchy framework to describe organizational needs.Carroll (1983)adds the components of ethics and philanthropy to the prevalent definition of CSR. To him, to be socially responsible "means that profitability and obedience to the law are foremost conditions to discussing the firm's ethics and the extent to which it supports the society in which it exists with contributions of money, time and talent" (p. 604). He concludes that CSR is a four-part construct: "economic, legal, ethical and voluntary or philanthropic".

Another key contributor to the literature during this period is management guru Peter Drucker who suggests seeing CSR through new lens, those of economic opportunity. Drucker (1984) not only posits that responsibility and profitability are compatible, but he also urges to "convert" social responsibility into business opportunity through which the firm can reap extra profit. He points out that "the proper 'social responsibility' of business is to tame the dragon, that is to turn a social problem into economic opportunity and economic benefit, into productive capacity, into human competence, into well-paid jobs, and into wealth" (p. 62)(Drucker, 1984). Other empirical studies follow from various scholars to depict the existence of links between social responsibility and financial performance and to further elaborate on the concepts of social responsiveness, business ethics and Corporate Social Performance (CSP).E. M. Epstein (1987)closes out this decade by introducing what he calls "corporate social policy process" by which he suggests the "institutionalization within business organizations of the following three elements...business ethics, corporate social responsibility and corporate social responsiveness" (p. 106).

These concepts and others are explored in depth in the period of the 1990s while remaining centrally hovering over the CSR term. Some examples include the work by DonnaWood (1991) who builds upon Carroll's (1983) work to formulate an extended framework for CSP, explicitly emphasizing outcomes and performance. Furthermore, Carroll (1991)elaborates on his basic four-pronged model to frame a pyramid of responsibilities where the economic layer rests at the basis and supports the other three on top of it. The same author conducts a survey in 1994 where it is depicted that CSP occupies a significant place in executives' list of social issues for research in the 90's while business ethics is found to be at the top of this list(Carroll, 1994).The end of this century is marked by the publication of a paper by Harrison and philosopher and academician R. Edward Freeman where authors report six "excellent efforts to tackle fundamental ideas" on the relationship between socially responsible organizational behavior and various forms of performance (p. 479) (Harrison & Freeman, 1999).

With the advent of the new millennium, research on CSR models and related topics explode in numerous directions. Various facets of relationships, frameworks and measurements are investigated. Ali Quazi and Dennis O'Brien open up this era by presenting a two-dimensional model for CSR based on the span of CSR activities and the range of outcomes of social commitments. The authors validate the model and conclude that CSR is "universal in nature and that different cultural and market settings in which managers operate may have little impact on the ethical perceptions of corporate managers" (p. 33) (Quazi & O'Brien, 2000).In 2001, the Commission of the European Communities officially defines CSR as “a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis” (Dahlsrud, 2008). On the research side, another important work by Donald Siegel and Abagail McWilliams builds upon the resource-based-view (RBV) framework of management to outline a model by which managers can determine the "ideal" level of CSR for the firm via a cost-benefit analysis(McWilliams & Siegel, 2001).Some other researchers focus on shedding light on the benefits of CSR from a strategic management perspective. Michael E. Porter and Mark R. Kramer present an excellent framework for "integrating business and society" in addressing the CSR question through what they call "Strategic CSR" or the strategic approach to corporate involvement in society(Porter & Kramer, 2006). In another research, John L. Campbell presents an institutional theory of CSR where he specifies a number of conditions under which corporations behave in socially responsible ways, arguing that the relationship between basic economic conditions and corporate behavior is mediated by several institutional conditions (Campbell, 2007).

This period of the history of CSR sees specific interest towards assessing the impact of CSR on different types of performances. Most of these works attempt to establish empirical-based correlation between CSR and corporate financial performance (CFP). While this relationship is initially found to be mixed and controversial depending on cross-cultural contexts and business settings, Van Beurden and

Gössling clear out the confusion by demonstrating through a thorough literature review that there is "clear empirical evidence for a positive correlation between corporate social and financial performance. Voices that state the opposite refer to outdated material (p. 407)"(Van Beurden & Gössling, 2008).

On a wider scale, the concept of sustainable development, or sustainability, emerges and attracts significant attention on the scholarly side. An extensive set of research explores the methods of designing, implementing and using what is called corporate sustainability performance measurement systems (SPMS). Searcy (2012) draws a very good literature review on this particular topic covering the period between 2000 and 2010.The measurement of corporate sustainability is heavily enriched by the contributions of some authors inspired by Kaplan & Norton's (1996a)balanced scorecard approach. The most noticeable ones are drawn byM. Epstein and Wisner (2001)and by Figge, Hahn, Schaltegger, and Wagner (2002) who propose to add and/or incorporate the social and environmental perspectives to the existing corporate balanced scorecard. Later, Gminder and Bieker (2002) make a cornerstone contribution through a classification of the sustainability balanced scorecard into four categories. A model of integrating ethics and integrity is soon proposed by the same author (Bieker & Waxenberger, 2002). Other interesting studies follow up suggesting different methods of assessing societal performance using the balanced scorecard(Hubbard, 2009; Thanaraksakul & Phruksaphanrat, 2009). A detailed description of the major architectures used in constructing the sustainability balanced scorecard is presented in CHAPTER 2. of this document.

This period is also witness of a rising interest among scholars in the connection between CSR and consumer behavior. In one of the first studies conducted in the field, Sen and Bhattacharya (2001)question whether doing good always leads to doing better. They come to the conclusion that companies with poor CSR records experience significant negative consequences, ranging from large-scale consumer boycotts to reductions in brand images and temporary drops in sales, when their negative records become public. In another interesting research, it is shown that "when social initiatives are not aligned with corporate objectives (low fit), CSR can actually become a liability and diminish previously held beliefs about firms (p.20-21)"(Becker-Olsen, Cudmore, & Hill, 2006). In addition, the same study finds that proactive CSR initiatives have a more positive impact on consumer perception and loyalty than reactive initiatives. It is suggested that only the high-fit and proactive initiatives lead to an improvement in consumer beliefs, attitudes, and intentions. Moreover, consumers consider corporate motives as altruistic and perceive CSR activities more positively when a company engages in them in line with their values and lifestyles (E. M. Lee, Park, Rapert, & Newman, 2012).More studies are conducted in the following years;Gao and Mattila (2014) show that perceived warmth and perceived competence mediate the relationship between service outcomes in green hotels and consumer satisfaction and behavioral intentions. Another empirical study demonstrates that loyalty is indirectly

affected by perceived CSR, via the mediation of trust, identification and satisfaction (Martínez & del Bosque, 2013).

Finally, it is important to mention the contribution of engineering and decision sciences to the evolution of the concept of CSR over the past fifteen years. Mathematicians and decision scientists have imbued the literature with a wide array of research works employing certain or fuzzy methods including multi-criteria decision making (MCDM) (Awasthi, Chauhan, & Goyal, 2010; Büyüközkan & Çifçi, 2011; Grisi, Guerra, & Naviglio, 2010), artificial intelligence (Bai & Sarkis, 2010; R. J. Kuo & Y. Lin, 2012; Yan, 2009), and mathematical programming (Yeh & Chuang, 2011) to name a few. This particular topic is covered in further detail in CHAPTER 2.

1.2 The Business Case for CSR

In addressing the question of the social responsibility of business, it is almost unavoidable to attempt mapping out the "balance sheet" of the subject; that is the advantages and disadvantages of CSR. In the midst of the debate that has long occupied the scholarly scene over the past 60 years, numerous authors have argued for or against the social responsibility of business. Nevertheless, using a chronological timeline, a general pattern seems to emerge. In fact, the most salient arguments against CSR appear in the period between the fifties and late seventies of the past century. In contrast, authors of the new millennium are increasingly aware of the importance and role of CSR and sustainability. Today, the debate has rather shifted toward *how* companies and organizations can be more responsible and sustainable.

This section presents the main arguments that have been advanced by some influential authors to support or undermine the reasoning behind business's social responsibility.

1.2.1 Arguments against CSR

The two authors who have most strongly shaped the school of thought against the social responsibility of business are Theodore Levitt (1958) and Milton Friedman (1962). The former's works highlight the following as the most salient arguments for corporations not to engage in social and environmental welfare:

- Embracing the "ideology" of social responsibility of business is the expression of belonging to a new fad whereby "it is not fashionable for the corporation to take gleeful pride in making money. What *is* fashionable is for the corporation to show that it is a great innovator; more

specifically, a great public benefactor; and, very particularly, that it exists to "serve the public. (p.42) "

- The involvement of corporations in social welfare breaks the rules of capitalism and free enterprise founded on the principles of a pluralistic society, of diversity and multiplicity of viewpoints, functions, cultures and lifestyles. Breaking such a system would mean convergence towards the omnipotent state overwhelmed by "dull and frightening conformity", which ultimately leads to a monolithic society, or what the author calls "feudalistic phantasmagoria. (p. 46) "
- The business of business is "making money, not sweet music" (p. 47). The functions of business and government should be clear andseparate, otherwise the dangerous result would be that the two coalesce in a single, unopposed and unopposable power.

Friedman's rhetoric draws much from Levitt's strand of ideas. In his two flagship publications (Friedman, 1962, 1970), he argues:

- In private-property system, a corporate executive's foremost responsibility is to conduct the business according to his employers' desires and goal which is generally to make as much money as possible.
- Involving corporations in social actions and public welfare poses a clear governance problem where the agent (the corporate executive) acts as a principal by spending the money of his employers, the time and energy he has contracted to devote to their purposes, to achieve non-profit-seeking goals. Therefore, "social responsibilities" should be the social responsibilities of individuals, not business.
- Corporate executives are not equipped enough (in terms of social welfare management skills) to solve social problems; they are rather versed in such functions as finance, marketing, selling and production. By engaging in CSR through, for instance, lowering prices to hedge inflation, reducing production levels for environmental reasons and so forth, they put the corporation at high risk of not being competitive enough at the global level.
- By spending on social welfare and charities, stockholders engage in "hypocritical window-dressing" because it serves their own self-interest from a taxation perspective. Indeed, instead of contributing directly to the charities they favor, stockholders will choose to do it through the corporation because such expenditures are tax deductible. As a result, the "cloak of social responsibility" is used as a mechanism for serving unadulterated self-interest in a way which is "approaching fraud".
- According to Friedman, this almost fraudulent way of using tax money is even more dangerous because, in doing so, the businessman is the one to "decide whom to tax, by how much

and for what purpose, and he is to spend the [tax] proceeds", which clearly interferes with the political duties of the government.

1.2.2 Arguments for CSR

As the reflection on CSR evolves, , the concept gains more acceptance among the sphere of business leaders and management scholars. The most frequently held arguments to support CSR are presented below.

1.2.2.1 CSR as a competitive advantage

CSR is posited to act as a powerful mechanism for value creation. It is argued, indeed, that alignment of social objectives with business objectives is the ultimate equilibrium for achieving a successful societal-profitability outcome. Management renowned academician Michael E. Porter casts light on this particular aspect by advising to use CSR as a lever for creating corporate competitive advantage. Porter et al. (2006) draw attention to the weakness that most schools of thought share, which is the focus on the tension between business and society rather than on their interdependence. The authors suggest the concept of "*Strategic CSR*" as an ultimate tool for corporations to achieve competitive advantage and long-term profitability. According to the authors, strategy is more than mere practices, and so is *Strategic CSR*. It is an approach of social management that goes "beyond good corporate citizenship and mitigating harmful value chain impacts to mount a small number of initiatives whose social and business benefits are large and distinctive. *Strategic CSR* involves both inside-out and outside-in dimensions working in tandem" –that is, integrating CSR to both the internal value chain and the external factors shaping business's competitiveness. In other terms, *Strategic CSR* posits that the more closely related a social issue is to a firm's business, the greater the opportunity to leverage the firm's resources and benefit society.

Sekhar Bhattacharyya (2010) builds upon Porter's business-society integration perspective, and presents an integrated conceptualization of a strategic CSR framework whereby the CSR programs that pass through the set of screens are evaluated based on some strategic characteristics and business gains. While companies are found to be generally less engaged in strategic CSR activities than non-strategic CSR ones, empirical evidence shows that the level of strategic CSR affects significantly positive companies' performance (measured by accounting financial performance, ROA) and that CSR activities that are aligned with companies' operations and strategy give positive impact on companies themselves (Sayekti, 2015).

1.2.2.2 CSR for long-term profitability

Several studies investigated the link between CSR and financial performance (CFP). The early econometric studies to examine this link appear in the late 90s and unveil overall mixed results. McWilliams and Siegel (2000)–somewhat hastily, explain this inconsistency by the misspecification of the models employed which don't "control for investment in R&D which has been shown to be an important determinant of firm performance" (p. 603). They conclude that "CSR has a neutral impact on financial performance". Many studies are conducted afterwards where the correlation between CSR and CFP is found to be either negative (Brammer, Brooks, & Pavelin, 2006; Seoki Lee, Singal, & Kang, 2013), neutral or non-significant (Fiori, Di Donato, & Izzo, 2007; Lenssen et al., 2005), or positive (Godfrey, Merrill, & Hansen, 2009; C.-H. Lin, Yang, & Liou, 2009; Tang, Hull, & Rothenberg, 2012).Van Beurden and Gössling (2008) wrap up the debate by presenting a holistic review of the literature examining the relation between corporate social and financial performance. They conclude that "Good Ethics is Good Business" and that there is clear empirical evidence supporting the positive correlation between CSR and financial performance. To date, research in this perspective continues to present evidence for an overall strong positive relation between doing good and doing well (Angelia & Suryaningsih, 2015; Rodriguez-Fernandez, 2015; Sayekti, 2015; Waworuntu, Wantah, & Rusmanto, 2014).

1.2.2.3 CSR as a key driver of innovation

If the social responsibility of business has long been perceived as an unwelcome intrusion into traditional management practices of the past century, researchers and decision makers increasingly acknowledge the reinforcing relationship between CSR and business innovation and growth. A recent study by Nidumolu, Prahalad, and Rangaswami (2009) exposes the five innovation stages that take place within an organization as a result of embedding the sustainability approaches into the corporate vision and mission. More specifically, innovation comes out at the early stage of compliance with CSR rules and regulations. The more sophisticated the company gets in its sustainability approach, the more innovative it is at the value chain level, then the product level. A higher innovation stage is reached when the business model is reshuffled to meet more sustainable goals, and the ultimate innovation stage is attained when managers start re-questioning the business boundaries and thinking outside of the "possible" achievable future.

1.2.2.4 CSR for enhanced customer relationship

The connection between societal practice and consumer behavior has been widely explored over the past decade. Recent research tends to intensify the connection between these two areas. It is found, in the banking sector for instance, that CSR activities offer banks higher client retention rates and a better image among its clients (Nehme & Aline, 2013), and that CSR activities exert influence on customer

purchase intention in cases where the customer was aware of such activities being conducted (Fatma & Rahman, 2016). In hospitality management, research shows that consumer satisfaction with green hotels is enhanced when a firm engages in green initiatives for public-serving (vs. self-serving) motives (Gao & Mattila, 2014).Martínez and del Bosque (2013), on their side, show that CSR associations do not only affect product evaluation, but also customer identification with the company, customer satisfaction and trust. More generally, corporate CSR activities impact upon consumers' purchasing behavior. K.-H. Lee and Shin (2010) demonstrate that there is significant positive relationship between CSR activities and consumers' purchase intentions. It is also found that CSR activities create and nurture consumers' trust in the company, which, in turn, brings about consumers' positive or improved perceptions of the firm (Park, Lee, & Kim, 2014).

1.2.2.5 CSR as a hedge against risk and crisis

It is argued that corporate social responsibility can function as a mechanism for hedging against risk and various forms of crises. Durmaz, Ateş, and Duman (2011) find that CSR can be used as a tool to cope with economic crises while Bansal, Jiang, and Jung (2015) use data records from 1,666 U.S. companies to analyze the facets of responsible management during a time of recession, more particularly, during the 2008-2009 global economic recession. The authors find that although strong corporate financial performance can counteract the negative impact of a recession, this tempering effect is stronger for strategic CSR –which comprises activities with long time horizons, large resource commitments and significant structural adjustments–than tactical CSR which consists of transactional activities with short time horizons and relatively few organizational resources. Governmental support for CSR activities can also yield substantial benefit for countries during recession times. In a recent study conducted over 25 countries during the 2000-2008 period, it is shown that " CSR firms are important for economic growth (positively affect growth) and that countries that strongly support CSR achieve higher growth rates. Specifically, countries without an organized and supportive CSR environment and guidelines can hardly expect to increase economy performance through the new growth channels generated by CSR companies (new markets and customers). (p. 562)"(Škare & Golja, 2014).

CSR can also operate as an effective risk management tool. Godfrey et al. (2009) present and test a CSR-based risk management model whereby they show that CSR activities create goodwill and offer "insurance-like" protection for companies carrying them out. Moreover, the authors demonstrate that this effect is stronger when companies participate in institutional CSR activities –those aimed at a firm's secondary stakeholders or society at large.

Another argument in favor of using CSR as a practical hedge tool is that it 'wards off government regulation' as it is assumed that "future government intervention can be forestalled to the extent that

business polices itself with self-disciplined standards and fulfills society's expectations of it. (p. 89) " (Carroll & Shabana, 2010).

1.3 International Norms and Standards

The social responsibility of business is not the only concept that caught the attention of global decision makers over the past decades. Sustainable development, or sustainability, has gained equal –if not greater– importance. Since the creation by the United Nations in 1983 of the World Commission on Environment and Development (WCED), an independent commission aimed at addressing the global environmental and social challenges, and which led to the publication of the famous Brundtland report, sustainability is on the agenda of nearly all governments and policy makers. The two constructs of CSR and sustainability are distinct yet highly intertwined. Defined by the Commission as the "economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Brundtland et al., 1987), sustainable development is more closely encompassing of the transnational endeavors to achieve growth while preserving the essential resources of the planet. In contrast, CSR is more focused on the corporate side of sustainability. It offers "some potential contribution to sustainable development because it brings incentives for corporations to act socially responsibly and this includes contributions to the sustainable development agenda" (Moon, 2007).In fact, "there is a trend to describe CSR as umbrella term for sustainability issues – especially in practice – sustainability science is becoming more diffuse"(Ebner & Baumgartner, 2006).

With the widespread expansion of sustainability thinking, the desire to establish reliable assessments of the changes in the global economic, environmental and social conditions is further reinforced. This led to the development of multi-level indicators, initiatives and regulations to help in the assessment, monitoring and reporting processes.

1.3.1 International Accountability Standards (IAS)

The growing interest in CSR and sustainability issues has led to the emergence, over the past two decades, of prolific ways to help organizations systematically measure, assess, and communicate about their societal activities and endeavors. Standards like the UN Global Compact, ISO 14001, the Global Reporting Initiative (GRI), and others, provide a set of rules aimed at standardizing firms' behavior with regard to social and environmental issues as well as at holding corporations accountable to their various stakeholders about their actions and omissions. These initiatives are labeled "International Accountability Standards" (IAS) and are defined as voluntary predefined rules, procedures and methods to systematically assess, measure, audit and/or communicate the social and environmental behav-

ior and/or performance of firms (Gilbert, Rasche, & Waddock, 2011). Although IAS are not binding by nature since they are not enforceable by law, they are not completely voluntary. This is due to at least three reasons: 1) these standards can turn into more binding rules in the future, 2) there is increased pressure for standard adoption in certain industries, constituting therefore a sort of barrier to entry for non-adopters, and 3) ignoring such standard can weaken existing stakeholder relations (Gilbert et al., 2011).

While policies and rules of conduct are defined at the firm level, IAS are some sort of "civil regulations" that are developed by third-parties in an increasingly globalized and interconnected world. The most important civil regulations are multi-stockholder codes, whose governance is shared by firms and non-governmental organizations (NGOs)(Vogel, 2008). There is no commonly agreed upon classification of IAS, and any attempt to do so should take into account the variation in content, scope and target audience of such standards. Nonetheless, Gilbert et al. (2011) propose a classification in four categories as follows: Principle-based standards, certification standards, reporting standards, and process standards. While the authors explain why some IAS fall under a given category, they do not fail to mention that categories are not mutually exclusive. In fact, overlaps might exist, such as the case of SA 8000 which is classified as a certification standard while it can also be considered as a process standard given that it defines management systems (and thus processes) which factories have to implement in applying this standard. This variation in classification is also found across literature papers. For instance, in a recent review of sustainability reporting tools bySiew (2015), the author defines the United Nations Global Compact as a sustainability reporting framework as opposed to Gilbert et al. (2011) who see it as a principle-based standard. Similarly, the same authors appear to differ on how to classify AA 1000, either as a process based standard (Gilbert et al., 2011) or as a reporting tool (Siew, 2015).

Building upon the classification by Gilbert et al. (2011), we put into perspective these most widely accepted IAS, highlighting, in addition, the area of focus (social, environmental and economic), the auditing/measurement capacity, and some more details (description, year of launch)[1](TABLE 1).

The emergence of IAS came in tandem with the development of sustainability indicators that complemented or fed into the above mentioned standards. The next section presents a brief introduction to the evolution of sustainability indices and a selection of the most widely accepted ones.

[1] The list of IAS in the table is not exhaustive and is based on the most frequently mentioned standards in the existing literature (Gilbert et al., 2011).

TABLE 1. CLASSIFICATION OF THE MOST WIDELY ACCEPTED IAS

Focus / IAS Class	Social	Environmental	Economic	Description	Operational launch	Performance auditing & measurement
Principle-based	UN Global Compact			Ten universally accepted principles focusing on human rights, labor rights, environmental sustainability and anti-corruption.	2000	No
	OECD Guidelines for MNEs			The Guidelines provide a more general framework for business behaviors and practice and focus on areas such as employment and industrial relations, human rights, environment, information disclosure, combating bribery, consumer interests, science and technology, competition and taxation (OECD, 2011).	1975	No
	Caux Round Table (CRT)			Founded by business leaders (in 1986), The CRT Principles for Business articulate a comprehensive set of ethical norms for businesses operating internationally or across multiple cultures. They are the product of collaboration between executives from Europe, Japan, and the United States(CRT, 2016).	1994	No
Certification	SA8000			One of the most widespread certification standards for compliance with workplace issues and basic human rights of workers ((SAI), 2016).	1997	Yes
	FLA Workplace Code			This code defines labor standards that aim to achieve decent and humane working conditions. The Code's standards are based on International Labor Organization standards and internationally accepted good labor practices ((FLA), 2016).	1999	Yes
		ISO14001		This standard maps out a framework that a company or organization can follow to set up an effective environmental management system. It can be used by any organization regardless of its activity or sector(ISO, 2016a).	1996	Yes
		Marine Stewardship Council (MSC)		International non-profit organization established to address the problem of unsustainable fishing and safeguard seafood supplies. MSC works with fisheries and businesses around the world and uses its ecolabel and fishery certification program to contribute to the health of the world's oceans by recognising and rewarding sustainable fishing practices and influencing the choices people make when buying seafood((MSC), 2016).	1996	Yes

Reporting	Global Reporting Initiative (GRI)	A dominant framework for sustainability reporting which attempts to provide a standardized framework for nonfinancial reporting that is akin to GAAP or generally accepted accounting principles for financial reporting ((GRI), 2016).	1997	No
	Sarbanes-Oxley Act	U.S. federal law that set new or expanded requirements for all U.S. public company boards, management and public accounting firms. It is aimed at reinforcing corporate governance and protecting shareholders.	2002	Yes[2]
Process	AccountAbility AA 1000	Series of standards providing organizations with an internationally accepted, freely available set of principles to frame and structure the way in which they understand, govern, administer, implement, evaluate and communicate their accountability (Göbbels & Jonker, 2003).	1995	Yes
	ISO 26000	Provides guidance that helps businesses and organizations translate principles into effective actions and shares best practices relating to social responsibility, globally. It is aimed at all types of organizations regardless of their activity, size or location (ISO, 2016a).	2010	No

[2] Unlike other IAS mentioned in the table, the Sarbanes-Oxley Act is mandatory for listed U.S. companies. Since its enactment in 2002, it has become a reference in addressing governance and agency issues.

1.3.2 Global SustainabilityIndices

The definition of sustainable development indicators has taken vital significance, especially following the Rio Earth Summit in 1992 whereby individual countries and international governmental and non-governmental organizations are called to "develop and identify indicators of sustainable development in order to improve the information basis for decision-making at all levels" (UNCED, 1992). Today, more than 500 sustainability indicator efforts are listed according to the International Institute for Sustainable Development (IISD). This prolific expansion of definitions of indicators encouraged the definition of composite indicators, or what is referred to as sustainability indices (SI)(Mori & Christodoulou, 2012). An impressive number of sustainability indices have emerged since the early 1970s (Nordhaus & Tobin, 1971; Osberg, 1985),which makes it only more complex for policy makers to make informed enough decisions about which index to take into account. This is due to two main reasons; first, authors of each SI enthusiastically advocate for the adoption of their measurement method, second, the analytical aggregation methods, although made transparent, are rarely explored by strategic decision makers at government and Corporate-level executive positions.

On the corporate side, the growing interest in sustainability has spurred investors' appetite for socially responsible and ethical investments. As such, numerous stock market indices have emerged in the major global financial places to provide investors with generally reliable benchmarks for socially responsible investments (SRI)(Fowler & Hope, 2007). These indices help investors identify listed companies that employ socially responsible business practices and present an assessment of the societal performance of such companies.

More generally, sustainability indices have been developed for as varied areas as human development, national markets, nations and regions, cities, industries, innovation, knowledge and technology, etc. Singh, Murty, Gupta, and Dikshit (2009) make a holistic overview of sustainability indices with additional focus on indices' formulation strategy, scaling, normalization, weighting and aggregation methodology.0showssome of the most widely accepted sustainable development indices.

Regardless of the widespread use of sustainability indicators globally, some authors question the usefulness of such indicators and their scientific viability. Böhringer and Jochem (2007), for example, argue that although sustainability indices are accredited for being concise and transparent "they fail to meet fundamental scientific requirements with respect to the three central steps of indices formation: normalization, weighting, and aggregation." The arbitrariness found in normalization and weighting of indices, coupled with the non-respect of some fundamental aggregation rules, makes these indicators "useless if not misleading with respect to concrete policy advice" (Böhringer & Jochem, 2007).

TABLE 2. MAJOR SUSTAINABILITY INDICES

	Sustainability Index	Origin& Date of launch	Companies/ Countries	Description
Stock Market Indices (Selection based on the work of (Fowler & Hope, 2007))	Dow Jones Sustainability Index	RobecoSAM and S&P Dow Jones Indices, 1999	Eurozone Asia Pacific U.S.A Australia Emerging markets	Family of indices which track the stock performance of the world's leading companies in terms of economic, environmental and social criteria. The indices serve as benchmarks for investors who integrate sustainability considerations into their portfolios (RobecoSAM, 2016).
	FTSE4Good Indices	FTSE and Russell, 2001	803 constituents in 25 countries[3]	Acronym for : Financial Times and London Stock Exchange. Index series designed to measure the performance of companies demonstrating strong Environmental, Social and Governance (ESG) practices (FTSE, 2016).
	Domini 400 Social Index	Ami Domini, 1990 (managed by KLD Research & Analytics)	USA	A market cap weighted stock index of 400 publicly traded companies that have met certain standards of social and environmental excellence[4].
	Calvert Responsible Index Series	2000	USA	Lists companies with strong sustainability profiles in the United States.
	ASPI Eurozone Index	ARESE, 2001	Europe	ASPI Eurozone Index tracks the financial performance of companies in the Eurozone that are leaders in sustainable business performance.
	Ethibel Sustainability Index	Ethibel, 2004	Europe	The Ethibel Sustainability Index contains a basket of companies that are evaluated according to four main criteria: internal social policy; environmental policy; external social policy; and ethical economic policy.

[3]According to FTSE Group as at 29 January 2016.FTSE Factsheet. Total Market Cap of constituents: USDm 31,078,706. (http://www.ftse.com/)
[4]Investopedia.Accessed February 3rd, 2016.

Non-Stock Market Indices (Selection adapted from Böhringer and Jochem (2007))	Human Development Index (HDI)	MahbubulHaq[5], 1990 (Adopted by UNDP)	156[6]	Index created to assess the development of countries not only from an economic standpoint but also from the human development perspective (UNDP, 2016).
	Ecological Footprint (EF)	Wackernagel and Rees, 1990[7]	152[8]	A data-driven metric that measures the impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated (WWF, 2016).
	Living Planet Index (LPI)	WWF, 1998	N/A	Index which measures the state of global biological diversity based on over 17,600 populations of more than 3,500 mammal, bird, fish, reptile and amphibian species from around the world (LPI, 2016).
	City Development Index (CDI)	UNCHS, 1996	125[9]	Index that measures the level of development in cities.
	Environmental Vulnerability Index (EVI)	SOPAC & UNEP, 1999	243[10]	Index developed through consultation and collaboration with countries, institutions and experts across the globe, designed to be used with economic and social vulnerability indices to provide insights into the processes that can negatively influence the sustainable development of countries (SOPAC & UNEP, 2016).
	Environmental Sustainability Index (ESI)	CELP, CIESIN, World Economic Forum 1999-2005	146[11]	A measure of overall progress towards environmental sustainability providing a composite profile of national environmental stewardship based on a compilation of indicators (published from 1999 to 2005) (SEDAC, 2016).

[5]The origins of HDI were devised by Pakistani economist MahbubulHaq in 1990 (from annual Development Reports of the United Nations Development Programme (UNDP)).
[6] UNDP Human Development Report 2015
[7]Global Footprint Network.
[8] According to the 2014 WWF-Living Planet Report.
[9] United Nations - Chapter 7 Epilogue p. 114-121 (data between 1996 and 2000).
[10]Number including nations and geographies such as Antarctica.
[11] 2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship. Yale Center for Environmental Law & Policy, New Haven.

	Environmental Performance Index (EPI)	CELP, CIESIN, World Economic Forum, European Commission, 2002	133[12]	An improved version of the ESI using outcome-oriented indicators to track environmental sustainability.
	Global Well Being Index	Gallup-Healthways, 2012	145[13]	Index to measure well-being worldwide.

[12]Pilot 2006 Environmental Performance Index.Yale Center for Environmental Law & Policy, 2006.
[13]According to the Gallup Healthways 2014 Global Well-Being Rankings Analysis.

1.3.3 CSR Global Labels

The increased interest in CSR issues by both corporations and their stakeholders has encouraged the development of national and regional certifications to recognize firms' efforts toward compliance with the principles of social and environmental responsibility. Numerous labels have emerged as a result of this evolution, pioneered either by private auditing firms, not-for-profit institutions, NGOs, or cross-national initiatives. To date, research examining CSR labels and certifications remains unexpectedly shallow given the substantial importance of the topic. Nonetheless, a few studies examined the link between CSR labels communication and consumers behavior such as the one by Mejri and Bhatli (2014) where it is found that communicating the "social quality" of the private label improves its perceived quality and the consumer's intentional loyalty to the brand and the retailer. A non exhaustive chronological list of some widely accepted CSR labels is presented in TABLE 3. The most salient measurement frameworks for CSR are looked at in detail in CHAPTER 2. .

TABLE 3. MAJOR CSR LABELS

Label	Year of launch	Organization	Country / Region	Description
NSF / ANSI	1944	NSF International	USA	A set of certifications to standardize sanitation and food safety requirements.
EcoLogo	1988 (Established) (acquired by UL in 2010)	Underwriters Laboratories	USA	ECOLOGO Certification is based on multi attribute, life cycle–based standards. It is classified as an ISO Type 1 ecolabel and has been successfully assessed by the Global Ecolabeling Network.
Green Seal Label	1989	Green Seal	USA	Green Seal utilizes a life-cycle approach to ensure tangible reductions in the whole environmental footprint. They are ANSI-accredited and meet ISO and GEN requirements.
Ecomark	1991	Government of India	India	A government operated seal of approval program for environmentally preferable consumer products.
ENERGY Star	1992	USA Government (Environmental Protection Agency)	USA	ENERGY STAR is a voluntary government-backed program dedicated to helping individuals protect the environment through energy efficiency.
Korean Ecolabel	1992	Korea Environmental Industry & Technology Institute (Government)	Korea	This ecolabel applies to as varied categories as appliances, building products, electronics, cosmetics/personal care products, transportation, textile, packaging, forest products, and others.
China Environmental Labelling	1993	SEPA	China	This label provides environmental standards for construction materials, textiles, vehicles, cosmetics, electronics, packaging, and more.
Tunisian Ecolabel	1997	CITET	Tunisia	This label was created in order to facilitate the access of Tunisian products and services to the European and International markets.
Green Tick	2001	Green Tick Certification Limited	USA	Independent sustainability certification of products, services, and corporations based on a life-cycle audit of performance against the Green Tick Sustainability Standards.
China Organic Food Certification	2002	China Organic Food-Certification Center (COFCC)	China	This is an organic food and product label whose mission is to promote the development of organic agriculture and food in China.

CASBEE	2002	Japan Sustainable Building Consortium	Japan	CASBEE (Comprehensive Assessment System for Built Environment Efficiency) is a Japanese assessment and certification tool for buildings that covers: Energy efficiency; Resource efficiency; Local environment; Indoor environment.
China Water Conservation Certification	2004	China Government	China	Water conservation label for Industrial Products; Agricultural Products; Residential Products; Unconventional Water Resources Utilization Products (62 different product categories).
Eco-Rail Mark	2005	Japanese Ministry of Land, Infrastructure and Transport	Japan	This ecolabel indicates certified products and companies that actively make an effort to protect the environment through a modal shift to rail transportation.
CEEP-CSR Label	2006	European Commission	Europe	CEEP represents employers and enterprises providing services of general interest supporting business, social and territorial cohesion, economic and social solidarity and a better quality of life for all citizens.
Label CGEM pour la RSE	2006	CGEM	Morocco	Awarded to more than 70 companies compliant with the CGEM CSR charter.
Label Lucie	2008	Vigeo&Qualité France Association	France	A label aligned to ISO 26000 standard for assessing, developing and rewarding organizational contribution to CSR.
SRI Label	2009	Novethic	France	European certification awarded to Socially Responsible Investment funds that integrate environmental, social and governance (ESG) criteria in their management.
Dubai Chamber CSR Label	2010	Dubai Chamber	United Arab Emirates	The label was presented to 137 companies in recognition for their CSR efforts.
Green Fund Label	2013	Novethic	France	European certification awarded to Socially Responsible Investment funds that integrate environmental, social and governance (ESG) criteria in their management.
FNG SRI Label	2015	FNG	Germany, Austria, Switzerland	Financial-product certification based on ESG criteria.

1.4 Sustainability: The Path Forward

In light of the review presented in sections 1.1 and 1.2, and taking a bird's view at CSR dynamics in various corporate contexts and fields of application, it becomes necessary to take a few steps backward and critically analyze the path forward for a concept that has raised such a large interest.

Critical management studies provide with a legitimate pool of ideas, concepts and analyses which are essentially helpful in the CSR context. Many authors examined the controversies arising from and with this concept, and help us, consequently, to unveil some important findings.

CSR is the whole and not the sum of parts. As pointed out by many authors (i.e.Porter and Kramer (2006) and Sekhar Bhattacharyya (2010)), a successful CSR strategy needs to be embedded into the core strategic orientations of the firm. Putting in place a program of disparate activities –regardless of how useful they are to the environment or society–and spending time and energy reporting and communicating about those activities does not amount to establishing CSR-based corporate level and business level strategies whereby societal considerations are deeply rooted in daily business processes and procedures.

CSR implementation is key. The literature on CSR implementation highlights several instances where the choice of certain approaches or programs yields the adverse effect and causes negative impact on firm's performance and profitability(Becker-Olsen et al., 2006; Sayekti, 2015; Sen & Bhattacharya, 2001; M.-W. Wu & Shen, 2013). A recent research by Tang et al. (2012) puts particular emphasis on this question by arguing that firm profits are shaped by *how* firms engage in corporate social responsibility. The authors empirically demonstrate that when a firm engages in CSR slowly and consistently, focuses on related CSR dimensions, and starts with internal dimensions of CSR, corporate financial performance will be enhanced.

CSR marketing can be tricky. As alluring as the concept of CSR might appear, it has a strong tendency to bring about confusion, especially if not marketed in an appropriate way. In a recent exploratory research, Perks, Farache, Shukla, and Berry (2013) find that CSR advertisements "contain a limited amount of substantial information and third-party associations, which reflects possible latent CSI [Corporate Social Irresponsibility] motives (p. 1881)." In another interesting paper byPrasad and Holzinger (2013), scholars are called "to account for how corporate marketing may be useful as a clandestine mechanism to lead to corporate social irresponsibility." Drawing on Zizek's theory of false consciousness of ideology(Žižek, 1989), the authors claim that "corporations may market CSR to further their own interests in ways that only offer the appearance of being responsive to the social and environmental concerns of the communities in which they are situated (p. 1920)." They conclude that "CSR may become –if it is not already there– a public relations invention with little, if any, positive

effect on social justice" and that "the marketing of CSR may be an example of corporations' flight from responsibility –or, the quintessential instance of social irresponsibility (p. 1920)."

CSR is not a one-size-fits-all concept. While CSR is a transverse concept that applies across various industries and areas of research, its application should be tailored to firms' specific concerns and contexts in order to yield positive outcomes. Research shows that the same CSR strategy does not function for all types of companies. In tourism management, for instance, it is found that hotel and restaurant executives may develop their overall CSR investments around community and product related issues, rather than employee relations, to maximize benefits of such investments over both short- and long-terms (Inoue & Lee, 2011). In contrast, it is found in the same paper that managers in the airline industry may focus their CSR initiatives on employee relations and product issues for the long term, not the short-term. In the consulting industry, an empirical study by Chaker, Janati Idrissi, and El Manouar (2015) suggests that in creating the firm's CSR strategy, decision makers should confer the highest priority to two focal aspects: building a sound and sustainable human resource policy based centrally on professional gender equality; and reinforcing ethics by working on reducing the number of ethical incidents through training and communication. Basically, as Porter and Kramer (2006) put it, two main reasons have prevented any efforts to improve firms' societal impact from achieving the desired goals. First, these efforts "pit business against society, when clearly the two are interdependent. Second, they pressure companies to think of corporate social responsibility in generic ways instead of in the way most appropriate to each firm's strategy (p. 78)."

This last point is of particular interest to the present research work. It is posited herein that for a firm's CSR strategy to be successful, this strategy should not speak in generic terms nor should it be modeled around a predefined template. Instead, managers and decision makers should mold their CSR programs based on some specific priorities inherent to their industries and business activities.

From CSR to Sustainability. At the time the debate is ongoing around the benefits of CSR and sustainability and on how these two concepts are closely intertwined, it is important to step back and highlight the fine lines that mark the differences and subtleties between the two. Several authors have explored the relationships between the two constructs. In a review of the literature, Ebner and Baumgartner (2006)find that a large portion of papers refers to CSR as the social strand of the stakeholder approach. In addition, it is found that many authors use the concepts of CSR and sustainable development interchangeably, which is clearly called back by the authors who argue that "terms should be used in their original semantic sense. Scientists, who use CSR synonymously for sustainable development or argue that sustainable development is the basis for CSR, mix up terms and alter their original meaning. (p.13)"(Ebner & Baumgartner, 2006). In clear terms, CSR involves applying the concept of sustainable development to the corporate world(Chand, Narwal, & Rani, 2015). Therefore,

it is recommended "using CSR as social strand of the [Sustainable Development]-concept which is mainly built on a sound stakeholder approach"(Ebner & Baumgartner, 2006).

This proposal is further consolidated by Porter & Kramer (2011) who introduced the "big idea" around the concept of Created Shared Value. In this approach which transcends the basic CSR view, firms should look at decisions and opportunities through the lens of shared value with local community clusters via product line and value chain reconfiguration. They should look to societal questions in value terms, and put in place long term strategies to create common wealth. As such, as soon as long term sustainable development is integrated into an organization's vision, it becomes a strategic driver of its activities, growth, and expansion, as opposed to a mere selection of programs and actions. Sustainability-based strategies can re-question the current business model and lead to a drastic revamping of how business is conducted throughout the value chain and supply chain.

In this view, we will be moving from the plain, almost weary, concept of CSR to a more genuine, more encompassing approach, embodied in sustainable development. And the once praised formula by which economic activity is essentially driven by short term profit maximization, carefully surrounded with isolated "islands" representing the weak stakeholders as not-much significant satellites of the main activity, becomes suddenly obsolete, almost prone to what some alert scientists would call *Corporate Social Irresponsibility* (Prasad & Holzinger, 2013).

In this view, indeed, the corporation's vision, culture and raison-d'être are rooted in eco-efficiency and sustainable development, and the weak stakeholders constitute an integral part of the business level and corporate level strategies. In this view, the company creates shared value with all ecosystem components (Porter & Kramer, 2011)and sustainability becomes a prized driver for innovation and uncontested long term success (Nidumolu et al., 2009) (Fig. 1).

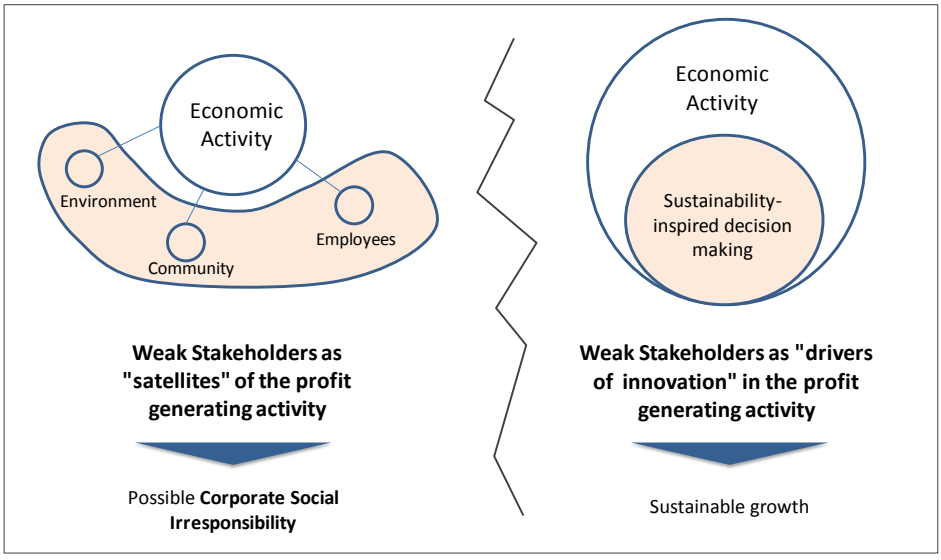


Fig. 1. Shifting the paradigm from CSR thinking towards Sustainability thinking

It is this view in which we must have hope. In a business world tainted with greed and short-term profit, managers need systemic frameworks that can help them reverse the trend and guide them in making informed and sustainability-driven decisions. With very few studies related to such frameworks, this thesis aims to fill the gap with a contribution on a more encompassing sustainability decision-aid approach.

Therefore, in this thesis, we fundamentally rely on the concept of sustainability as defined in the Brundtland report (Brundtland et al., 1987) to develop our framework. we might refer though, at times, to CSR when the case describes a context that is specifically tied to the concept, namely in the literature review.

More specifically, we propose a decision aid framework based on decision making techniques to help advise management, in a systematic approach, on the most appropriate sustainable growth strategy to be followed depending on the economic and business contexts in which their organization evolves.

The next chapter presents a holistic review of the decision making models and approaches used in CSR and sustainability management, then particular emphasis is put on one of these approaches and a critical evaluation of its construction methodology and underlying assumptions is conducted.

CHAPTER II:

SUSTAINABILITY DECISION AID FRAMEWORKS: REVIEW AND CRITICAL EVALUATION

CHAPTER 2. SUSTAINABILITY DECISION AID FRAMEWORKS: REVIEW AND CRITICAL EVALUATION

In this Chapter, we browse the foundational frameworks that have been used in sustainability assessment, monitoring and decision making. We consider frameworks used for both CSR and sustainability issues. Initially, we make a literature synthesis of these frameworks across the main areas of sustainable development decision making; namely energy, forestry and biodiversity, water management, supply chain management, and technology. This synthesis allows organizing the frameworks into two broad categories: those using operational decision modeling methods, and the ones relying on systemic (strategic)decision aid approaches. The following sections describe the most widely used methods and approaches within these two categories. Then, the focus is put more particularly on the SBSC, a systemic decision aid approach, in order to address it in more detail in the rest of the document.

Several reviews have been conducted over the past fifteen years on the tools and frameworks in sustainability decision making. In the following, we present a general synthesis of these detailed and well referenced works, arranged by sustainability area. The selected areas are those which are most frequently found in the literature, they are: Energy (with derivative names such as green energy, bio energy, renewable energy, etc.), Forest management (including biodiversity, natural resource management, soil management, etc.), Water management (including watersheds, rivers, fresh water management), Supply Chain management (with linked concepts as green supply chain, sustainable supply chains, green suppliers...), and sustainable Technology management.

In order to reap the largest benefit from the existing literature in an efficient way, the synthesis method consisted of reviewing the major literature review works that have been already published in referenced journals between 2002 and 2017. The aim of the synthesis is to depict the types and usage frequency of the various decision making frameworks and detailed methods that are sometimes embedded within. The resulting classification would be the starting point which will help to identify the strengths and deficiencies in the existing frameworks in the literature, and thus help us to focus on one or more frameworks for this research thesis.

The major decision aid frameworks can fall under two categories: operational decision aid methods and systemic decision aid approaches (Fig. 2). Operational methods help the decision maker solve a particular and a precisely formulated question inherent to CSR or sustainability. Examples include the measurement of the environmental impact associated with a given product's life cycle, the selection of the "best" green supplier based on a set of criteria, or the calculation of the sustainability score of a

given corporation, etc. Generally, operational methods make use of analytical formulae and lead to crisp results.

On the other hand, systemic approaches look into a system as a whole and aim to help in the understandingof the interrelations that govern the elements of that system. Establishing connections and behavioral rules of lower level elements makes it possible to draw patterns, make forecasts, and subsequently formulate a strategy.

In the coming sections, we describe decision aid models and methods for sustainability management that are cited in the literature by adopting the following classification: the class of operational modeling methods, which includes analytical techniques, sustainability performance evaluation systems and other operational methods; and the class of system thinking approaches, which includes feedback and emergent self-organization approaches, the sustainability balanced scorecard, and other systemic approaches (Fig. 2) (Chaker, Janati Idrissi, & El Manouar, 2017).

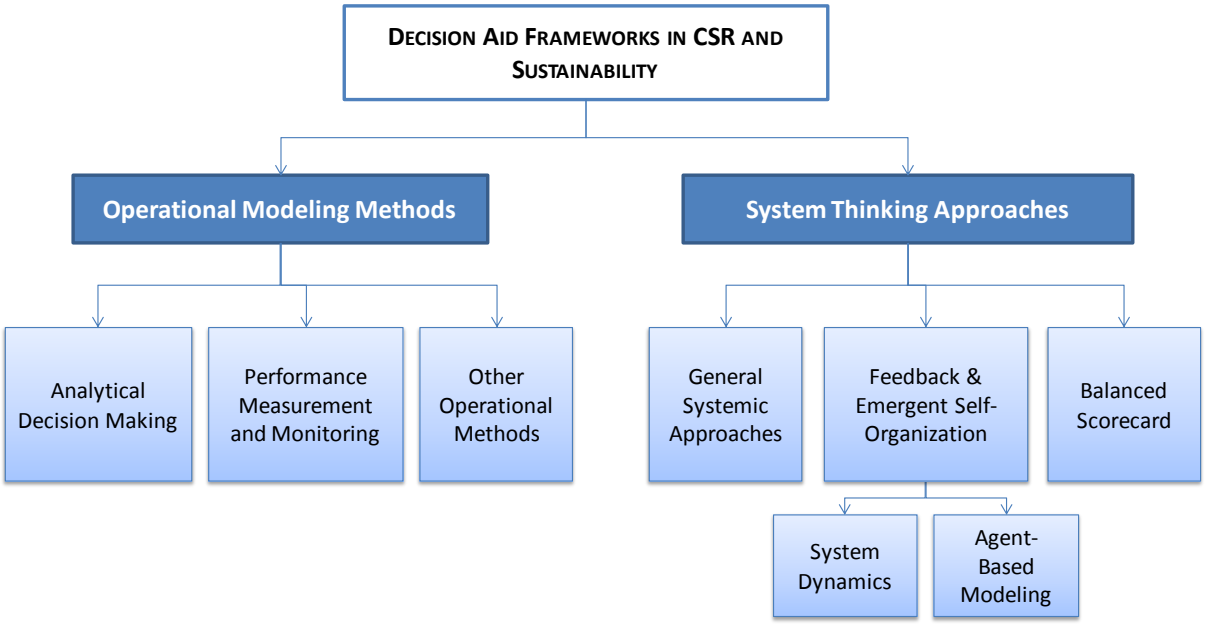


Fig. 2. Classification of the decision making frameworks in CSR and sustainability management

Generally speaking, the literature on sustainability decision making is more abundant with respect to operational methods as compared with system thinking approaches (Williams et al., 2017).

2.1 Operational Modeling Methods

The literature on operational decision making methods addressing sustainability and CSR issues is abundant, especially over the past two decades. Multiple decision aid techniques or their combinations have been used in various domains. We distinguish two main sub-classes of methods in this particular context: analytical decision making methods, typically multi-criteria decision methods addressing, among other things, selection and outranking problems; and sustainability performance evaluation systems including stand-alone and composite indices, and sustainability performance management systems.

2.1.1 Analytical Decision Making Methods

Research conducted on sustainability decision making problems is rich and diverse. When generally dealing with such questions as ranking CSR indicators, selecting the best 'green' supplier, or choosing the most appropriate sustainability program, multi-attribute decision making (MADM) methods become a natural fit. In other settings where the decision maker seeks to optimize a decision function or reach a certain goal, mathematical programming (MP) methods are rather more strongly used. Artificial Intelligence (AI) presents also an important set of techniques to address CSR questions. These methods are usually combined with one another to yield the best possible outcomes. Fig. 3 presents a general overview of the most widely used analytical decision making techniques in CSR and sustainability management.

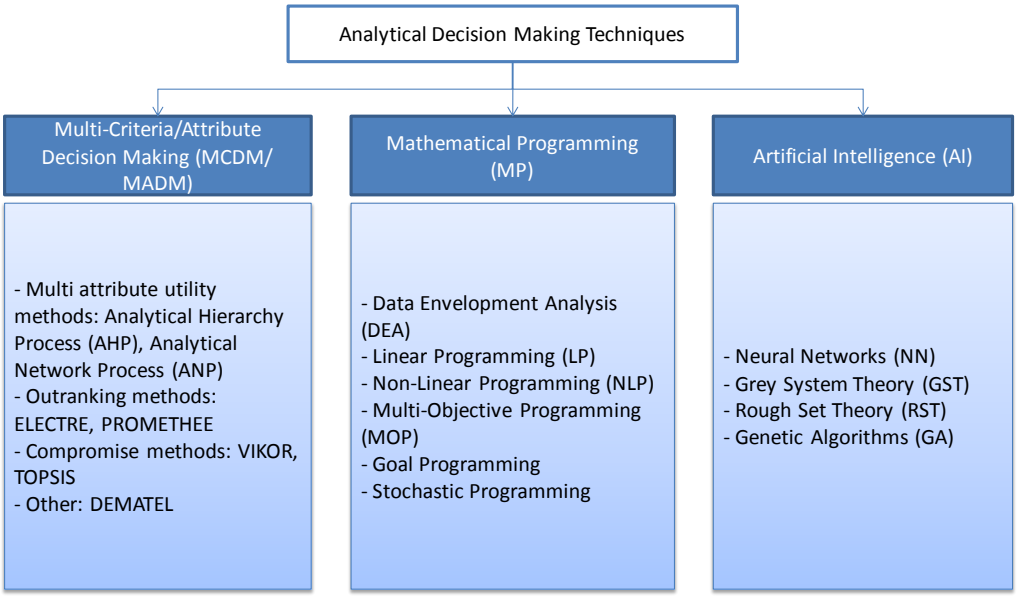


Fig. 3. Most frequently used analytical decision making techniques in CSR and sustainability

2.1.1.1 Multi-Criteria/Attribute Decision Making

These are the most widely used techniques in sustainability management. The literature presents a wide range of applications in different domains. In green supply chain management, for instance, Govindan, Rajendran, Sarkis, and Murugesan (2013) make a comprehensive review of the literature–published between 1997 and 2011 in international journals and conference proceedings–on the selection and evaluation of green suppliers. The authors find that more than 16% of journal articles reviewed propose the Analytic Hierarchy Process (AHP) method (including Fuzzy AHP) to select green supplier based on sets of criteria and attributes while 11% use the Analytic Network Process (ANP) method for the same goal. Multiple methods are used as well in forestry management. A literature review of over 250 references published in the period 1978-2008 reveals that multi-attribute utility methods are used in 43 references while AHP method is used in 56 references(Diaz-Balteiro & Romero, 2008). These methods are used to address such problems as forest biodiversity conservation, harvest scheduling problems, risk and uncertainty management, and forestry industry related questions, to name a few. Outranking and compromise methods are also employed in sustainability management issues such as in the study by Khalili and Duecker (2013) where the authors propose to build a sustainable environment management system using ELECTRE III (Elimination Et ChoixTraduisant la Réalité), the study by Shen, Olfat, Govindan, Khodaverdi, and Diabat (2013) which uses TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution)method to generate performance scores for green suppliers, or the work byChung and Lee (2009) combining a hydrologic simulation model with AHP and ELECTRE II to prioritize water management alternatives, to mention a few. Overall, Huang, Keisler, and Linkov (2011) make a holistic review of the multi-criteria decision making techniques used in environmental management sciences in the period between 2001 and 2011.

Decision Making Trial and Evaluation Laboratory (DEMATEL) method occupies an important place in sustainability decision making. It is widely used for its high adaptability to various fields of application. DEMATEL is employed in as varied areas as–but not limited to–green supply chain management(Büyüközkan & Çifçi, 2012; Gandhi, Mangla, Kumar, & Kumar, 2015; Hsu, Kuo, Chen, & Hu, 2013; R.-J. Lin, 2013; H.-H. Wu & Chang, 2015; K.-J. Wu, Tseng, & Vy, 2011), environmental sciences(Tsai & Chou, 2009; Tseng, 2009; Tseng & Lin, 2009), responsible mining (Govindan, Kannan, & Shankar, 2014; Muduli & Barve, 2013), ecotourism(Chang, Chen, Hsu, & Hu, 2015; Chuang, Lin, Chen, & Chen, 2013; Hsu, Kuo, Shyu, & Chen, 2014; Tsai & Hsu, 2008; Tsai, Hsu, Chen, Lin, & Chen, 2010), green manufacturing (Guo et al., 2015; R.-J. Lin, Chen, & Nguyen, 2011), and socially responsible consulting (Chaker, Janati Idrissi, et al., 2015).

These techniques are also frequently encountered in their fuzzy version. For example, Heo, Kim, and Boo (2010) use fuzzy AHP to analyze the assessment factors for renewable energy dissemination program evaluation. In another study, Kannan, de Sousa Jabbour, and Jabbour (2014)employ fuzzy Tech-

nique for Order of Preference by Similarity to Ideal Solution (TOPSIS) with green supply chain management practices to help select green suppliers for a Brazilian electronics company. Fuzzy DEMATEL is also used in sustainability decision making such as in the works byR.-J. Lin (2013), Tseng and Lin (2009), or Mehregan, Hashemi, Karimi, and Merikhi (2014), to name a few.

2.1.1.2 MP and AI Methods

A significant amount of research works have addressed CSR problems from either a Mathematical Programming (MP) or Artificial Intelligence (AI) perspective, or some combination of them. Data Envelopment Analysis (DEA), for example, is used in multiple areas of study includinggreen supplier selection (A. Kumar & Jain, 2010; R. J. Kuo & Y. J. Lin, 2012; Wen & Chi, 2010), CSR-based corporate ranking (Belu, 2009), or corporate sustainability measurement (K.-H. Lee & Saen, 2012). Compared to previously mentioned methods, Goal Programming (GP) is less frequently used in solving CSR related questions (Tsai & Chou, 2009; Tsai, Chou, & Hsu, 2009; Tsai & Hsu, 2008; Tsai et al., 2010), and even less applied are other mathematical programming methods.

With respect to artificial intelligence, few research papers highlight CSR and sustainability issues. For instance, in green supplier evaluation and selection, such approaches as Rough Set Theory, Neural Networks, or Genetic Algorithms are used each only once in all the research published on journal articles and conference proceedings between 1997 and 2011 (Govindan et al., 2013).

It is worth mentioning that a large set of research papers combined two or several decision making techniques in the sustainability context. Examples include the work by Tsai and Chou (2009) which uses DEMATEL, ANP, and Zero-One-Goal Programming to help select systems for sustainable development in SMEs; the study by Wen and Chi (2010) where AHP, ANP, and DEA are integrated to develop a green supplier selection procedure; or Liu et al.'s work where DEMATEL, ANP, and VIKOR are combined to improve sustainable tourism policy implementation (Liu, Tzeng, & Lee, 2012), to mention a few.

In addition, fuzzy set logic is frequently combined with individual or integrated methods such as in the study by Shaw, Shankar, Yadav, and Thakur (2012)who combine fuzzy AHP with fuzzy multi-objective linear programming in order to develop a low carbon supply chain, the research that combines fuzzy DEMATEL, fuzzy ANP, and fuzzy TOPSIS to evaluate green suppliers (Büyüközkan & Çifçi, 2012), or the study by Kannan, Khodaverdi, Olfat, Jafarian, and Diabat (2013) where the authors combine fuzzy AHP with fuzzy TOPSIS and multi-objective programming to establish an approach for green supplier selection while optimizing order allocation. Overall, the literature on the use of fuzzy MCDM methods in CSR and sustainability is extensive.

2.1.2 Performance Measurement & Monitoring

In this section, a brief review of the main models used in sustainability and CSR performance measurement is presented. These models can be classified in two sub-sets: performance measurement indices and comprehensive sustainability performance measurement systems (SPMS).

2.1.2.1 Stand-alone indicators and composite indices for societal performance measurement

Measuring corporate social responsibility and sustainability has raised accrued interest as of late. Building upon the observation that managers can improve only what they can measure, a series of attempts to surround the concept with numbers and frameworks has been made. It is important, at this stage, to differentiate between sustainability assessment –via indices– and CSR measurement within a corporation. Generally, sustainability indices are a representation of a collection of the best performing firms from both a financial and a sustainability perspective (Chapter 1.3.2). They are aimed at socially responsible investors and investment funds to present them with the least possibly biased evaluation of socially engaged corporations in a country or a region. For instance, The Domini Social Index screens large-capitalization US companies with significant financial and social performance and no significant revenue from such industries as alcohol, tobacco, gambling, nuclear power and weapons contracting. In contrast, sustainability and CSR assessment within firms and organizations is concerned with establishing models and defining indicators which track the daily performance of the organization subject to study in terms of sustainable development. This is generally directly linked to operations management, the organization's value chain, internal processes, or customer relationships. Since sustainability indices have been dealt with in a previous section (Section 1.3), we focus now on monitoring and measuring societal performance within firms and organizations.

A substantial amount of efforts have been made to develop CSR performance measurement tools and models. Stand-alone indicators give the performance levels of distinct areas or sub-areas of sustainability –for example, such indices measure separately carbon emissions, water consumption, or number of work-related incidents, etc. Various methods are used for the selection, weighting and calculation of sustainability indicators. In a holistic literature review, Ibáñez-Forés, Bovea, and Pérez-Belis (2014) summarize the different quantitative and qualitative methods for indicator construction in sustainable technological alternative selection.

Composite indices (CIs) bring a more comprehensive coverage of sustainability performance. They aggregate different single indicators into one measure, summarizing multidimensional concepts (Grupp & Mogee, 2004). They are useful decision making tools (Giambona & Vassallo, 2014) in as varied areas as manufacturing, energy, education, development, among others. While some authors rely on existing CSR measures provided by rating agencies (Ioannou & Serafeim, 2012), others devel-

op their own CIs. However, Paredes-Gazquez, Rodriguez-Fernandez, and de la Cuesta-Gonzalez (2016) argue that CIs are useful measurement tools only if they are constructed following a transparent process. The authors thus propose a theoretical framework on how to construct a CI based on the guidelines of the handbook of OECD for constructing CIs (Commission, 2008).

Among the authors who developed CIs to capture the essential information on societal performance isHubbard (2009)who proposes a single organization sustainability performance index (OSPI) to reflect the triple bottom line of a firm. Hubbard builds upon the balanced scorecard approach to suggest ratings for various components of the scorecard, before aggregating those into a single OSPI. Another interesting work is presented by Singh, Murty, Gupta, and Dikshit (2007) who propose a method for development of composite sustainability performance index (CSPI) that addresses the sustainable performance of steel industries along all the three pillars of sustainability –economic, environmental and societal. The authors use AHP method to weigh the various components of the CSPI which are also comprised of organizational governance and technical aspects as fourth and fifth dimensions of sustainability. A more recent work on developing a composite indicator for sustainability measurement is presented by Dočekalová and Kocmanová (2016) where the authors develop a Complex Performance Indicator aggregating 69 key performance indicators using multivariate statistical methods.

2.1.2.2 Sustainability performance measurement systems (SPMS)

As firms increasingly recognize the importance of sustainable development and social responsibility, the interest for sustainability measurement systems grew in parallel. The notion of corporate sustainability measurement has been discussed by many authors (for example G. Atkinson (2000), Beloff, Tanzil, and Lines (2004), and Wood (2010)). The literature on sustainability measurement provides insights on development processes of CSR performance measurement systems, selection criteria of sustainability indicators, the construction of composite indices, among others. In a holistic review of the literature on SPMS between 2000 and 2010, Cory Searcy (2012) frames the state of the art of corporate SPMS in three parts: 1) design of SPMS, 2) implementation and use of SPMS, and 3) evolution of SPMS.

A large array of research explored the development process of designing corporate SPMS. Authors likeZolfani and Saparauskas (2013), Chee Tahir and Darton (2010), Fernández-Sánchez and Rodríguez-López (2010), andSearcy, McCartney, and Karapetrovic (2007)worked on methods and framework for selecting or prioritizing sustainability indicators. The Global Reporting Initiative (GRI) provides a comprehensive set of sustainability indicators covering multiple sectors and industries ((GRI), 2016). Although criticized for not being a management tool, for being overly general and for presenting too many indicators (Smith & Lenssen, 2008), the GRI remains the most commonly referred to sustainability measurement initiative on a global scale. Overall, Moldan, Janoušková, and

Hák (2012) analyze the different approaches and types of indicators developed which are used for the assessment of environmental sustainability, putting particular focus on setting targets and then "measuring" the distance to a target to get the appropriate information on the current state or trend. Another group of authors focused on developing or adapting composite indices for sustainability measurement (see section 2.1.2.1). Finally, the literature highlights the category of research focused on building SPMS around the concept of the balanced scorecard. The main contributors in this area are Figge et al. (2002), Bieker (2002),Schaltegger and Wagner (2006), andHubbard (2009). More detail on this development approach with a critical analysis of related literature is presented in subsequent sections.

In terms of implementation and use of corporate SPMS, research is still in its embryonic stages (Searcy, 2012). The few authors that addressed this area of research include Searcy, Karapetrovic, and McCartney (2006) and Jørgensen (2008) who discuss the integration of sustainable development indicators with existing business infrastructure and management systems, and Adams and Frost (2008) and Searcy (2009) who explore the use of sustainability indicators in corporate planning, management practices and decision making.

As for the evolution of SPMS, there are relatively few publications that give insight into how the evolution of such systems should be accomplished (Searcy, 2012). Searcy et al. (2006) identified nine key steps to guide the evolution of a system of sustainability indicators, while Ramos and Caeiro (2010)developed a conceptual framework that "aims to evaluate how appropriate a set of sustainability indicators is and allow an evaluation of overall performance-monitoring activities and results".

Despite their usefulness in monitoring sustainability and CSR engagement of corporations, SPMS present some visible shortcomings, as pointed out by Staniškis and Arbačiauskas (2009) who note that the "biggest shortcoming of many existing sustainability performance evaluation systems is their focus on external reporting and underestimation of internal information needs for decision making, increased management effectiveness and actual performance improvement".

Finally, it is worth mentioning that some firms resort to internationally recognized and industry certified sustainability management systems, such as EMSs (environmental management systems) to measure their triple bottom line. For instance, one of the most widespread sustainability performance measurement tools is the ISO 14000 family, particularly ISO 14001, a leading EMS which registered 1 609 294 certificates issued worldwide in 2014 alone according to the 2014 ISO survey (ISO, 2016b). The same source indicates that in energy management, and during the same year, 6 778 ISO 50001 certificates were awarded of which 50% reported in Germany alone.

2.1.3 Other Operational Methods

Besides SPMS and composite indices, the literature on sustainability assessment provides with some other valuable techniques. Some of the most widespread are Life-Cycle Assessment (LCA) and Cost-Benefit Analysis (CBA).

LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (ISO14044:2006). There are four phases in an LCA study: a) the goal and scope definition phase, b) the inventory analysis phase, c) the impact assessment phase, and d) the interpretation phase. LCA has been widely used in recent publications; for instance, it represents 8% coverage of decision making works on green energy(Strantzali & Aravossis, 2016), and 26% of publications on water management decision making(Aivazidou, Tsolakis, Iakovou, & Vlachos, 2016).

CBA is the second most widely used method in this sub-category. CBA deals with the balance between the economic cost associated to a measure or a process and the environmental benefit or harm resulting from its introduction. In other terms, it reflects the relationship between the value created and the environmental effect involved in achieving it (Ibáñez-Forés et al., 2014). CBA has been used in various sustainability related fields (TABLE 4).

Other methods are being used in the CSR/sustainability assessment. They include, but are not limited to, Input-Output balance which consists of the evaluation of all the material and energy flows involved in the development of a process of system, and the configuration and analysis of the inventory of all the inputs and outputs of material, energy, emissions into the atmosphere, discharges and solid waste at each stage of the life cycle of the system (ISO/TS 14048: 2002). Another method uses Risk Assessment by determining the value of the risk associated with a certain system or process by calculating the magnitude of the possible losses and the likelihood of the damage occurring (UNE 150008, 2008[14]).

Overall, the literature synthesis on operational sustainability decision aid frameworks shows the strong predominance of analytical methods with a visible prevalence of CSR focused questions. MCDA techniques are generally more frequently used than other analytical methods while LCA and CBA are approximately as strongly prevalent as sustainability performance evaluation systems. We note that various individual methods are developed by scholars, they represent either general frameworks or a combination of existing ones (TABLE 4).

[14]UNE 150008 EX Spanish standard is a voluntary tool for the analysis of the environmental risk of organizations, whose scope includes the assessment of the human, socioeconomic and natural characteristics of the site's surroundings.

TABLE 4. DISTRIBUTION OF OPERATIONAL METHODS IN CSR & SUSTAINABILITY DECISION MAKING BASED ON THE MAJOR LITERATURE REVIEWS

			Operational Decision Aid Methods				
			Analytical Methods		***Performance Assessment***	***Other Operational Methods***	
Area	**Major Reviews**		*MCDA*	*Other analytical*	*SPMS/indices*	*LCA/CBA*	*Individual methods*
Energy	(Strantzali & Aravossis, 2016)		76 %	--	11 %	13%	--
Forestry Management	Diaz-Balteiro and Romero (2008) Ananda and Herath (2009)		100% *	--	--	--	--
Water Management	Aivazidou et al. (2016)		--	--	35% (WFA) 4% (ISO 4040/44/46)	26%	15% (individual) 20% (multiple)
Supply Chain Management	Tajbakhsh and Hassini (2015)		8%	3% (AI, MP) 14% (computational & statistical)	8%	--	18% (Empirical case study) 7% (Questionnaire) 26% (General frameworks)
Technology	(Ibáñez-Forés et al., 2014)	**Indicator calculation**	5%	13%	--	65% (LCA/CBA and similar methods)	17% (Expert judgment)
		Optimal alternative selection	68%	--	--	--	32% (Direct comparison)

* Based on the literature works cited herein.

2.2 System Thinking Approaches

While operational decision making methods prove effective in tactical management of sustainability, system thinking allows gaining a strategic overview and longer term perspective of the various dynamics that take place within and across systems. System thinking is a useful lens to understand change across scales (Williams et al., 2017). Scale is *"the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon,"* and elements of analysis are *"the units of analysis that are located at different positions on a scale"*(Cash et al., 2006).

Generally, pertaining to sustainability management, we can categorize system thinking approaches under three main sub-categories: general systemic approaches, feedback and emergent self-organization approaches, and the Balanced Scorecard approach. While feedback loop modeling and emergent self-organization are accepted as systemic thinking approaches (Williams et al., 2017), the Balanced Scorecard naturally fit as well into this class given the overarching representation it makes of the interconnectedness existing within organizational components thanks to cause-effect chains (Kaplan & Norton, 1996a).

2.2.1 General Systemic Approaches

We refer by general systemic approaches to some well-known system examination approaches that have been developed specifically to tackle sustainability issues. These approaches are developed by international organizations and are summarized by Meyar-Naimi and Vaez-Zadeh (2012). They include, among others, Pressure–State–Response (PSR), Driving Force–State–Response (DSR), Driving Force–Pressure–State–Impact–Response (DPSIR), Driving Force–Pressure–State–Effect–Action (DPSEA), and Driving Force–Pressure–State–Exposure–Effect–Action (DPSEEA). These frameworks were developed to analyze such sustainability issues as environment, energy, and resource management. TABLE 5 provides an overview of these frameworks.

TABLE 5. GENERAL SUSTAINABILITY SYSTEM THINKING FRAMEWORKS

Framework	Issuing Organization	Date of Launch	Purpose
PSR	OECD	1970	Analyze environmental issues (land use, ecosystems, natural resources, etc.)
DSR	United Nations Commission on Sustainable Development (UNCSD)	1998	Provide a consistent set of indicators and to assess progress towards a sustainable energy future
DPSIR	European Commission	1999	Evolution of PSR framework to further analyze environmental problems (e.g. sustainability assessment of subsurface ground water protection, CO_2 capture from power plant, etc.)
DPSEA & DPSEEA	World HealthOrganization (WHO)	1993	Model the linkages between environment and human health.

Supplementary frameworks have been also proposed with fewer applications. They include Pressure–State–Impact–Response (PSIR) and Pressure–Carrying Capacity–State–Response (PCCSR) (Meyar-Naimi & Vaez-Zadeh, 2012).

While the abovementioned general frameworks are frequently encountered in the literature, there are a few other general systemic approaches including disparate attempts individually developed by authors on particular cases in order to understand and interconnect the sustainability components within a given system.

2.2.2 Feedback & Emergent Self-Organization

Feedback loops describe the interconnectedness existing within a system. They represent the "secondary effects of a direct effect of one variable on another" causing a "change in the magnitude of that effect. A positive feedback enhances the effect; a negative feedback dampens it" (Walker & Salt, 2012). Emergence occurs in complex systems when novel higher level structures and patterns arise due to interaction between lower level systems variables (Rotmans & Loorbach, 2009).

In this section, the most widely accepted decision aid modeling approaches representing feedback and emergence are presented, namely System Dynamics (SD) and Agent Based Modeling (ABM), respectively.

2.2.2.1 System Dynamics

System Dynamics (SD) is a methodology introduced by Jay W. Forrester in the mid-1950s for conceptualizing the complex interrelations between elements of a system and assessing how these elements progress within and impact upon the entire system over time. Because our world involves many complexities, it is not always obvious to comprehend systems and make sense of the intertwined relationships that govern them. Complexity can be combinatory, arising from the links among, and the number and scope of elements in the system, or dynamic, resulting from the dynamic aspect of those elements and thus their counterintuitive behavior over time (J. Sterman, 2000). System Dynamics Modeling brings the advantage of modeling this complexity by combining the technical grounding from mathematics and engineering with the nonlinearities of social sciences, organizational behavior, and psychology. As such, models are constructed by incorporating various elements that could affect the system either from the inside or the outside, including those variables that could wrongly be overlooked because no historical data is available, for example. Indeed, omitting such variables is equivalent to saying they "*have zero effect, which is probably the only value that is known to be wrong*" (Forrester, 1961).

System dynamics modeling is based on the concepts of feedback loops and Causal Loop Diagrams (CLD). A CLD is a graphic representation of the relationships and feedback loops among the elements of a system. In a feedback loop, a component may impact upon another one and cause it to change. The impact is transferred to other components along the loop, causing the change to occur back into the originating component (Hannon & Ruth, 1994). In addition, when the change throughout the loop causes to strengthen the originating element, the loop is reinforcing, otherwise, it is called a balancing loop (Hannon & Ruth, 1994). A CLD also highlights the polarity of the impact created. Positive (+) or negative (-) signs are placed next to each arrow indicating the type of impact. A positive link indicates that "*if the cause increases, the effect increases above what it would otherwise have been*"(J. Sterman, 2000). Likewise, a negative link indicates that "*if the cause increases, the effect decreases below what it would otherwise have been*"(J. Sterman, 2000). By modeling the feedback loops on a simulation software using appropriate variables and equations, it is possible to view the results of the intricate links created in the system and to simulate the future behavior of each component of the model.

Another central concept of the SD approach is the stock-flow diagram. Stocks represent the accumulations within the system, either tangible or intangible. An example of a tangible stock is inventory, or the number of trained workers. An intangible stock could be the level of employees' motivation or customer satisfaction. Flows symbolize the rate of change in the system. They are represented by inflows - which augment the level of the stock, or outflows - which reduce the level of the stock. Examples of flows are the daily production rate, or the monthly number of trained workers. When put together, stocks and flows of a system constitute the stock-flow diagram. In general, the mathematical relation between stocks and flows is represented by the following integral form (J. Sterman, 2000):

$$\text{Stock}(t) = \int_{t0}^{t} [\text{Inflow}(s) - \text{Outflow}(s)]ds + \text{Stock}(t0)$$

where t0 is the initial time, Stock (t0) the stock level at the initial time, and t the current time. ds indicates the change in the time variable between the initial time and the current time, Inflow(s) and Outflow(s) represent respectively the information coming into and going out of the stock at time s. In the stock-flow diagram, connectors are arrows linking the system's components to each other and transmitting information throughout the system using linear or non-linear equations (eg. Fig. 4).

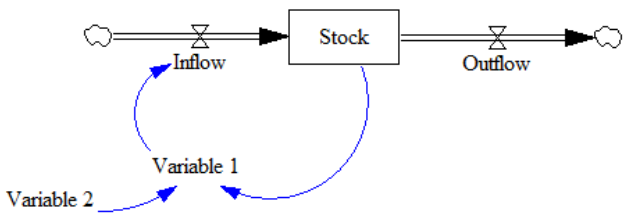


Fig. 4. Example of a stock-flow chart

The SD approach brings the main advantage of helping to overcome the limitations of mental models. In fact, as advanced as our understanding of the world could be, research has shown that the human mind is unable to make sense of the intricacies that link numerous elements of a system to one another and how these links unfold in time. Controlled experimental research has confirmed the limitations of our mental models (Brehmer, 1992; Kleinmuntz, 1993; J. D. Sterman, 1989). As J. D. Sterman (2001) put it, "*Our mental models are limited, internally inconsistent, and unreliable*." (p.10) " *Where the world is dynamic, evolving, and interconnected, we tend to make decisions using mental models that are static, narrow, and reductionist. Among the elements of dynamic complexity people find most problematic are feedback, time delays, stocks and flows (accumulations), and nonlinearity*." (p.11) Both system dynamics researchers and cognitive psychologists have agreed that the human mind "*cannot mentally simulate any but the simplest models without error*" (p.10) (Doyle & Ford, 1998). The response came from industry specialists and system dynamics researchers who developed computerized simulation models to help overcome the limitations of mental models-based decision making. System dynamics provides, indeed, a structured approach of conceptualizing system complexities and simulating the evolution of their intrinsic relationships over time.

In critically analyzing the design process of SD as a strategic decision making approach, Chaker, El Manouar, and Janati Idrissi (2015) argue that since our mental models prevent us from simulating complex systems with an acceptable degree of accuracy, then they must also be distorting our processes of constructing the business dynamics models supposed to help resolve these complexities. They could, for example, prevent us from realizing the very existence of some non-obvious relations among variables in the SD model. As demonstrated by existing research, it is often assumed that events have a single major cause, and as soon as this first sufficient cause is identified, people stop short of considering other potential causes (Plous, 1993). Research has also shown that our representation of the world depends on the way we look at, think about, and act upon systems, more particularly, SD modeling depends on the modeler's points of view and understanding of the context subject to study (Vázquez & Liz, 2011) causing a subjectivity bias to occur. This bias is further emphasized when defining the model's equations, especially those related to qualitative and intangible variables for which no solid historical data might exist. The authors thus propose a systematic method for constructing SD models employing MCDM technique DEMATEL (Chaker, El Manouar, et al., 2015).

SD is essentially based on simulation and has been used in as varied fields as, but not limited to, industrial processes (Dong et al., 2012), forestry projects management (Machado, Conceição, Leite, de Souza, & Wolff, 2013), supply chain management (Georgiadis & Besiou, 2008), and sustainable development (Sora Lee, Geum, Lee, & Park, 2012; Saysel, Barlas, & Yenigün, 2002).

2.2.2.2 Agent-Based Modeling

Agent-based modeling (ABM) is the computational study of social agents as evolving systems of autonomous interacting agents (Janssen & Ostrom, 2006). The key feature of agent-based modeling is that it involves a bottom-up approach to understanding a system's behavior. While traditional models take a top-down approach in which key aggregated variables are scrutinized in the real world and then reconstructed into a model, agent based modeling looks into the properties of each individual agent and how the behavior of these individuals gives rise to the aggregate result (Twomey & Cadman, 2002).

According to Macal and North (2010), an agent based model is composed of agents, interactions, and the environment. In addition, to build and run the model, a computational engine is needed. An agent is a self-contained, modular and uniquely identifiable individual. It is autonomous, self-directed, can function independently, and has a state that varies over time. An agent has also attributes (e.g. age, sex, preferences) and behaviors (e.g. actions based on decision making algorithms such a utility maximization). The attributes and behaviors may not only vary across agents in the model but they may also change within agents during the simulation. For example, an agent-based model may incorporate genetic algorithms or neural networks within the agents which allow the agents to learn throughout the simulation (Macal & North, 2010). As much as agent based modeling is concerned with defining and modeling agents, it looks into modeling the relationships and interactions between those agents. In this regard, the modeler specifies who is, or could be, connected to who, and by which rule or mechanism (Macal & North, 2010). Finally, the modeling environment is used to provide information on the spatial or geographic location of an agent relative to other agents (Macal & North, 2010). For example, in Schelling's segregation model (Schelling, 1971), which aims at understanding social segregation in American cities, the environment is a grid where inhabitants (agents) are located (everyone within a separate box). An inhabitant's neighbors are the ones located in immediate surrounding cells.

Multi-agent systems (MAS) have been largely used in diverse application areas. As far as sustainability is concerned, ecosystem management received significant interest as summarized in the review by Bousquet and Le Page (2004) where the authors argue that MAS are useful for problems integrating social and spatial aspects. The authors also discuss how MAS can be used for several purposes, from theorization to collective decision-making support. More recent studies continue to leverage the modeling possibilities offered by MAS to address sustainability related questions such as the work byBenDor, Scheffran, and Hannon (2009)where a model is constructed for understanding the dynamics of competition and cooperation in the fishery activity in rural coastal areas. MAS is also used in sustainability assessment of resource sharing in freight transport (Furtado & Frayret, 2015), as well as in sustainable urban management (Pijoan, Borges, Oribe-Garcia, Martin, & Alonso-Vicario, 2015), and land use optimization allocation (H. Zhang et al., 2016), to mention a few. At a firm decision mak-

ing level, Chaker, Aaminou, El Manouar, and Aboulaich (2015) explore the CSR dynamics of consumers in a simulated market from a game theoretic perspective featuring the prisoner's dilemma and highlighting the irrational components of human decision making pertaining to peer pressure and behavioral psychology. Overall, the area of research at the crossroads of engineering, mathematics, simulation, and the nonlinearity of social and behavioral sciences offers a profusion of research opportunities that can still be considered as largely unexplored, especially in the field of CSR.

2.2.3 The Balanced Scorecard (BSC)

2.2.3.1 The "What" and the "Why"

Historically, performance management systems have been used to monitor a firm's performance based on existing financial reporting systems for their reliability and direct relationship to the economic bottom line. However, management scientists have long criticized such systems arguing, for example, that "*financial performance measures lack the requisite variety to give decision makers the range of information they need to manage processes*" and that "*performance measurement systems based primarily on financial performance measures lack the focus and robustness needed for internal management and control*" (A. A. Atkinson, Waterhouse, & Wells, 1997). Another study concluded that "*There's a growing concern...that financial measures are inadequate tools for strategic decision making*." (Brancato, 1995).

In 1992, Kaplan & Norton introduced the Balanced Scorecard (BSC) as an instrument for monitoring organizational performance from a wider angle than the traditional financial viewpoint. The authors realized that existing performance management systems presented two main limitations. First, standard financial ratios usually relied on in accounting and financial statements present a snapshot of the firm's past achievements as opposed to current or future performance. Therefore, they are not a dependable indicator of how the firm is likely to perform in the future. Second, strategies usually follow a top-down pattern and are hard for employees to translate into clear measures they can readily make sense of. TheBSC approach proposes to evaluate the firm not only from the financial perspective, but also from "softer" perspectives. This approach is based, in fact, on the assumption that capital investment is no longer the only determinant of firms' success, instead, such factors as customer satisfaction, innovation ability and adaptability are more and more viewed as essential elements of a firm's long term success. Kaplan and Norton suggested that in addition to the finance perspective, organizations should screen three more perspectives: learning & growth, internal processes, and customer relationship (Kaplan & Norton, 1996a) (Fig. 5).The BSC's dimensions can be briefly summarized as follows:

Financial perspective: Being the most traditionally used tool for measuring corporate performance, financial ratios reflect the firm's economic achievements. They are based on historical data and follow strict measurement patterns and rules. In the BSC, the financial perspective indicates whether the

transformation of a strategy leads to improved economic success (Figge et al., 2002). Measures chosen in this perspective should reflect the product or service life-cycle stages which are summarized by Kaplan and Norton (1996a) as rapid growth, sustain, and harvest. Examples of ratios are sales volume, return on investment, economic value added, and revenue volume.

Customer perspective: This perspective describes the firm's customer value proposition via a set of objectives, measures, and initiatives reflecting how the firm wants to be perceived by its customers. It defines the market segment and reflects the positioning that the firm desires to have to be competitive in the marketplace. Examples of measures in this perspective include customer satisfaction, customer retention, new customer acquisition, market positioning, and market share.

Internal Processes perspective: This perspective focuses on the internal production or service processes that take place throughout the value chain. It reflects the firm's ability to adapt, change, and innovate. Examples of metrics here are quality, error rate, cost, and product to market lead time.

Learning & Growth perspective: This perspective helps to measure the strength of internal capital including human capital, information capital and organization capital. Measures here pertain to employee motivation, training and progress, the information systems, databases and networks, and the corporate culture and leadership. Internal capital represents the infrastructure that drives performance and allows the firm to achieve the three dimensions above (Kaplan & Norton, 1996a). Common measures here include employee satisfaction and information system availability.

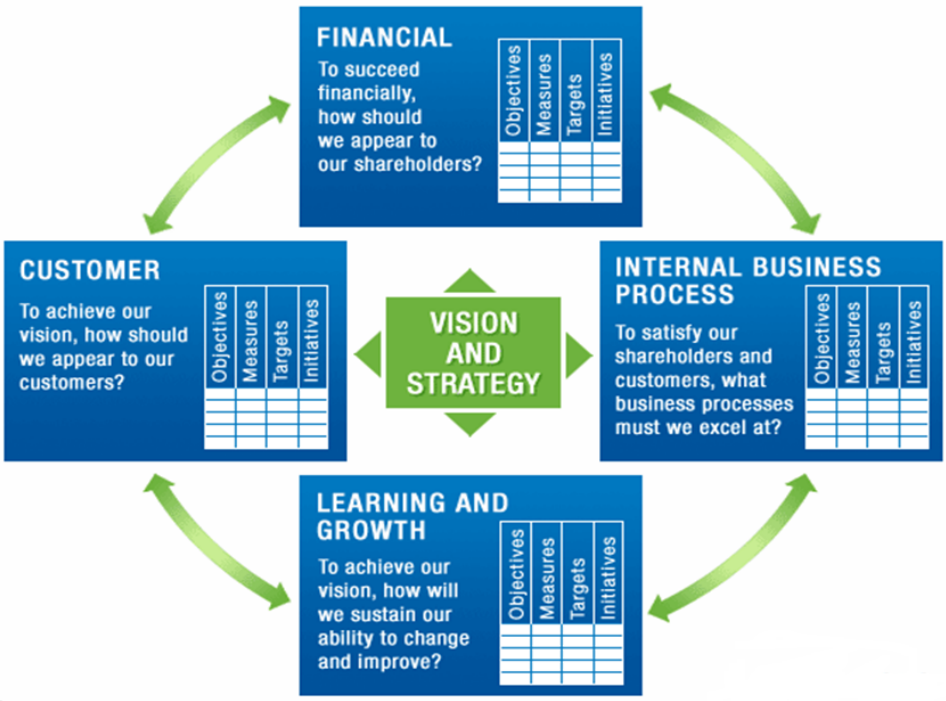


Fig. 5. The Balanced Scorecard framework(Kaplan & Norton, 1996a).(Image:Learn.com)

By including, in addition to financial ratios, such metrics as customer loyalty, knowledge availability, activity improvement, etc., the BSC can be considered as a "*strategic control system*" (Mooraj, Oyon, & Hostettler, 1999) which presents a more balanced and holistic view of organizational performance. With both financial and non-financial key performance indicators at hand, managers are able to provide consistency between the aims of the organization and the strategies undertaken to achieve those aims. The BSC allows decision makers to more fairly balance the needs of shareholders and stakeholders. By simultaneously looking into what makes investors, employees and customers satisfied, managers go beyond pure economic considerations to include the softer aspects that can affect competitive advantage and long-term profitability. AsKaplan and Norton (1996b) put it: "*The Balanced Scorecard provides managers with the instrumentation they need to navigate to future competitive success*". It *"... addresses a serious deficiency in traditional management systems: their inability to link a company's long-term strategy with its short-term actions*" (Kaplan & Norton, 1996a). In a study conducted by Mooraj et al. (1999), the authors demonstrate that the BSC is a "*necessary good*" for today's organizations. They show that the BSC does "*improve on current systems in a variety of ways. It provides relevant and balanced information in a concise way for managers, thereby reducing the time for 'digestion' of information and increasing the time for decision making*."

Nevertheless, the BSC has been mainly criticized for involving an overly subjective assessment of strategy drivers by managers. More precisely,A. A. Atkinson et al. (1997), who view the BSC as a performance measurement tool based essentially on "*one output of strategic planning: senior management's choice of the nature and scope of the contracts that it negotiates...with its stakeholders*", claim that the "*performance measurement system is the tool the company uses to monitor those contractual relationships*". Therefore, the authors argue that the BSC fails to:

- Adequately highlight employees and suppliers' contribution to achieve strategic objectives.
- Clearly identify the role of the community in defining the environment within which the firm evolves.
- Present performance as a two-way process by which not only the firm can assess stakeholders' contribution to achieving corporate goals, but also stakeholders can measure and assess the extent to which the firm is responding to their demands now and in the future.

From a conceptual perspective, critics are concerned with the unclear and often ambiguous concept of causality, and the complexity and time involved in the BSC's development (Akkermans & Van Oorschot, 2005). For example, Barnabè (2011) contends that a particular limitation of the BSC is that "*it basically considers unidirectional cause and effect linkages; it does not consider time delays and suffers from relevant limitations both in the design phase and in its implementation and use*." (p.447) In addition, although the framework has gained substantial publicity amongst research and management circles, executives fail to see the tangibles benefit they can reap from it. In fact "*many BSC im-*

plementation processes fail and therefore, [authors] have begun to focus on the limitations, consequently suggesting alternative or complementary approaches able to overcome [the BSC's] flaws." (Barnabè, 2011)(p.452).

2.2.3.2 Linking the BSC to Strategy: The Strategy Map

In order to execute strategy, executives need to communicate to their subordinates, in a detailed yet concise way, appropriate information about the vision, the objectives, the business environment, the possible threats and opportunities that might be encountered. Strategy maps allow executives to undertake such a task employing a visual representation of key objectives and how they relate to each other in order to achieve the firm's strategy. According to Kaplan and Norton (2000), strategy maps provide a tool for organizations to communicate both their strategy and the systems and processes needed to implement that strategy. They "*give employees a clear line of sight into how their jobs are linked to the overall objectives of the organization, enabling them to work in a coordinated, collaborative fashion toward the company's desired goals*." (Kaplan & Norton, 2000).

In addition to highlighting the strategic objectives of the firm, strategy maps emphasize the cause-effect relationships among those objective, showing "*how an organization will convert its initiatives and resources—including intangible assets such as corporate culture and employee knowledge—into tangible outcomes*." (Kaplan & Norton, 2000). The authors argue that the best way to construct a strategy map is to adopt a top-down approach. They posit that executives should start with understanding their core values and mission statement in order to translate those into a vision statement, and derive, consequently, the strategic objectives that allow them to achieve that vision. Managers then adopt a backward thinking process whereby they identify the causes –or performance drivers– for the above-mentioned objectives and draw cause-effect links between them.

According to its protagonists, the strategy map is constructed based on the Balanced Scorecard's (BSC) framework. In a strategy map, the financial perspective is placed at the highest level and is considered to be the ultimate objective of the firm. Therefore, executives should start by defining the financial objectives they desire to achieve. Then, managers define thecustomersvalue proposition that best fits the financial goals. The latter clarifies the key differentiators that the firm needs to adopt to appeal to its target market segment. From that stage, the firm can determine the operational means by which it will achieve both its customer value proposition and its financial targets. This corresponds to the internal processes perspective of the BSC. Finally, the learning and growth perspective comes at the bottom, representing the foundation of the map. Valuing employees and empowering them with the necessary infrastructure helps to achieve operational excellence, which allows to establish successful customer value proposition and a strong brand name, thereby driving long-term financial performance (Fig. 6). This representation of the firm's strategic goals allows to highlight the importance of

intangible assets and how they can create measurable value while translating into tangible outcomes (Kaplan & Norton, 2000, 2004a).

More practically, through the concept of the strategy map, the purpose of the BSC is to establish a hierarchy of objectives and indicators linked to one another with cause-effect relations to express the long-term goal of the firm. In this sense, Kaplan and Norton (1996a) distinguish between *leading indicators* and *lagging indicators*. Lagging indicators represent the long-term objectives that the firm aims to achieve. They characterize the strategic core issues within each perspective of the scorecard. In contrast, leading indicators are the root causes allowing the lagging indicators to be achieved. In this respect, leading indicators are very firm specific and are closely related to each perspective and business context. Managers are required to define strategic goals, and accordingly, specific objectives and indicators for the BSC. Then, they identify the leading and lagging indicators for each perspective of the scorecard. By formulating the strategy as a top-down approach starting with the financial perspective down to other perspectives, and employing the cause-effect chain of links between indicators, the firm understands which indicators are clearly responsible for its financial long-term performance. This chain of linkages is maintained by the fact that a lagging indicator of a lower perspective becomes a leading indicator of the perspective above (Fig. 6).

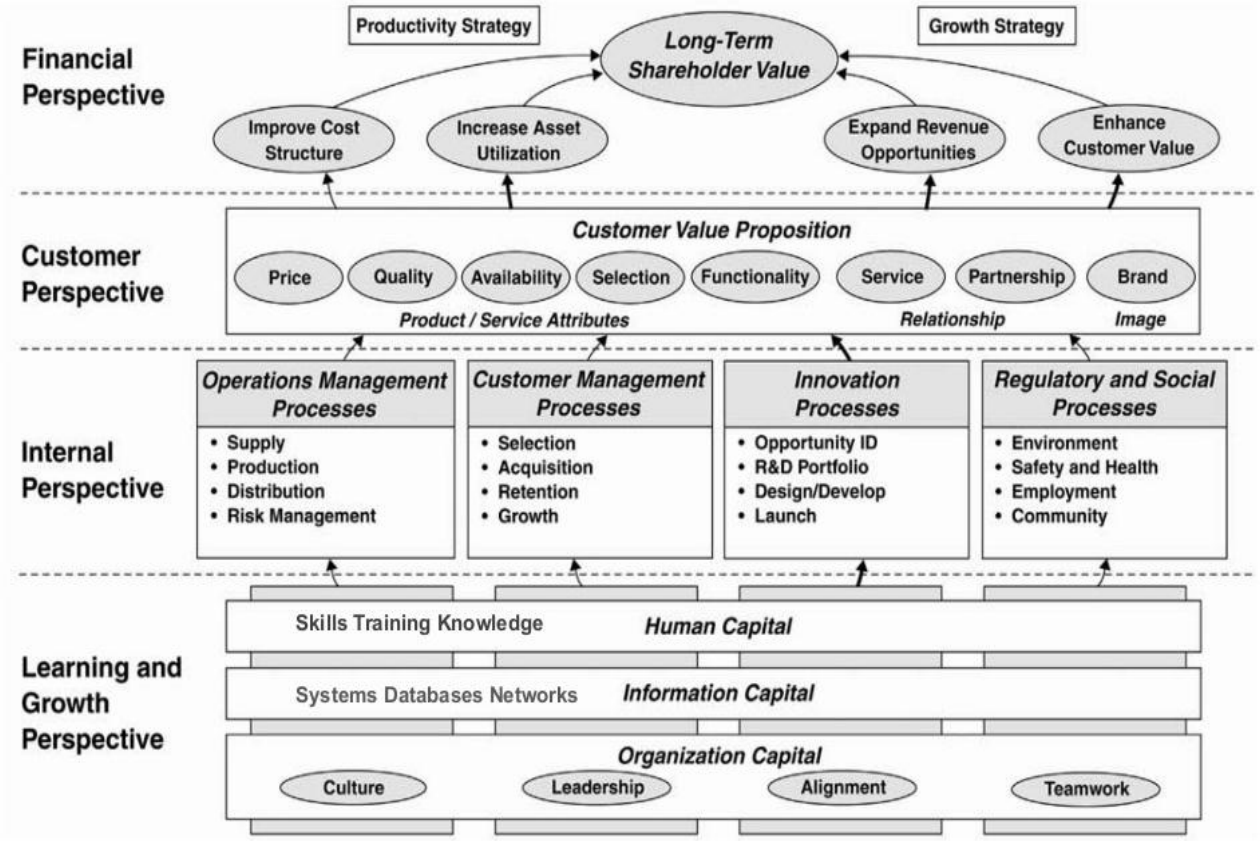


Fig. 6. The Strategy Map: Converting intangible assets to tangible outcomes(Kaplan & Norton, 2004b)

2.2.4 The Dynamic Balanced Scorecard (DBSC)

The visible limitations of the BSC approach has led researchers to explore ways of overcoming some of them. Barnabè (2011), for instance, explicates the strengths and shortcomings of the BSC, and outlines the necessity to incorporate the BSC approach with System Dynamics thinking. In fact, this combination had already been explored in earlier works mainly via case studies (Akkermans & Van Oorschot, 2005; Rydzak, Magnuszewski, Pietruszewski, Sendzimir, & Chlebus, 2004; T. Zhang & Gao, 2008) where authors explain by example the benefits accrued from applying system dynamics tools to the BSC. David Norton once wrote*: "dynamic systems simulation would be the ultimate expression of an organization's strategy and the perfect foundation for a Balanced Scorecard"*(Norton, 2000) (pp 14-15).

The resulting decision aid system is denoted the Dynamic Balanced Scorecard (DBSC).

Despite the extensively addressed advantages of the DBSC, some strategic limitations are encountered. In fact, few studies investigated these conceptual limitations relating mainly to design and implementation of the DBSC. In fact, many approaches fail to involve bidirectional or multidirectional relationships among indicators. In addition, the causal loop diagram is not necessarily derived using methodological steps with little subjectivity bias (TABLE 6). The main features of the DBSC and how they are addressed by existing literature works are summarized below (TABLE 6).

TABLE 6. MAJOR FEATURES ASSOCIATED WITH THE DBSC CONSTRUCTION METHODOLOGY

	Features of DBSC construction						
Major research works	Dynamic scorecard with a simulation case study	Methodological construction of the Strategy Map	CLD generated using intuitionist mental models	CLD generated using objective methodology	Multi-directional relationships	Quantification resolution of ambiguous relationships	Overcoming Systemic mental models
Rydzak et al. (2004)	√		√		√		
Akkermans and Van Oorschot (2005)	√	√ (from CLD)	√		√		
Bianchi and Montemaggiore (2008)	√		√ (from strategy map)				
T. Zhang and Gao (2008)	√	√	√ (from strategy map)		√		
Capelo and Dias (2009)	√		√		√		√ (partially via strategy map review)
Barnabè (2011)	√		√		√		

2.2.5 The Sustainability Balanced Scorecard (SBSC)

2.2.5.1 Concept and standing

With the growing concern about sustainability and the social responsibility of business, researchers and practitioners turned increasingly interested in developing methods to introduce the sustainability component into existing management systems. Among these efforts is introducing the "sustainability ingredient" to the Balanced Scorecard, being one of the most popular system modeling approaches. Several attempts have been made by researchers and practitioners in "greening" the BSC, and the literature provides with a rich panel of design architectures. The resulting framework is denoted the Sustainability Balanced Scorecard (SBSC).Today, the SBSC is gaining increased interest both from scholars and practitioners due mainly to the rising need to incorporate sustainability strategies into business development and monitoring.

In the coming subsections, we choose to make a detailed focus on the SBSC, to review its construction methodologies, and to critically evaluate them. We think this is a thoughtful and timely choice. Indeed, in earlier sections of this chapter, we show that operational methods for tactical sustainability decision making are abundant. However, one quickly realizes that a mature understanding of sustainability issues requires adopting a holistic multidisciplinary approach that brings together economic, political, social and ecological issues. Such an approach can only come about within a system thinking methodology that addresses sustainability across all its dimensions. Being one of the most popular system thinking approaches that clearly incorporates the sustainability element, the SBSC seems a strong candidate. The importance of this framework, coupled with some still unexplored research avenues −namely the time dimension and the classical BSC limitations (section 2.2.3.1), and contrasted with the relatively shallow literature on systemic approaches (Williams et al., 2017), has spurred our interest in further analyzing the SBSC across all its design and implementation dimensions. The focus of this research thesis is then shifted to developing a robust SBSC modeling methodology and testing its relevance with a concrete application on a real-life case study.

The following subsection describes the major works concerned with designing the SBSC. It is then followed by a critical analysis of the main advantages and limits of these works.

The main research studies that addressed the design of the SBSC appeared in the late 1990s and early 2000s. While some papers deal with the SBSC design as pertaining to a specific case, industry, or field of research, others attempt to develop methods that are strictly theoretical and independent of a particular case. A recent systematic review of the literature on SBSC architectures pinpoints 69 papers that addressed this question (Hansen & Schaltegger, 2016). These papers will be considered for critical evaluation. In this work, we opt to introduce in more detail only a few which are most referred to in

the literature, and which present a clear conceptual design framework. Below are brief descriptions of these major contributions to the reflection on designing the SBSC.

2.2.5.2 Major Works in developing the SBSC

The following works are those we selected for detailed analysis:

M. Epstein and Wisner (2001): Good Neighbors. Being among the first who incorporated sustainability thinking into the BSC, the authors of this study suggest using the BSC approach as an effective tool to help managers "*establish clear links between corporate resources for an S&E [social and environmental] strategy and the bottom-line payoffs*." Authors propose to incorporate social and environmental (S&E) performance metrics within each of the four quadrants of Kaplan and Norton's BSC (Fig. 7). They highlight the importance of cascading those metrics down to strategic business units (SBUs) and functional units of the firm for increased efficiency. The paper shows case studies from two international giants in the pharmaceutical and consumer goods industries respectively: Bristol-Myers Squibb and Unilever as an illustration of the importance of cascading metrics down the corporate ladder.

ENVIRONMENTAL	SOCIAL	ENVIRONMENTAL	SOCIAL
Financial		**Internal Process**	
<Environment related financial metrics>	<Social related financial metrics>	<Environment related internal process metrics>	<Social related internal process metrics>
Customer		**Learning & Growth**	
<Environment related customer metrics>	<Social related customer metrics>	<Environment related learning & growth metrics>	<Social related learning & growth metrics>

Fig. 7. Sustainability Balanced Scorecard framework for social and environmental impacts (M. Epstein & Wisner, 2001)

Figge et al. (2002): Linking Sustainability to Business Strategy. In this work, the authors discuss the BSC as the most preferred tool to incorporating environmental and social aspects into the main management system of a firm. They propose three possible approaches of integrating environmental and social aspect to the BSC:

i. *Subsumption approach*: whereby strategic social and environmental indicators are identified for each of the four existing perspectives of the BSC and then integrated to them. These indicators become, as such, an integral part of the system and its chain of cause-effect links.

ii. *Additive approach*: where it is suggested to add a fifth non-market perspective to the BSC. The authors argue that in order to integrate strategically relevant social and environmental (non-market) components to the market-oriented BSC, it might be necessary to augment the latter with an additional non-market dimension, especially when these strategic components cannot be reflected in the four existing perspectives at the same time according to their strategic relevance.

iii. *Social and environmental scorecard*: the authors propose as a third approach to derive a distinct scorecard specifically for social and environmental performance monitoring. They stress that this approach is only an extension of the two variants discussed above since such a scorecard cannot be developed in parallel to the conventional scorecard.

Figge et al. (2002) propose a procedural way of constructing the SBSC at the strategic business unit (SBU) level. After choosing the business unit, managers identify the BU's social and environmental exposure and the strategic relevance of social and environmental aspects. This step should be indicative of whether an additional dimension should be added to the BSC. Leading and lagging indicators are then defined for each perspective (Fig. 8).

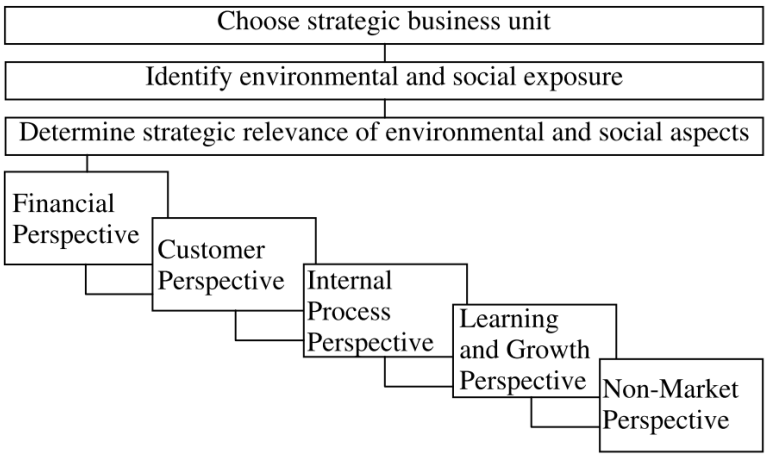


Fig. 8. Process of formulating a SBSC (Figge et al., 2002) (p. 277)

Gminder and Bieker (2002): The Integrated SBSC. In this work, authors propose three approaches to constructing the sustainability BSC (SBSC):

i. *Stand-alone SBSC plus "integration later" approach*: The SBSC is considered as a stand-alone tool for sustainability-related departments for the purpose of organizational learning, planning and reporting. The SBSC, at this stage, is considered barely "virtually existing" as it is not integrated to the corporate management system and the existing BSC on corporate or business unit level.

ii. *Integrated SBSC approach*: Four integration types are proposed. 1) Partial integration where only one or two social or environmental objectives and indicators are integrated. 2) Additional integration which consolidates social and environmental aspects into one separate dimension. 3) Complete integration whereby social and environmental indicators are integrated to each of the four existing perspectives of the scorecard. 4) Total integration which is based on adding a fifth dimension to the BSC besides integrating social and environmental indicators to scorecard's four perspectives.

iii. *SIGMA sustainability scorecard*: This approach does not consider adding a fifth dimension to the BSC, but suggests instead revising the financial and customer perspectives by incorporating ecological aspects and stakeholder considerations to these dimensions respectively.

The authors also discuss the social aspects and suggest that the BSC can be used to integrate them by leveraging top management transparency, communication, and serious involvement in tackling CSR issues.

Bieker (2002); Bieker and Waxenberger (2002): BSC for Integrity Management. The authors discuss the use of the BSC for sustainability management, more particularly, they sketch a conceptual model for managing integrity with the BSC. In addition to addressing the traditional perspectives of the BSC, the authors suggest adding ethics management and ethical auditing to fully respond to stakeholders requirements. They conclude that sustainability development is a process, not an outcome. Basically, it isproposed to gradually integrate the aspects of ecological, social and ethical considerations across all levels of the BSC.

Sidiropoulos, Mouzakitis, Adamides, and Goutsos (2004): The Eco-Balanced Scorecard. Authors of this research propose to add a fifth dimension to the existing BSC to address ecological issues. While separate from existing perspectives, the new dimension is linked to them and equally important. The additional Eco-perspective is related to issues such as energy and waste consumption, material use, pollutant emissions etc... The strategic objectives of the eco-perspective are set according to the concept of industrial ecology and are linked to measures that could be derived from environmental management systems like ISO 14001 and the life cycle analysis of products.

Dias-Sardinha and Reijnders (2005): The Thematic BSC. This paper proposes to use a thematic SBSC based on the traditional BSC. Basically, the first two dimensions of the BSC are significantly modified. First, the financial perspective is broadened to a triple bottom line perspective including social and environmental objectives, measurements and initiatives alongside the financial ones. Second, the customer perspective is changed to stakeholders perspective incorporating the needs of internal and external stakeholders.

Hansen, Sextl, and Reichwald (2009, 2010): The Community-enabled BSC (CeBSC). The authors develop a generic model for community-enabled BSC to encourage corporate community involvement as a proxy for the concept of CSR for small and medium sized companies or local units of MNCs. The authors use the action research methodology to best capture the context and needs of the case company. The resulting CeBSC is developed based on a set of interviews with local managers and decision makers.

Hubbard (2009): A Single Indicator.In this work, the author discusses the various conceptual approaches to measuring sustainable organizational performance. He concludes that the BSC offers the best suited approach. He suggests adding a non-market component to the scorecard as a unique composite indicator. Drawing from various triple bottom line metrics, the author proposes a simple aggregation method to deduct the OPSI (Organization Performance Sustainability Index).

Sundin, Granlund, and Brown (2010): A Top-Down Approach. The construction of the BSC here follows a top-down approach whereby the authors derive the scorecard's perspectives from the company's vision statement and corresponding priorities. Then perspectives are categorized into *enablers* (or cause perpectives) and *outcomes* (effect perspectives) based on experience and best judgment. The authors integrate the social and environmental components within the BSC's defined perspectives and do not consider adding a separate one.

Hsu, Hu, Chiou, and Chen (2011): MCDM to construct the SBSC. In this paper, the authors use fuzzy Delphi method (FDM) coupled with Analytic Network Process (ANP) method to construct a sustainability BSC for companies in the semiconductor industry. Sustainability metrics are defined for each perspective, then the top ten most important ones are systematically selected.

Wati and Koo (2011): Green IT BSC. This work proposes the construction of a green IT oriented BSC by slightly modifying the traditional BSC. Although this work is limited to the technological aspect of sustainability, it shows in a sufficient degree of detail how the technological component interrelates with business strategy and serves the ultimate bottom line. The perspectives used in the proposed scorecard are the financial, stakeholders, process, and future orientation.

Nikolaou and Tsalis (2013): The GRI-based SBSC. This research reviews some of the weaknesses presented by previous attempts to constructing the SBSC and proposes alternatively a SBSC approach based on the Global Reporting Initiative's (GRI) indicators. The authors use the same perspectives as those of the conventional BSC and propose a scoring technique for evaluating indicators and overall organizational sustainability performance. The scoring is based on an aggregation of (a) an accountability indicator that measures the comprehensiveness and completeness of sustainability information based on GRI indicators and (b) a performance indicator that presents the evolutionary route of per-

formance for each GRI indicator as obtained from published sustainability reports. The total score is then calculated for each perspective of the SBSC.

2.2.5.3 Critical Evaluation and Analysis

The major works concerned with the design of sustainability BSC (SBSC) (section 2.2.5.2) present an interesting grounding for a deeper reflection on the functions and strategic aims of a SBSC. Overall, each of the above discussed works presents a clear conceptual structure and enriches the existing literature from a different perspective. TABLE 7 summarizes the design structure, strengths and limits of these works.

Taking a closer view, the existing research in the area of SBSC design can be classified into three categories as shown below:

1. ***Add Only approach:*** In this category, authors focus on integrating the sustainability aspect by adding one or more perspectives to the standard BSC. Each perspective represents a specific aspect such as the social or environmental dimension. In this category, sustainability metrics belong exclusively to the added perspective(s) and are not found in other perspectives of the scorecard. The authors who propose this approach areHubbard (2009) andSidiropoulos et al. (2004). Note thatGminder and Bieker (2002) and Figge et al. (2002)suggest using this additive approach when the sustainability dimension is strategic to the firm or to the business unit.

2. ***Integrate Only approach:*** This approach is based on the idea of integrating sustainability metric into all four dimensions of the existing balanced scorecard without bring any structural modification to the latter. As such, the four standard perspectives (Kaplan & Norton, 1996a)are preserved and social and environmental indicators are interspersed across. Authors like Nikolaou and Tsalis (2013)and (Sundin, Granlund, & Brown, 2010)propose this design approach with real data on specific case studies. In addition to integrating social and environmental metrics,Bieker and Waxenberger (2002) propose to integrate as well ethics related measures across the BSC as a tool for integrity management. Gminder and Bieker (2002)have proposed this design structure as a conceptual framework.

3. ***Add and Integrate approach:*** Finally, some studies(Dias-Sardinha & Reijnders, 2005; Hsu et al., 2011) addressed the sustainability BSC design issue by augmenting or restructuring existing BSC's perspectives alongside adding sustainability indicators across the system. In these studies sustainability related dimensions are either added and merged with existing dimensions, or simply added separately. In an early work, Gminder and Bieker (2002)have conceptually proposed this approach.

TABLE 7. STRENGTHS AND LIMITS OF THE MAJOR CONTRIBUTIONS TO SUSTAINABILITY BALANCED SCORECARD DESIGN

Reference	Construction Method	Strengths	Limits
M. Epstein and Wisner (2001)	1. Start with defining key S&E performance metrics. 2. Translate these into the BSC framework. 3. Cascade the metrics from headquarters to divisions, SBUs, EH&S (Social and Environment, Health & Safety), and support functions. 4. Create customized scorecards per SBU to reflect their individual market and operational challenges.	• Forces managers to define S&E metrics for each level of the BSC • Integration of S&E considerations throughout the value chain (all four aspects of the BSC) • Focuses on cascading the BSC through SBUs and functional units, which allows to cover all organizational levels	• Particular focus on Social and Environmental (S&E) responsibility. The components of ethics and governance are not discussed. • Does not show how metrics relate to one another and lead to the ultimate bottom line. Seems like a loose collection of good, but somewhat scattered, indicators. • End up with too many metrics as opposed to a concise snapshot of the organization's sustainability performance.
Figge et al. (2002)	1. Determine SBU. 2. Determine exposure of SBU to S&E aspects. 3. Determine strategic relevance of S&E aspects and decide of whether a fifth dimension should or should not be added. 4. Integrating indicators to all perspectives.	• Procedural method. • Discusses when and how social and environmental aspects have strategic relevance to the business unit.	• Limited to social and environmental aspects. • Proposes a scorecard for every SBU, which could result in a selection of disparate scorecards that yet need to be connected to one another to make sense of the whole corporate strategy.

Gminder and Bieker (2002)	1. Corporate vision and mission. 2. Clarify sustainability strategies. 3. Deduct sustainability objectives. 4. Identify causal relationships. 5. Define indicators, targets and measures. 6. Integrate into core management system.	• The four approaches of the integrated SBSC present a well structured framework which gives solid grounding for developing a SBSC. • Theoretical background is supported with workshops and fieldwork with partner companies.	• Does not specify what the term "sustainability strategies" cover: does it mean actions, programs, or roadmap? How is a sustainability roadmap drawn? • Does not specify –as is the case for the BSC approach in general–*how* the cause-effect relations are established. • Does not tackle *how* defined indicators will be integrated into the existing management system.
Bieker and Waxenberger (2002)	1. Commitment of top management to sustainability. 2. Set goals, vision and mission. 3. Define guiding principles for the company. 4. Consider the public as a partner and a referee in the sustainability development process. 5. Empower employees, raise awareness about, and integrate in daily business, social, environmental and ethical concerns. 6. Include ethical metrics to account for key stakeholders. 7. Develop ethical indicators to measure the "ethical performance" of a firm. 8. Establish ethical auditing as a means of controlling and feedback.	• Addresses the aspect of ethics and integrity management from a philosophical perspective and a business perspective. • Discusses in relevant detail each step of the process.	• Presents the SBSC creation process as an *art* drawing basically from philosophical and social science backgrounds. This process is surely purposeful but nonetheless complex with no straightforward "ready-to-use" formula for usually very busy business executives. • Does not specify how the SBSC should be practically designed –whether there should be an additional perspective for ethics or society for example.

Sidiropoulos et al. (2004)	1. Start with the conventional BSC, and add a new perspective for ecology management. 2. Define indicators for the new perspective based on pre-existing environment management frameworks and systems.	• Highlights the ecological dimension in sustainability assessment.	• Assumes that green behavior should be planned and assessed at the operations/manufacturing strategy level. • Does not address the social aspect of sustainability. • Does not address ethics and governance.
Dias-Sardinha and Reijnders (2005)	1. Design the traditional BSC. 2. Add governance, social and environmental indicator categories to the financial perspective (Triple bottom line perspective). 3. Add internal and external stakeholder indicator categories to the customer perspective (stakeholder perspective). Introduce ethical aspects. 4. Add social and environmental measurements to the remaining two categories.	• The triple bottom line perspective is more comprehensive than the single financial dimension. • Attending to the needs of stakeholders as a whole allows to cover the entire value chain requirements in terms of social and environmental considerations. • The conceptual model is supported with real market data from 13 Portuguese companies.	• Ethics management is addressed as part of the stakeholders perspective whereas this aspect is actually omnipresent across all organizational dimensions (Bieker & Waxenberger, 2002). • Governance is addressed at the highest level of the BSC –considered as a result indicator–whereas it could be the cause of the success or failure of businesses–a cause indicator (S. Johnson, Boone, Breach, & Friedman, 2000; Mitton, 2002).
Hubbard (2009)	1. Start with the conventional BSC and add two quadrants for social and environmental performance to end up with six quadrants. 2. Define performance indicators for each quadrant. 3. Determine a rating on a scale (1 - 5) for each indicator. 4. Average indicators' ratings for each of the six components into a single rating. 5. Average the overall ratings into a single performance index (OPSI). 6. Follow the same steps with prior year data and compare.	• Simplicity of design, easy to replicate. • One single indicator to be tracked by managers.	• Does not specify which indicators to use in the composite index. How are they selected? Which ones are most important? • Does not clarify the aggregation methodology of the composite index. What are the weighs used? How are they calculated? • A single indicator is generally not reflective enough of how well the company is doing in each area of sustainability. A good performance in one area can compensate a bad perfor-

			mance in another area, which can mislead decision making.
Hansen, Sextl, and Reichwald (2009, 2010)	1. Determine the overall integration option of the social perspective. 2. Create the non-market perspective (community perspective). 3. Decide to keep community-related goals in the community perspective. 4. Define input, output and impact community metrics.	• The general structure of the BSC is determined before the metrics (indicators) are defined (general to detail orientation). • Authors distinguish between input, output and impact community-related metrics and include them to the BSC. • Allows to incorporate community involvement in corporate strategy.	• The relationships between metrics are not systematic and rather established based on subjective judgment. • The triple bottom line is not wholly achieved (the environmental component is missing).
Sundin et al. (2010)	1. Define the strategy statement and the vision. 2. Translate the vision into broad goals. 3. Determine the criteria for the goals to be achieved. 4. Extract corresponding priorities. 5. Conclude the areas in which the priorities will be measured. 6. Turn the areas into BSC perspectives. 7. Define metrics for each perspective.	• The focus on balancing the needs of multiple stakeholders. • A top-down inclusive approach of deriving perspectives. • Perspectives and measures are structured into outcomes and enablers. • Non-market objectives are integrated within the strategic BSC's perspectives, which confers them strategic importance.	• Relationships between indicators and perspectives are based on "*experience and common sense*", which "*could not be statistically validated*" as mentioned by the authors. • The classification of perspectives into enablers and outcomes remains heavily subjective and based, once again, on managers' intuition.
Hsu et al. (2011)	1. Determine the SBSC's perspectives: replace the finance and customer perspectives with sustainability and stakeholders perspectives respectively as suggested by Dias-Sardinha and Reijnders (2005). 2. Define the SBSC measures using fuzzy Delphi method with a group of experts. 3. Determine relationships among perspectives and measures. 4. Apply ANP method to determine the ten most important measures of the SBSC.	• Combination of two decision making techniques to construct the SBSC (Fuzzy Delphi and ANP). • Systematic selection of the most important measures using a powerful decision making technique (ANP).	• The relationship among perspectives and measures are not defined based on a systematic analytic method but rather solely on subjective judgment of the experts involved in the experiment. • The proposed framework is applied to the semiconductor industry and is not generalized to other fields of research.

Wati and Koo (2011)	1. Build upon the conventional BSC to introduce Green IT components and measurements. 2. Construct the Green IT BSC around the four perspectives: Finance, Stakeholders, Future orientation and Processes. 3. Define Green IT metric for each perspective. 4. Define cause-effect relationships among metrics.	• Focuses on the environmental perspective in Green IT management • Integrates Green IT measures within the four perspectives of the scorecard.	• Does not envisage the correlations between the social aspect and Green IT. • Does not discuss ethics in the proposed Green IT BSC.
Nikolaou and Tsalis (2013)	1. Start with the conventional BSC 2. Define GRI-based indicators for each perspective. 3. Score indicators using a proposed scoring-benchmarking technique. 4. Calculate the total score per perspective. 5. Calculate the total SBSC score.	• Standardization of indicators using the GRI social and environmental framework. • Proposes a new, simple and concise scoring-benchmarking technique. • Analyzes sustainability performance across sectors using a case study application.	• The aggregation method is based on unweighted addition, which gives equal importance to accountability and performance in the score calculation. • Equal weights are given to perspectives across industries in calculating the total SBSC score. • The methodology can be conducted only on firms following the GRI reporting framework with consistently published sustainability reports.

In analyzing SBSC design structures, Hansen and Schaltegger (2016) distinguish between three types of architectures: **hierarchical**, **semi-hierarchical**, and **non-hierarchical** (network). According to the authors, a *strictly hierarchical* structure features the conventional hierarchy of the BSC, that is a structure driven by the ultimate profit-driven objective; the financial perspective. Proponents of this approach hold that it supports the goal of profit maximization and that it allows the SBSC to be a meaningful strategic management tool and not merely a public relations exercise (Zingales & Hockerts, 2003). With more than 60% frequency, strictly hierarchical architectures account for the majority of SBSC design structures mentioned in the literature (Hansen & Schaltegger, 2016).

In *semi-hierarchical* SBSC structures, two major modifications are made: modifications to the cause-effect chains, and modifications to the bottom line. In these architectures, the direct links pointing upwards to the financial perspective are relaxed to make other objectives stand for their own and not necessarily as a cause for ultimate financial goals. Thus, this first modification allows to balance conflicting interests of various stakeholder groups. The second modification in semi-hierarchical architectures concerns broadening the financial perspective to include other non-financial goals (Dias-Sardinha & Reijnders, 2005; Dias-Sardinha, Reijnders, & Antunes, 2002; León-Soriano, Jesús Muñoz-Torres, & Chalmeta-Rosalen, 2010). While both strictly hierarchical and semi-hierarchical architectures place social and environmental perspectives at the top level with the financial goal, in the former architecture, social and environmental objectives are expected to contribute directly or indirectly to financial objectives. However, this link is not mandatory in semi-hierarchical architectures where social and environmental goals can exist in their own right, ensuring thereby a more balanced governance of stakeholder group interests. Papers which propose semi-hierarchical structures are much fewer than those featuring strictly hierarchical designs, they represent 13% of the total number of relevant publications, and concern not only cooperatives, state-owned companies and family businesses, but also privately held and listed companies (Hansen & Schaltegger, 2016).

In *Non-hierarchical* SBSC structures, perspectives are represented in a network configuration where all aspects of the scorecard are closely interconnected. No particular dimension is targeted as the ultimate objective to be maximized. The general criticism for non-hierarchical structures stems from this particular point. Van Marrewijk (2004) argues that while such structures are characterized by flexibility, open systems and an "*alignment between the various entities within the network*", their associated drawbacks include "*difficulty in maintaining focus*" and a risk of a "*lack of commitment to organisations and people*" (p. 155).

This categorization is augmented by the interesting link that Van Marrewijk (2004)establishes between the SBSC architecture and the firm's value system (Fig. 9). As such, it is found that companies which adopt a strictly hierarchical SBSC structure tend to have a more strongly profit-driven value system that is motivated by pragmatic profit maximization. This type of value system is qualified as *instru-*

mental (Hansen & Schaltegger, 2016). In contrast, non-hierarchical SBSC architectures reflect predominantly a *normative –or ethical–*approach whereby "*the firm is seen as having responsibilities to a wider set of groups than simply shareholders*" (Hubbard, 2009). This view differs from the conventional strategic stakeholders theory in that it does not consider including stakeholders for instrumental purposes. On the contrary, the normative perspective entails considerations for stakeholders for ideological, ethical and moral obligations (Sundin et al., 2010). Finally, it is found that semi-hierarchical SBSC structures are more related to the *social/political* approach as they allow to balance the conflicting interests of different stakeholders via the simultaneous pursuit of multiple objectives. In this approach, managers discard profit maximization for satisfactory balance creation. Accordingly, decisions "*ensure an outcome that is at least minimally satisfactory along all dimensions*"(Sundin et al., 2010) (p. 208).

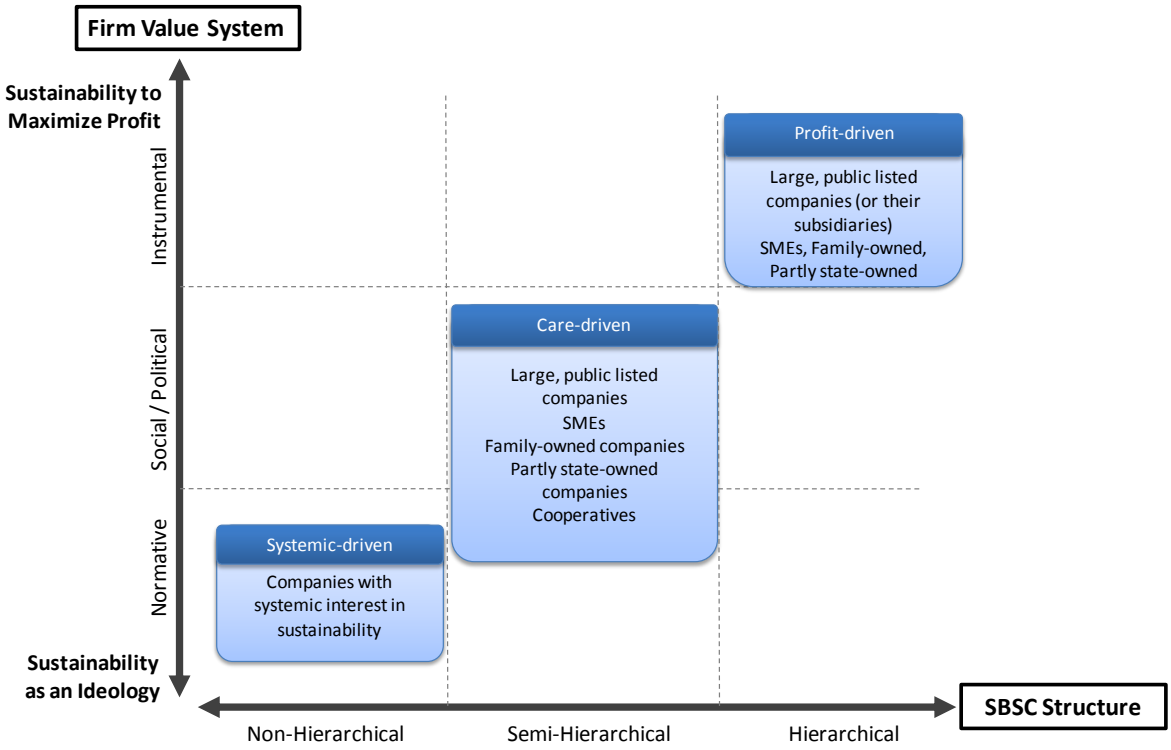


Fig. 9. Relationship between firm value system and SBSC structure(Types of companies are based on case studies conducted by Hansen and Schaltegger (2016))

In addition to the classifications presented above, some structural characteristics are particularly striking, namely at two levels: **orientation** and **confinement**.

From an **orientation** perspective, nearly all studies adopt a detail-to-general orientation as opposed to a general-to-detail one. Specifically, in most papers found in the literature, authors start with analyzing

BSC indicators and focusing on *how* these will be integrated into the existing scorecard. Then, they establish –in various ways and for those which do it– the cause-effect relationships among indicators, in order to deduct, subsequently, the firm's strategy map. This bottom-up orientation whereby the sustainability strategy is based first, on defining key objectives and metrics, then, on drawing the overall roadmap, seems in contradiction with the normative principle of strategy creation which stipulates rather a top-down approach –that is, an approach where the general roadmap is first designed, then objectives and metrics are determined in order to implement that roadmap's broad guidelines. Gminder and Bieker (2002) and Bieker and Waxenberger (2002) propose to define the sustainability strategy before delving into objectives and indicators, but they do not provide much detail on how the definition of such strategies should be undertaken.

Another key characteristic common to the existing studies cited in the literature is **confinement**. The greatest majority of the studies covered (more than 70%) build essentially on Kaplan and Norton's BSC framework and the causal relationship structure predefined in this framework. This leads to two direct consequences. First, when no social and environmental (S&E) dimension is explicitly added or merged with existing ones based on the original BSC framework (this is especially the case for strictly hierarchical and semi-hierarchical models), authors focus on methods of selecting S&E indicators and how those could be best incorporated into the system. Second, few authors address ethics and governance issues as part of the sustainability problem. In fact, little studies devote a sufficient amount of analysis and detail to these two aspects of sustainability and how they should be integrated to the SBSC. As a result, most cited works found in the literature outline the SBSC within the boundaries of the preexisting BSC framework by attempting to introduce –or slot in– sustainability, or some aspects of it, along with the causal relationships as initially assumed in the original BSC framework. Based for most of them on intuition and managers' perception and experience, these studies remain mostly confined to Kaplan and Norton's view of the BSC hierarchy, placing financial objectives at the top and all other objectives as direct or indirect contributors. They do not question, for instance, the predefined hierarchical order among perspectives or how this order should dynamically change, in a technically correct fashion, to best reflect the firm's context, industry, and overall sustainability strategy.

Finally, it is noteworthy to highlight the mechanisms through which the SBSC's components are interconnected to one another. In the greatest majority of publications, authors rely on managers' best judgment and experience to build cause-effect relationships between indicators and perspectives. A few authors resort to analytical techniques to resolve the interdependencies between the BSC's elements (eg. Hsu et al. (2011)).

2.2.5.4 Then What's Missing?

The critical evaluation discussed above (section 2.2.5.3) suggests that at least three central issues arise from the existing literature covering the design of the SBSC architectures. These issues relate to the characteristics identified earlier, namely, design orientation, design confinement, and structural relationships. In addition, the SBSC design methodologies proposed in the literature fail to systematically incorporate ethics and governance perspectives, and none, to our knowledge, has addressed methodologically the time dimension in the scorecard by proposing a Dynamic SBSC.

Design Orientation. Conventionally, the strategy creation process consists of some established general steps studied in theory and confirmed in practice (Thompson & Martin, 2010):environment scanning (exogenous factors pertaining to political, economic, socio-cultural, technological and competitive landscapes), strategy formulation (at the corporate level, business level and functional level), strategy implementation (involving communication, resource alignment, empowerment and change management), and strategy evaluation (via assessment, corrective actions and strategy reformulation). Defining operational objectives and key performance indicators is a task that managers undertake at the business unit level only after the corporate strategy and business strategy have been set and the general direction of the firm well defined. This order is crucial and is remindful of the famous quote from the legendary Chinese military strategist Sun Tzu: "*Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat*." When trying to define operational objectives and specific metrics for sustainability management a step before outlining the overall sustainability strategy, we are doing just that: "tactics without strategy", and this could not possibly be the surest path to success.

However, most of the literature on SBSC design overlooks this paramount principle in strategic management. While the detail-oriented approach mostly found in the papers allows to have a good understanding of the metrics involved in the scorecard and how they are integrated into it(Dias-Sardinha & Reijnders, 2005; Hsu et al., 2011; Nikolaou & Tsalis, 2013), it presents the major drawback of discarding an important step: defining the sustainability strategy map first and foremost. Therefore, the detail-to-general orientation that is adopted in most SBSC design methods presents a clear discrepancy in this area of research.

Design Confinement. On the other hand, the confinement of the existing studies on SBSC design to the predefined hierarchy of perspectives as hypothesized by BSC authors Kaplan and Norton, especially the instrumental and socio-political ones, does not offer the greatest possible flexibility to capture the changing dynamics of business, society, and the environment in general. From a conceptual perspective, one could argue that the SBSC's architecture should vary across industries and sectors. As an example, the sustainability strategy of a company operating in the fisheries industry or the oil industry

could not possibly be similar to that of a retailer or a service-based business model. The fisheries company's sustainability manager is concerned, for instance, with how much of impact this year's captures of fish will have on the oceanic ecosystem stability and on next year's captures. The oil company's sustainability manager is rather focused on the hazards an oil spill would have on the environment and, consequently, on the firm's reputation. On the other hand, a banker realizes that his business is less influenced by how much paper or electricity was consumed than by a possible ethical scandal in which the bank gets entangled. The priorities are different, vary across industries and sectors, and so should be the strategies. Empirical research has confirmed this variation in SBSC architecture based on the firm's value system (see Fig. 9), but not much has been said on the possible correlation between SBSC architecture and the firm industry. Proposing a dynamic model that captures this possible correlation will bring a net advancement in the research on SBSC design.

Structural Relationships. Finally, it is found that in all proposed SBSC architectures, the cause-effect relationships established between KPIs are strongly based on local managers' intuition, best knowledge and judgment of the firm's context. This point is particularly worrisome considering the danger posed by human mental models. Mental models prevent us from simulating complex systems with an acceptable degree of accuracy, they can distort our processes of constructing the business dynamics models supposed to help resolve these complexities. For example, mental models could prevent us from realizing the very existence of some non-obvious relations among variables in a system (Chaker, El Manouar, et al., 2015). More particularly, according toNikolaou and Tsalis (2013), the strategy map construction could be loaded by many human judgmental streams filled with errors and unexpected missed judgments. As demonstrated by existing research, it is often assumed that events have a single major cause, and as soon as this first sufficient cause is identified, people stop short of considering other potential causes (Plous, 1993). Research has also shown that our representation of the world depends on the way we look at, think about, and act upon systems(Vázquez & Liz, 2011), causing a subjectivity bias to occur. Therefore, proposing a model in which managers can systematically define causal relationships using a technically proved method would ward off the subjectivity bias and thus bring an additional strength to the design of SBSC architectures.

Ethics and Governance Perspectives. In designing the SBSC, the literature presents various approaches and frameworks. Some of the first and pioneering attempts were conducted by Figge et al. (2002) and M. Epstein and Wisner (2001) who added and/or incorporated the social and environmental perspectives into the existing BSC. Later, Bieker (2002) and Bieker and Waxenberger (2002) analyzed in depth the interrelation of ethics with sustainability and the SBSC. They proposed a more encompassing framework that took into consideration ethics and integrity management in sustainability. Dias-Sardinha and Reijnders (2005) explored the governance aspect in addition to environment, health, and safety in assessing some large Portuguese companies using the BSC. Other authors opted to develop a single index to represent sustainability performance using, but not limited to, the BSC

approach such as Hubbard (2009), or multi-criteria decision making methods (Krajnc & Glavič, 2005; Mori & Christodoulou, 2012; Singh et al., 2007; Zhou, Tokos, Krajnc, & Yang, 2012).

While these studies approached sustainability measurement and SBSC construction from various interesting angles, none, to our knowledge, has explicitly incorporated both Ethics and Governance as distinct dimensions of the scorecard.

Time Dimension or the Dynamic Sustainability BSC. While the dynamic BSC has been explored in a few studies over the past decade (see section2.2.4), none of the works has proposed a methodological approach for introducing time dimension into the Sustainability BSC. Therefore, two avenues are here to explore: construct the *Dynamic Sustainability BSC*, and construct it with a systematic methodology that overcomes the existing DBSC construction failures mentioned in TABLE 6. This is, in fact, an importantand opportune amelioration point to be made to the SBSC.

To summarize, the cornerstone limitations of existing SBSC design methodologies can be summarized as follows:

1- Orientation with a detail-to-general approach as opposed to a general-to-detail one;

2- Confinement to a pre-assumed hierarchy of perspectives;

3- Subjectivity bias in causal relationships among indicators and perspectives.

4- Ethics and Governance not systematically included as two distinct perspectives.

5- Time dimension not −methodologically− explored.

In this thesis work, we propose an alternative methodology for designing the SBSC which takes into account all five limitations cited above. That is, the proposed methodology offers a general-to-detail approach with the possibility to dynamically restructure the perspectives' hierarchical order ("adaptive" SBSC) while systematically defining cause-effect relationships. In addition, the proposed method will incorporate the perspectives of ethics and governance, along with a dynamic evolution in time ("dynamic" SBSC).

CHAPTER III:

ADSBSC: A NEW ADAPTIVE & DYNAMIC SUSTAINABILITY DECISION-AID FRAMEWORK

CHAPTER 3. ADSBSC: A NEW ADAPTIVE & DYNAMIC SUSTAINABILITY DECISION-AID FRAMEWORK

In the previous chapter, we made a holistic literature synthesis of sustainability decision aid frameworks, and made a critical evaluation of the SBSC architectures. Given the significant importance the SBSC has gained over the past decade, and with regards to the flaws yet to be addressed (see section 2.2.3), we propose in this chapter a new framework based on a combination between an "adaptive" SBSC and System Dynamics (SD). The novelty of this work is multi-fold:

1) It addresses the inter-dimensions causality concept which was severely criticized by many authors (Akkermans & Van Oorschot, 2005; Barnabè, 2011; Norreklit, 2000; Nørreklit, 2003).

2) It questions the classical BSC hierarchical structure and offers a new methodology leading to a flexible architecture that can sporadically vary across firms and organizational contexts.

3) It attends to the traditional limitation of the "mental model" based construction of causal loop diagrams in SD models (Akkermans & Van Oorschot, 2005; Chaker, El Manouar, et al., 2015).

4) The rule-based model generation makes it possible to computerize a large part of the solution and scale it technologically.

The framework design follows two steps: first, the Adaptive SBSC construction methodology is proposed, then the dynamic ASBSC is designed (Chaker, El Manouar, & Janati Idrissi, 2017).

3.1 Designing the Adaptive SBSC (ASBSC): A Strategic & Systematic Model

3.1.1 ASBSC: Why and How?

As demonstrated in Section 2.2.5.3 of this document, the existing methods found in the literature for designing the SBSC rely, for most of them, on Kaplan and Norton's conception of the balanced scorecard. In other terms, these methods use the predefined hierarchy of perspectives proposed by Kaplan and Norton (1996a) along with the already defined liaisons between those perspectives.

In this research, we claim that the construction of the SBSC should be dynamic, reflecting the varying priorities that organizations have depending on their industries, constraints, and contexts. In addition, we argue that the liaisons between perspectives should also be dynamic and not necessarily reflective of a predefined hierarchical order.

Our proposed SBSC design methodology allows overcoming the basic limitations of the SBSC construction (discussed in Chapter II, Section 2.2.5.4). In this subsection, four of them are addressed,

namely: orientation, confinement, comprehensiveness (additional dimensions), and structural relationships. The proposed methodology aims to respond to the critical needs of sustainability managers by offering the advantages of mathematical rationality while leveraging strategic insight and simplicity of execution. In other words, it addresses the following questions:

1. Which sustainability dimensions are most important to / impact most our business?
2. How do these dimensions rationally relate to one another? and in which hierarchy order?
3. Which performance measurements are most meaningful for each dimension?

In order to answer these questions, our model should not only help to rationally define dynamic hierarchies amongst perspectives, but also prioritize KPIs within each perspective.

For this aim, we combine two multi-criteria decision making methods: Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Hierarchy Process (AHP). In addition, since the sustainability balanced scorecard's construction relies heavily on subjective assessment of decision makers who cannot precisely translate their evaluations into crisp data, fuzzy logic seems a good candidate to support decision making in this particular setting.

In this work, we first derive cause-effect relationships and priority levels amongst the balanced scorecard's perspectives using fuzzy DEMATEL. This leads to an automatic generation of the Sustainability Strategy map (SSM) using an innovative method, which also brings an informed answer to questions 1 an 2 posed above. Then, AHP is used to prioritize key performance indicators (KPIs) within each perspective in order to help focus managerial attention on the most salient components of the resulting SBSC, addressing thereby question 3.

Thanks to its automatically and highly adaptive characteristic, the resulting SBSC is denoted as the Adaptive Sustainability Balanced Scorecard (ASBSC).

3.1.2 Conceptual Methodology

Before presenting the conceptual methodology of the ASBSC, we present the two MCDM methods referred to earlier along with the main principles of fuzzy logic.

3.1.2.1 DEMATEL: Original and revised versions

DEMATEL method is a MCDM technique initiated in the mid-seventies by the Battelle Memorial Institute of Geneva as a technique to structure complex cause and effect relationships among the elements of a system. This method has been widely used and applied in various fields over the past years (Chen, Hsu, & Tzeng, 2011; Govindan et al., 2014; Horng, Liu, Chou, & Tsai, 2013; Hsu et al., 2013; C.-L. Lin & Tzeng, 2009; Shaik & Abdul-Kader, 2014; Tsai & Chou, 2009; Tsai et al., 2010; Yang, Shieh, Leu, & Tzeng, 2008). In its original version, the DEMATEL method can be summarized as follows (Yang et al., 2008):

First, the pair wise impact matrices of n indicators are collected from a group of p experts following a comparison scale as shown in TABLE 8.

TABLE 8. COMPARISON SCALE OF DEMATEL TECHNIQUE

Numerical Value	Meaning
0	No influence
1	Low influence
2	Medium influence
3	High influence
4	Very high influence

Let $X(k)=[x_{ij}(k)]_{nxn}$ denote the nxn answer matrix of expert k. The nxn average matrix A ($A=[a_{ij}]_{nxn}$) is then calculated by averaging out the experts' scores as in Eq.1:

$$a_{ij} = \frac{\sum_{k=1}^{p} xij(k)}{p} \qquad (1)$$

Second, the normalized initial direct matrix D is obtained by multiplying the elements of average matrix A by the number λ as explained in Eq.2 and Eq.3. The resulting matrix is the normalized initial direct matrix D.

$$D = \lambda * A \qquad (2)$$

$$\lambda = \text{Min}\left[\frac{1}{\text{Max } 1\le i\le n \sum_{j=1}^{n}|aij|}, \frac{1}{\text{Max } 1\le j\le n \sum_{i=1}^{n}|aij|} \right] \quad (3)$$

Third, the total direct/indirect influence matrix is obtained by raising matrix D to an infinite power, which guarantees the continuous decrease of indirect effects along the powers of D and the convergence of the total direct/indirect matrix $T=[t_{ij}]_{nxn}$ to the inverse matrix $T=D*(I-D)^{-1}$ as $\lim_{m\to\infty} D^m = [0]_{nxn}$ (Eq. 4).

$$T = D+D^2+D^3+...+D^m \qquad (4)$$

$$=D(I+D+ D^2+...+D^{m-1})(I-D)(I-D)^{-1}$$

$$= D(I-D)^{-1}$$

where I denotes the identity matrix.

However, this method has been contested in the study conducted by Lee, Tzeng, et al. (H.-S. Lee, Tzeng, Yeih, Wang, & Yang, 2013) who argued that the normalized initial direct-indirect matrix D does not necessarily converge to the null matrix, meaning that $\lim_{m\to\infty} D^m = [0]_{nxn}$ might or might not be true. In fact, the study has proven that the convergence is only possible under the sufficient condition that the column sum of each column of the initial direct-indirect matrix D is less than one. To correct for this condition, a modification is made to normalizing factor λ such that (Eq.5):

$$\lambda' = \frac{1}{\text{Max}\left(\text{Max}\ 1\le i\le n \sum_{j=1}^{n}|aij|,\ \ \varepsilon + \text{Max}\ 1\le j\le n \sum_{i=1}^{n}|aij|\right)} \quad (5)$$

In this research, normalizing factor λ' is used as in Eq.5 where ε is a very small positive number. With this modification, the original DEMATEL is corrected for, and the total influence matrix T converges to the inverse matrix (Eq.4). In addition, vectors R and C are defined such that:

$$R = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \quad (6)$$

$$C = [c_j]_{1\times n} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n}$$

The sum r_i of the i^{th} row of matrix T denotes the total direct and indirect influence that factor i exerts on all other factors, while the sum of the j^{th} column of matrix T, c_i, shows the direct and indirect influence that factor j has received from all other factors of the system. In addition, when i=j, (r_i+c_i) indicates the central role that factor i plays in the system while (r_i-c_i) reveals whether factor i is a net dispatcher, when $(r_i- c_i)$ is positive, or a net receiver, when $(r_i- c_i)$ is negative.

Finally, a graphical representation of the causal relationships is made through the Impact Relation Map (IRM) which translates values of the total influence matrix T into directed graphs or di-graphs (Fig. 10). In order to reduce the complexity of the resulting IRM, a threshold value α is set for matrix T, keeping only values greater than α, those deemed most important for the analysis. The resulting matrix T' is referred to as the α-cut total influence matrix.

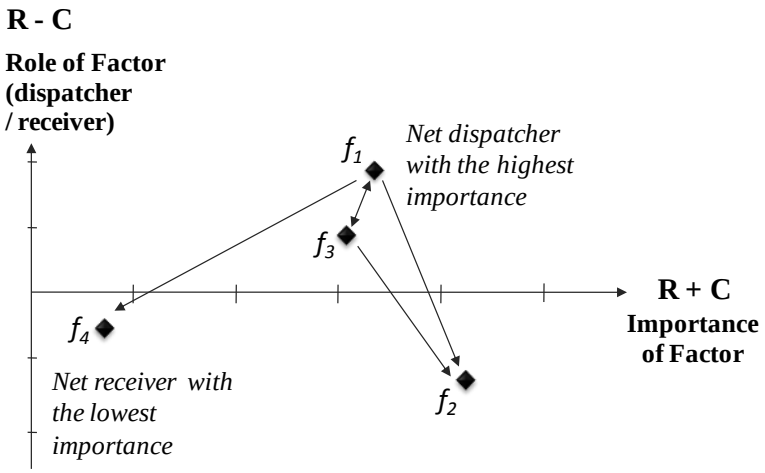


Fig. 10. Illustration of DEMATEL Impact Relation Map (IRM)

3.1.2.2 Fuzzy DEMATEL

In the real world, we make decisions that are constantly based on subjective judgment of situations and things. Often, we use imprecise −or vague− words to describe the world around us. In 1965, Lotfi A. Zadeh introduced the notion of fuzzy sets as a mathematical way to represent and deal with ambiguity in human language. In fuzzy logic, a linguistic judgment is translated into a fuzzy number which features a membership function (Zadeh, 1965). These are not probabilities but rather crisp numbers, or *truth values*, comprised in the range [0,1] that describe the membership value (or degree of membership (DOM)) of an element *z* to a fuzzy set *A*. This membership function is denoted $F_A(z)$. More precisely, $F_A(z) \in [0,1]$ and $F_A(z)=1$ reveals that *z* completely belongs to *A* while $F_A(z)=0$ denotes that *z* does not belong to fuzzy set *A*. In between, the function allows to describe *partial membership*.

Fuzzy DEMATEL method is based on regular DEMATEL with fuzzy values instead of crisp values. In the case at hand, we deal with interdependencies existing among perspectives using triangular fuzzy extension. Triangular fuzzy DEMATEL responds adequately to the pairwise evaluation problem and has proved adequate to handle linguistic imprecision and human being's ambiguous judgment pertaining to settings where it is difficult to generate crisp evaluations (Jassbi, Mohamadnejad, & Nasrollahzadeh, 2011). A triangular fuzzy number *z* can be defined as a triplet (l, m, u) and the corresponding membership function $F(z)$ as follows :

$$F(z) = \begin{cases} 0, & z < l \\ (z - l)/(m - l), & l \le z \le m \\ (u - z)/(u - m), & m \le z \le u \\ 0, & z > u \end{cases}$$

In this work, pairwise impacts among perspectives are evaluated using linguistic terms as shown in TABLE 9.The corresponding membership functions are drawn on Fig. 11.

TABLE 9. CORRESPONDENCE BETWEEN LINGUISTIC TERMS AND LINGUISTIC VALUES

Linguistic term	**Linguistic triangular value**
No Influence (No)	(0, 0, 0.25)
Low Influence (L)	(0, 0.25, 0.5)
Medium Influence (M)	(0.25, 0.5, 0.75)
High Influence (H)	(0.5, 0.75, 1)
Very High Influence (VH)	(0.75, 1, 1)

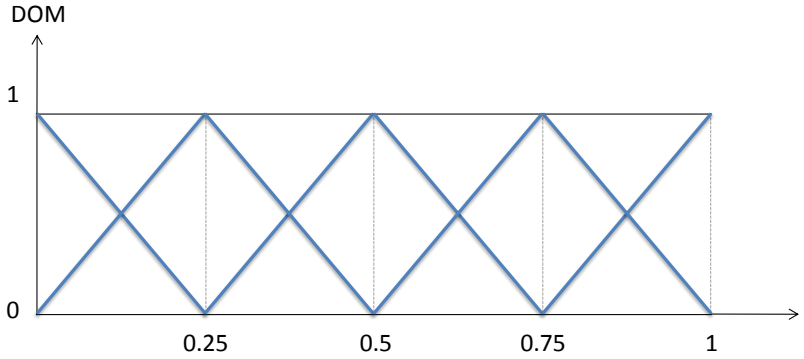


Fig. 11. Membership function representations of fuzzy input values

A set of triangular fuzzy matrices $\check{Z}$ is obtained and represents the linguistic evaluations of a group of p experts. A typical $\check{Z}$ matrix is shown below (Eq. 7).

$$\check{Z} = \begin{pmatrix} 0 & z_{12} & \dots & z_{1n} \\ z_{21} & 0 & \dots & z_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ z_{n1} & \dots & \dots & 0 \end{pmatrix} \quad (7)$$

Where $z_{ij}=(l_{ij}, m_{ij}, u_{ij})$ is a triangular fuzzy number representing the impact evaluation of factor i on factor j using corresponding linguistic values (TABLE 9).n is the number of perspectives, and z_{ii} $(i=1, 2, ..., n)$ the null triangular fuzzy number (0, 0, 0).

The average fuzzy matrix $\tilde{A}$ $[a_{ij}]_{n \times n}$is calculated (Eq. 8, 9) then normalized into fuzzy normalized matrix $\check{D}[d_{ij}]_{n \times n}$ (Eq. 10 - 12).

$$\begin{cases} \tilde{A}\,[a_{ij}]_{n\,x\,n} = \dfrac{(z1 \oplus z2 \oplus \ldots\ldots \oplus zp)}{p} & (8) \\ a_{ij} = (al_{ij},\ am_{ij},\ au_{ij}) \quad \text{and} \quad (i, j = 1, 2, \ldots, n) & (9) \end{cases}$$

$$\begin{cases} \check{D}[d_{ij}]_{n\,x\,n} = \tilde{A} * \lambda & (10) \\ d_{ij} = (al_{ij} * \lambda,\ am_{ij} * \lambda,\ au_{ij} * \lambda) & (11) \\ \lambda = \dfrac{\mathbf{1}}{\boldsymbol{Max}\,(\,\boldsymbol{Max}\mathbf{1} \le \boldsymbol{i} \le \boldsymbol{n} \sum_{\boldsymbol{j=1}}^{\boldsymbol{n}} |\mathbf{auij}|,\ \ \boldsymbol{\varepsilon} + \boldsymbol{Max}\mathbf{1} \le \boldsymbol{j} \le \boldsymbol{n} \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} |\mathbf{auij}|)} & (12) \end{cases}$$

whereε is a very small positive number. Fuzzy total influence matrix $\check{T}$ is obtained (Eq. 13).

$$\begin{cases} \check{T} = \lim_{k \to \infty} \quad (\check{D} + \check{D}^2 + \check{D}^3 + \ldots + \check{D}^k) & (13) \\ t_{ij} = (l'_{ij},\ m'_{ij},\ u'_{ij}) \\ [l'_{ij}] = \check{D}_l * (I - \check{D}_l)^{-1},\ [m'_{ij}] = \check{D}_m * (I - \check{D}_m)^{-1},\ \ [u'_{ij}] = \check{D}_u * (I - \check{D}_u)^{-1} \end{cases}$$

Fuzzy vectors $\check{R} = [\check{r}_i]_{n \times 1}$and $\check{C} = [\check{c}_j]_{1 \times n}$ are obtained as the respective sums of fuzzy row numbers and fuzzy column numbers from total matrix $\check{T}$. For each perspective, $\check{R}$, $\check{C}$, $\check{R}_i + \check{C}_i$ and $\check{R}_i - \check{C}_i$ are calculated then defuzzified into R, C, $R+C$ and $R-C$ respectively. The defuzzification method employed here is Center of Gravity (COG) (or centroid). This choice is based on the vast use of this method in the literature to solve similar problems(Jassbi et al., 2011), indeed, COG method is seen to be the most prevalent and physically appealing defuzzification method (C.-C. Lee, 1990; Sugeno, 1985).

3.1.2.3 AHP

The Analytic Hierarchy Process (AHP) is used in our model to prioritize KPIs within each perspective of the ASBSC. AHP was introduced in the early 1980s by Thomas L. Saaty as a method of measurement based on paired comparisons to derive ratio scales in a decision making problem(R. W. Saaty, 1987). The comparisons can be either discrete or continuous and are used to reflect the strength of relative criteria preferences. In its general form, AHP method requires the use of a hierarchy of criteria, sub-criteria, and alternatives (Fig. 12).

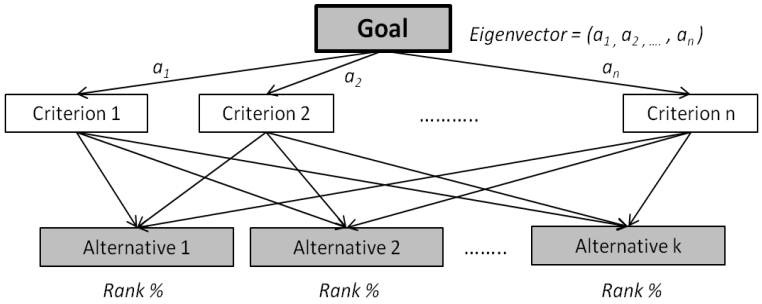


Fig. 12. Hierarchy in the AHP model

First, criteria are rated using paired comparisons according to Saaty's fundamental scale(R. W. Saaty, 1987)(TABLE 10).

TABLE 10. THE FUNDAMENTAL SCALE (R. W. SAATY, 1987)

Intensity of Importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over the other	Experience and judgment strongly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	
Rationals	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

A matrix of pairwise comparisons C is generated to obtain local derived scales for every criterion. The matrix is filled out by comparing how much each criterion is preferred over the others on a scale from 1/9 (indicating not at all preferred) to 9 (indicating definitely strongly preferred). Since those are paired comparisons, the matrix has reciprocal numbers with respect to the diagonal which is represented by unity numbers indicating that each element is equally preferred to itself (Fig. 13).

	C_1	**C_2**	**C_3**
C_1	1	2	1/4
C_2	1/2	1	1/7
C_3	4	7	1

Fig. 13. Example of comparison matrix C

Second, the columns of matrix C are normalized by dividing each column element by the column sum such that the resulting matrix (A) columns sum up exactly to unity (Fig. 14). The local derived scales represent the Eigenvector W which is obtained by averaging out each row of normalized matrix A. In the illustrated example Eigenvector W=(0.187, 0.098, 0.715)(Fig. 14).

	C_1	**C_2**	**C_3**
C_1	1	2	0.25
C_2	0.5	1	0.143
C_3	4	7	1
Sum	**5.5**	**10**	**1.4**

⇒ A =

	C_1	**C_2**	**C_3**	**W**
C_1	0.182	0.200	0.179	**0.187**
C_2	0.091	0.100	0.103	**0.098**
C_3	0.727	0.700	0.718	**0.715**
Sum	**1**	**1**	**1**	**1**

Fig. 14. Calculation of Eigenvector W

However, the calculation at this point of the principal Eigenvector does not necessarily mean that it is the optimal solution for the problem. It is required to check the matrix consistency with respect to the comparisons initially introduced. A matrix is said to be consistent if transitivity of judgment is respected, that is $c_{ij}c_{jk} = c_{ik}$, ∀ i, j, k(R. W. Saaty, 1987).In the illustration case used above, matrix C is inconsistent as $c_{12}*c_{23} = 2*0.143 = 0.286$ which is greater than $c_{13} = 0.25$. However, this small inconsistency is compensated by $1/c_{13} = 4 > 1/0.286 = 3.49$, which translates the idea that if a value exceeds the corresponding consistent value, the reciprocal of that value is less than the reciprocal of the consistent value, driving a tendency to compensate.

More generally, R. W. Saaty (1987) proposes to use the consistency ratio (CR) as a means of judging overall consistency of the model. This ratio is obtained by calculating the principal Eigenvalue λ_{max}such that (Eq. 14):

$$\sum_{j=1}^{n} c_{ij}w_j = \lambda_{max}w_i$$

$$\text{and} \quad \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}w_j = \sum_{j=1}^{n}\left(\sum_{i=1}^{n} cij\right) w_j = \sum_{i=1}^{n} \lambda_{max}\, w_i = \lambda_{max} \qquad (14)$$

The consistency index (CI) of a matrix of comparison is given by (Eq. 15):

$$CI = (\lambda_{max} - n) / (n - 1) \qquad (15)$$

To calculate the consistency ratio (CR), Eq. 16 is used:

$$CR = CI / RI \quad (16)$$

where RI is the random consistency index (RI) obtained from the average consistency index calculated over a sample of 500 randomly generated reciprocal matrices. R. W. Saaty (1987) summarized RI calculation findings in TABLE 11. If the calculated CR is less than or equal to 0.1 then the Egeinvalue and Eigenvector are acceptable and can be used as a final solution, otherwise, the solution is rejected unless the pairwise comparisons are revisited and carefully reconsidered.

TABLE 11. RANDOM CONSISTENCY INDEX (RI) (R. W. SAATY, 1987)

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Random consistency index (RI)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

In the illustrative example used above, $\lambda_{max} = 3.002$, CI = 0.001 , and CR = 0.0017< 0.1

Note that the matrix is nearly perfectly consistent, and could have been so (CR = 0) had $c_{32} = 8$ to represent perfect transitivity.

Although widely used by researchers, AHP's employment has been significantly restrained by the limited human processing capacity; indeed, the largest number of criteria and alternatives used has been assessed to seven plus or minus two (T. L. Saaty & Ozdemir, 2003). This "magic" number has been determined on the basis of mathematical calculations and the human mind's capacity to deal with those calculations. T. L. Saaty and Ozdemir (2003) demonstrated that when the number of paired elements exceeded seven, the resulting increase in inconsistency is represented by too small perturbations for the human mind to point out the actual element responsible for the inconsistency, and therefore correct it. Conversely, as the number of paired elements decreases below seven, the inconsistency measurement is relatively large and the individual pairing elements is at ease correcting for the existing inconsistency.

While AHP is highly useful in multi criteria decision making problems, it is a top-down approach that presupposes the independence of upper level elements from lower level elements and the independence of elements within the same level, which is not always the case. To cope with this relative limitation, the Analytic Network Process (ANP) was suggested (T. L. Saaty, 2001) as a more general form of AHP.

3.1.2.4 The Adaptive SBSC (ASBSC): A Combined Framework

The proposed methodology is conducted in a two-fold process: First, fuzzy DEMATEL method is used to determine cause-effect relationships between the dimensions (also denoted as perspectives) of the SBSC. Impact weights are derived through the total impact matrix, and a resulting network relation map (NRM) is constructed. In addition, a novel graphical representation is proposed to help prioritize dimensions by importance and by total impact produced or received in the system (Chaker, Janati Idrissi, et al., 2015). The result of this first step is an automatically prioritized and constructed network of relationships among the SBSC's dimensions, or what is referred to as the Sustainability Strategy Map (SSM). The second step consists of generating priority graphs for criteria within each dimension. To do so, a set of key performance indicators (KPIs) are defined for each dimension of the ASBSC, then AHP is used to rank these KPIs and arrange them by priority levels. The overall description of the methodology is presented in Fig. 15 followed by a detailed explanation of each step.

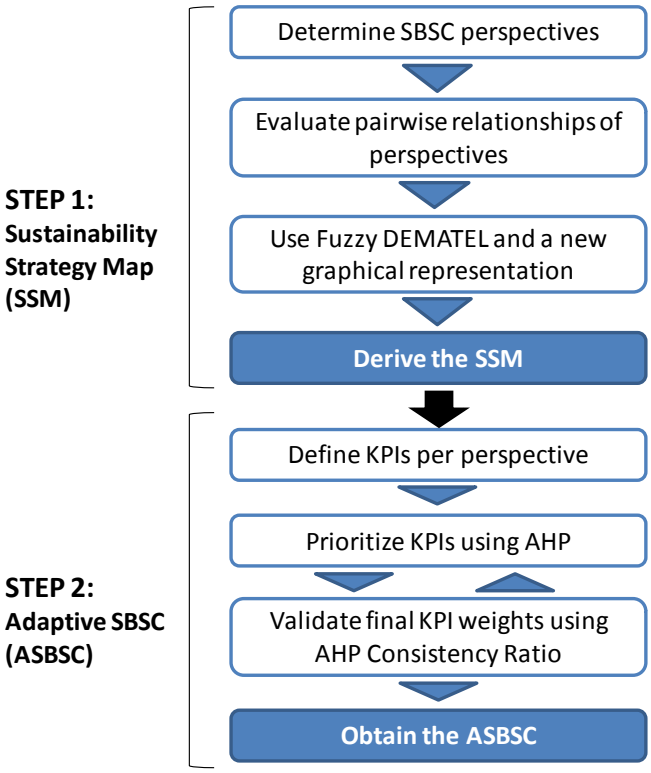


Fig. 15. Proposed methodology for constructing the ASBSC

a. Determine the ASBSC's perspectives

In the proposed ASBSC framework, we introduce ethics and governance as two additional and distinct perspectives of the scorecard besides the traditional social and environmental dimensions. These two perspectives have gained, in fact, immense importance in today's economy. Recent research highlights

the importance of governance and ethics in emerging markets. Historical evidence from either the Asian financial crisis of 1997-98, the global economic meltdown of 2008-09, or the main business collapses over the past two decades, speak for the central role that governance and ethics occupy in economic growth and prosperity.

When briefly revisiting, for instance, the Asian financial crisis, one realizes that the major causes of the crisis were a combination of macroeconomic factors with poor corporate governance. S. Johnson et al. (2000) demonstrate that "*weak enforcement of shareholder rights had first-order importance in determining the extent of exchange rate depreciation and stock market collapse in 1997-98*" p.3.In another important work, La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997) draw evidence from a sample of 49 countries to show that weak investor protection and poor institutions lead to small capital markets and underdeveloped stock markets. More generally, corporate governance is shown to be a significant factor that explains not only the financial crisis, but also the differences in corporate performance across countries as demonstrated by Mitton (2002) in an experience involving a sample of 398 East-Asian firms during the crisis.

Business ethics are no less important. Some of the most scandalous business failures of the century were mainly driven by unethical behavior of top executives as in the infamous Enron case(Culpan & Trussel, 2005; Rhode & Paton, 2002). A few years later, the world witnessed some of the most dramatic days of Wall Street's history with the collapse of such large symbols of American capitalism as Lehman Brothers, Bear Stearns, Merill Lynch and some of the largest financial institutions. The financial crisis transcended throughout continents, turning to a global economic recession. Many researchers and business analysts pointed out ethics as one of the root causes of the global recession (Clive R Boddy, 2011; Clive RP Boddy, Ladyshewsky, & Galvin, 2010; Donaldson, 2012; Jeffers, 2011).Greed, self-interest and lack of empathy are often cited as common traits of the "*corporate psychopaths*" responsible for the crisis(Donaldson, 2012; Jeffers, 2011).

As a result, we conclude that monitoring a firm's performance without regard for its ethical and governance standards will most likely mutilate the evaluation process, leadingconsequently to incomplete and inadequate results. This is because ethics and governance embody an important part of corporate culture and thus can strongly shape a firm's future performance.

Therefore, in the present work, we respond to this particular need by proposing an encompassing evaluation of sustainability which introduces four additional perspectives to the traditional BSC. These perspectives are: Environment, Community and Society, Ethics, and Governance. We choose to group Community and Society into a single perspective as social impact is an extension and a natural evolution of community impact. By organizing the SBSC in eight dimensions, we make sure that sustainability performance is dealt with in a more comprehensive fashion (Fig. 16).

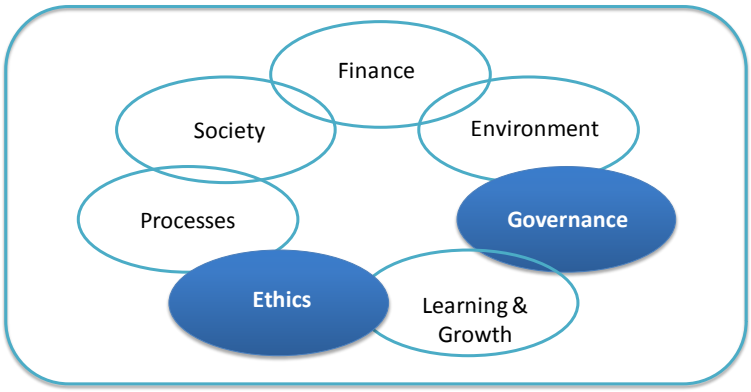


Fig. 16. The eight perspectives of the ASBSC

b. Evaluate pairwise relationships of perspectives

After recognizing the importance of constructing the SBSC using the eight perspectives mentioned in Fig. 16, we deal with interdependencies existing among perspectives using fuzzy DEMATEL method. This consists of collecting the pairwise impact evaluations among each two dimensions taken separately from a group of experts, resulting in a set of pairwise comparison matrices with linguistic values.

c. Apply Fuzzy DEMATEL and a novel graphical representation

The pairwise comparison matrices are used as inputs for Fuzzy DEMATEL method described earlier. The total defuzzified relation matrix is obtained highlighting the total effects produced and received by each perspective. At this stage, we modify the standard DEMATEL graphical representation in order to improve the decision making process. Indeed, while the traditional DEMATEL's IRM graphical representation is useful in plotting factors in terms of importance and function (dispatching vs. receiving), it does not readily inform of the factors which represent the highest intensity of impact, and which deserve, consequently, the closest attention from managers and decision makers. For instance, in Fig. 10, while the standard IRM shows that factor f_1 is a net dispatcher with the greatest R-C value, it does not necessarily imply that this factor produces the greatest intensity of impact on the system as a whole. In fact, it could be that factor f_3 is the one which produces the highest impact on the system even though it displays a lower R-C value. Similarly, net receivers f_2 and f_4 could vary in terms of the intensity of impact received regardless of their R-C values. Therefore, a framework exhibiting factors with respect to not only their importance but also the intensity of impact they either produce or receive could be highly informative. In a previous work, we proposed such a framework and applied it to a case study on an international IT consulting firm (Chaker, Janati Idrissi, et al., 2015).

In this layout, we used a three-dimensional representation of the factors on the plan (R+C,R,C) (Fig. 17). Net dispatchers are represented on the (R+C, R) plan while net receivers are represented on the (R+C , C) plan. In addition, factors are subdivided into three categories as follows:

- **First Impact Factors (FIF):** are the factors which rank in the top 10% of overall importance in the system –that is the top 10% $R+C$ values– and in the top 10% of the total impact produced or received by factors.

- **Second Impact Factors (SIF):** are the factors which rank in the range [60% - 90%][15] of the overall importance in the system –that is the factors whose $R+C$ values fall in the range [60% - 90%]– or the factors with top 10% importance but which are not FIF (Fig. 17).In addition, we enlarge the scope of SIFs to include extreme factors with exclusive dispatching or exclusive receiving characteristics but with low relative overall importance. These factors lay in the ranges with top 10% dispatching intensity and top 10% receiving intensity regardless of their overall importance. This amendment allows taking into account those factors which are either exclusively dispatching or exclusively receiving, and which are therefore susceptible of seriously impacting the system's components. The range of Third Impact Factors (TIF) is subsequently changed based on this extension (Fig. 18).

- **Third Impact Factors (TIF):** are the factors which rank in the least 60% of overall importance in the system.

With this layout, it is possible to reposition the system's factors based on their importance and the amount of consideration they should get from the decision maker. Indeed, FIFs are the most sensitive factors of the system, they are responsible for the greatest overall amount of impact produced or received. They deserve, consequently, the closest attention from the decision maker. In second place come the SIFs, these are factors which directly impact upon the receiving FIFs or which are themselves moderately impacted by the system's indicators. Finally, TIFs represent the set of indicators with the lowest impact produced or received. Thus, this proposed layout presents a straightforward basis for setting management priorities and making recommendations on the strategy formulation.

[15] The proposed interval values are purely nominative and not based on research findings. Managers can choose to vary these thresholds based on their assessment of the firm's context.

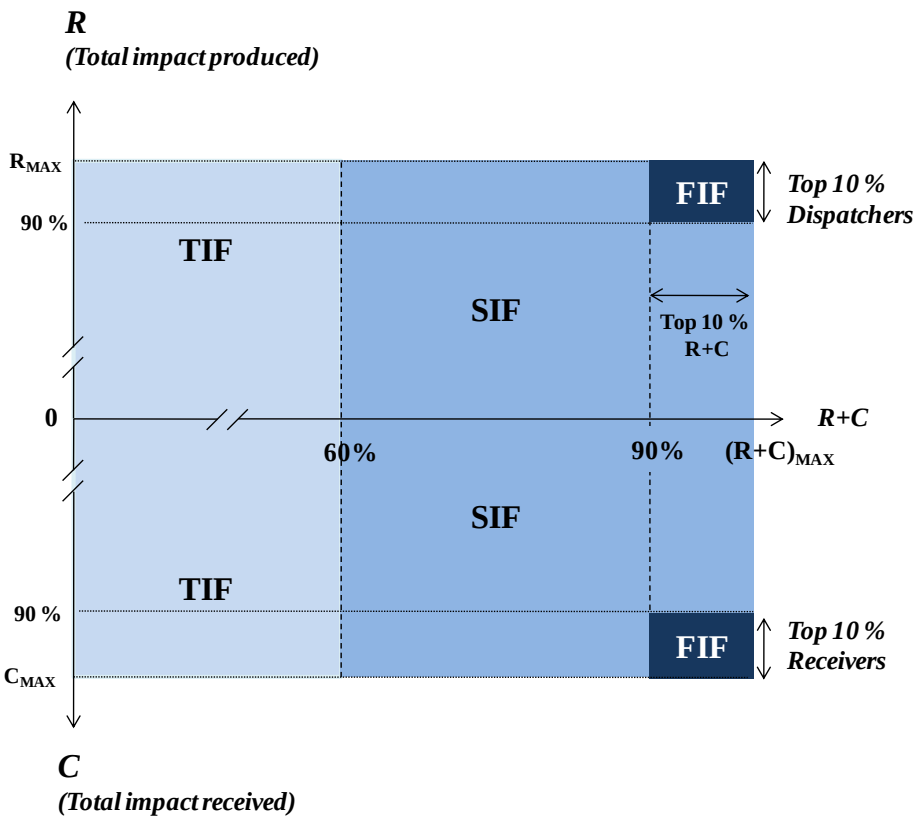


Fig. 17. The proposed graphical layout (Chaker et al., 2015)

The proposed layout brings two main advantages. Firstly, it helps to categorize corporate indicators in a straightforward framework. Each category suggests the appropriate level of importance and priority that indicators within should get from managers and decision makers. Secondly, this layout helps to put indicators in perspective by displaying them in a more intuitive and more informative graphical representation. While the standard *(R+C, R-C)* representation used in DEMATEL's Impact Relation Maps (IRMs) is useful in plotting indicators by importance and role (dispatching vs. receiving), it does not inform of the indicators responsible for the greatest amount of influence exerted on the system. Our proposed framework helps to correct for this limitation by suggesting to use the three-dimensional plan *(R+C, R, C)*(Fig. 17).

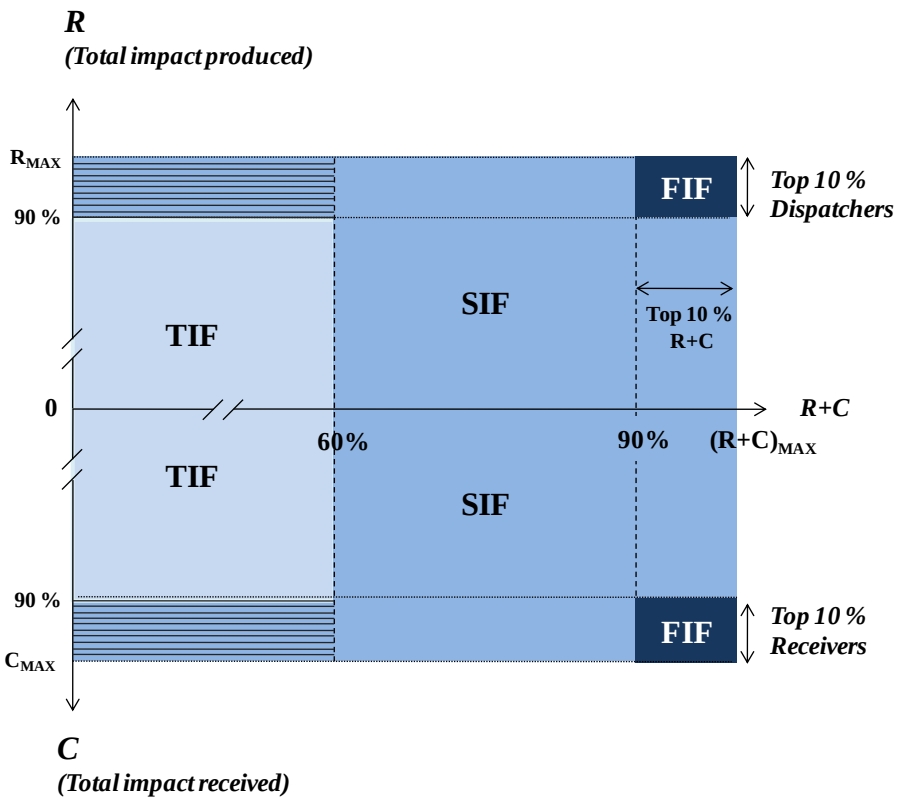


Fig. 18. Proposed framework extension

d. Derive the Sustainability Strategy Map (SSM)

Based on the DEMATEL graphical layout, we derive the SSM in a systematic manner. Since factors (here the SBSC perspectives) are categorized as FIFs, SIFs, and TIFs, the most important and impactful perspectives are readily recognizable, namely the dispatching FIFs. These perspectives contribute most to the system's overall influence and retain the highest overall importance. Therefore, they should be placed at the bottom layer of the SSM as impact generators. On the other hand, the receiving FIFs are the most importantly influenced perspectives with the highest overall importance as well. They should, hence, be placed at the top layer of the SSM as impact receivers. In between, SIFs will be placed according to whether they are dispatching (below) or receiving (above). TIFs, being the least important elements of the system (with the least total impact produced and received), are discarded and not incorporated in the resulting arborescence. The influence relationships exerted are represented by directed arrows linking perspectives with one another (Fig. 19). These links are derived from the α-cut total influence matrix T'.

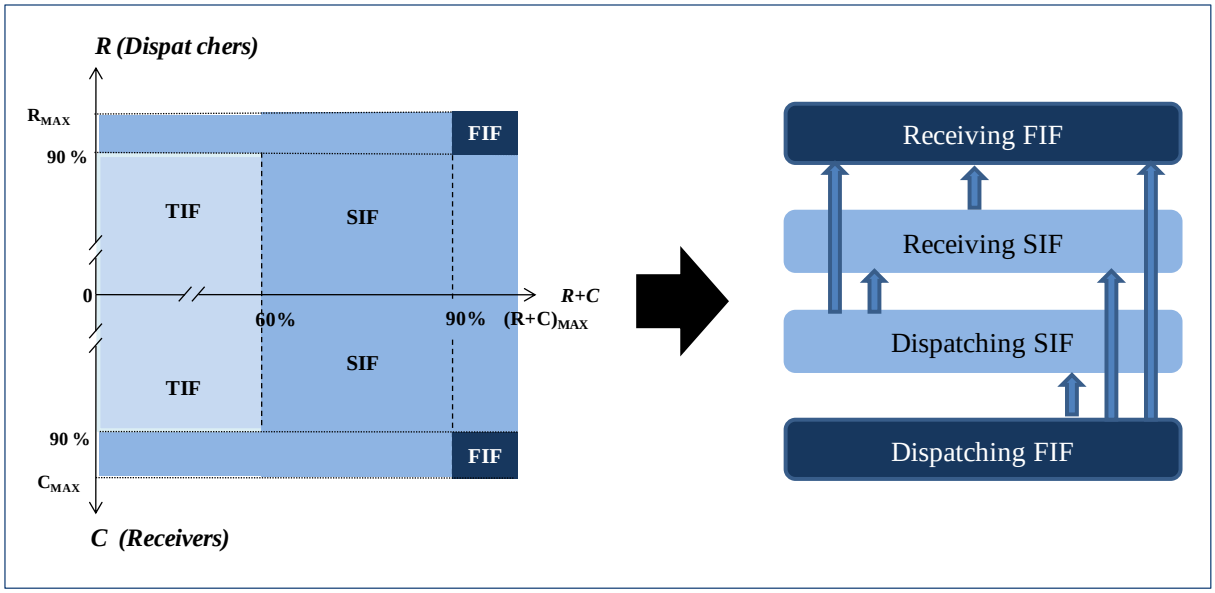


Fig. 19. Deriving the adaptive SSM from DEMATEL graphical layout

It is important to note that some perspectives will be arranged in clusters. A cluster is formed when two or more elements are placed at a distance of less than or equal to 10% of the maximum importance ($(R+C)_{MAX}$:horizontal axis) or maximum impact produced or received (R_{MAX} or C_{MAX} :vertical axes). In the final ASBSC, clusters are included in one single element when there is at least one relationship linking them. Fig. 20 presents an illustration of clusters and how they are translated into hierarchies in the final SSM. From a decision making standpoint, a cluster of factors represents the group of factors which deserve the same amount of attention and analysis from management. In fact, these factors either have nearly equal overall importance, or generate or receive similar overall impact.

Once the SSM generated, we determine a priority order of KPIs within each perspective to help management focus on the most important performance indicators. These priorities are calculated based on AHP method.

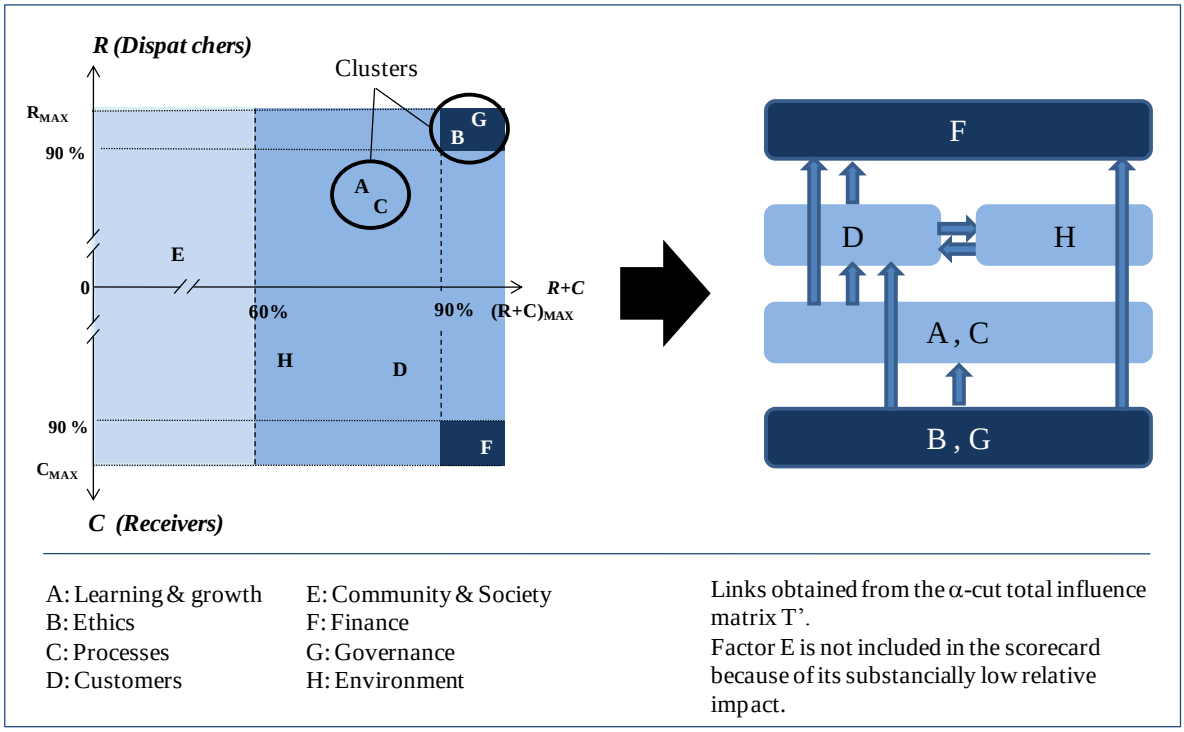


Fig. 20. Illustration of the use of layout clusters to derive the adapted SSM

e. Define KPIs per perspective

For each perspective, a set of performance indicators (KPIs) is defined by a lead expert. This expert could be a manager in charge of sustainability within the organization, or a manager knowledgeable about performance management and the specific KPIs mostly used to monitor corporate activity. In either case, the lead expert is expected to work in close collaboration with other managers from other departments to make sure their priorities and specific needs and taken into account.

f. Prioritize criteria with AHP and validate obtained weights

A comparison matrix is constructed for each perspective to allow pairwise importance comparison amongst indicators. Following AHP method described in Section 3.1.2.2, importance weights are derived in the Eigen vector , and a corresponding Eigen value λ is calculated. To check for model consistency, a consistency index (CI) is calculated along with the consistency ratio (CR).

The consistency ratio (CR) helps gauge the model's consistency. In other terms, if the calculated CR is below a certain threshold (Section 3.1.2.2), the weights are accepted as priority levels, otherwise, the model presents inconsistencies that need to be corrected. To correct for model inconsistency, it is required to revisit the pairwise comparisons entered in the initial comparison matrix C such that more logical sequences are respected. The user is then required to put more thought into the comparison

values he/she defines for each couple of indicators. In this phase, it might prove useful to discuss the possible evaluation levels with colleagues and subordinates in order to resolve inconsistency.

After inconsistency is cleared out, the model is accepted and the resulting Eigen vector W* is used as the ultimate priority vector.

It is important to mention here that AHP method is used as a method for filtering out "unnecessary" indicators. Indeed, we follow the 80/20 Pareto principle which suggests that the largest impact is made by a small number of key indicators. This is consistent with the BSC philosophy of focusing on a small number of strategic measures and it also makes practical sense – the human brain simply cannot process too much complex information (Hubbard, 2009).

The method presented above leads to the systematic generation of the ASBSC such that the resulting scorecard is adapted to various organizational contexts and industries. Yet, this resulting scorecard represents a static picture of the current state of the organization. In fact, while the ASBSC provides management with a strategic hierarchy of priorities and related metrics, it does not bring a visual representation of the future organizational dynamics. In the following section, we introduce a conceptual methodology for adding *Time dimension* to the ASBSC.

3.2 ADSBSC: Adding the Dynamic Component to the ASBSC

In response to the drawbacks posed by the traditional BSC (Akkermans & Van Oorschot, 2005; Barnabè, 2011), the Dynamic BSC was introduced and implemented on a few case studies (Akkermans & Van Oorschot, 2005; Rydzak et al., 2004; T. Zhang & Gao, 2008). However, none of the existing works has addressed extending System Dynamics (SD) modeling to the Sustainability BSC (SBSC). Moreover, the conceptual limitations accrued from system dynamics mental models dissimilarity make it even more urgent to take a step back and think of how these limitations can be addressed in a holistic and effective manner. A responsive framework for an unbiased Dynamic-SBSC can be, indeed, highly informative for companies and organizations at large as it has the potential to be a powerful tool for assessing the current strategy and testing the future one. In this section, we present a novel structured method for such a framework.

As a first step, the Causal Loop Diagram (CLD) is technically derived from the ASBSC using systematic analytical methods. Then, its corresponding time dimension is implemented on a System Dynamics tool where the whole model is checked, simulated and calibrated (Fig. 21).

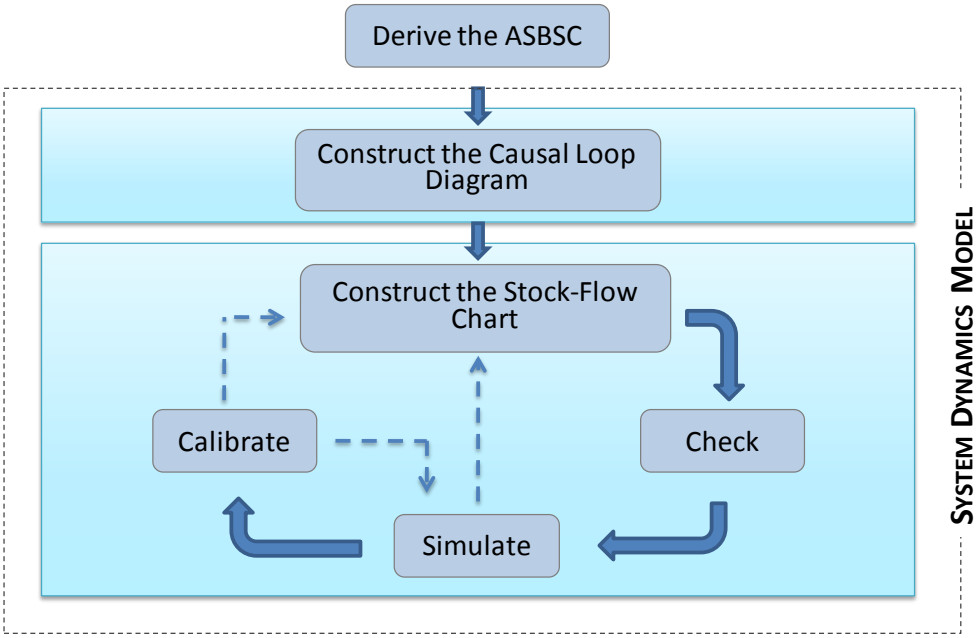


Fig. 21. ADSBSC construction methodology

3.2.1 The Causal Loop Diagram of the SD Model

In an earlier work, Chaker, El Manouar & Janati Idrissi (2015) present a System Dynamics (SD) modeling method based on DEMATEL. In the paper, the authors argue that existing SD conceptualization methods rely mostly on intuitionist mental model based assessment as opposed to rigorous objective

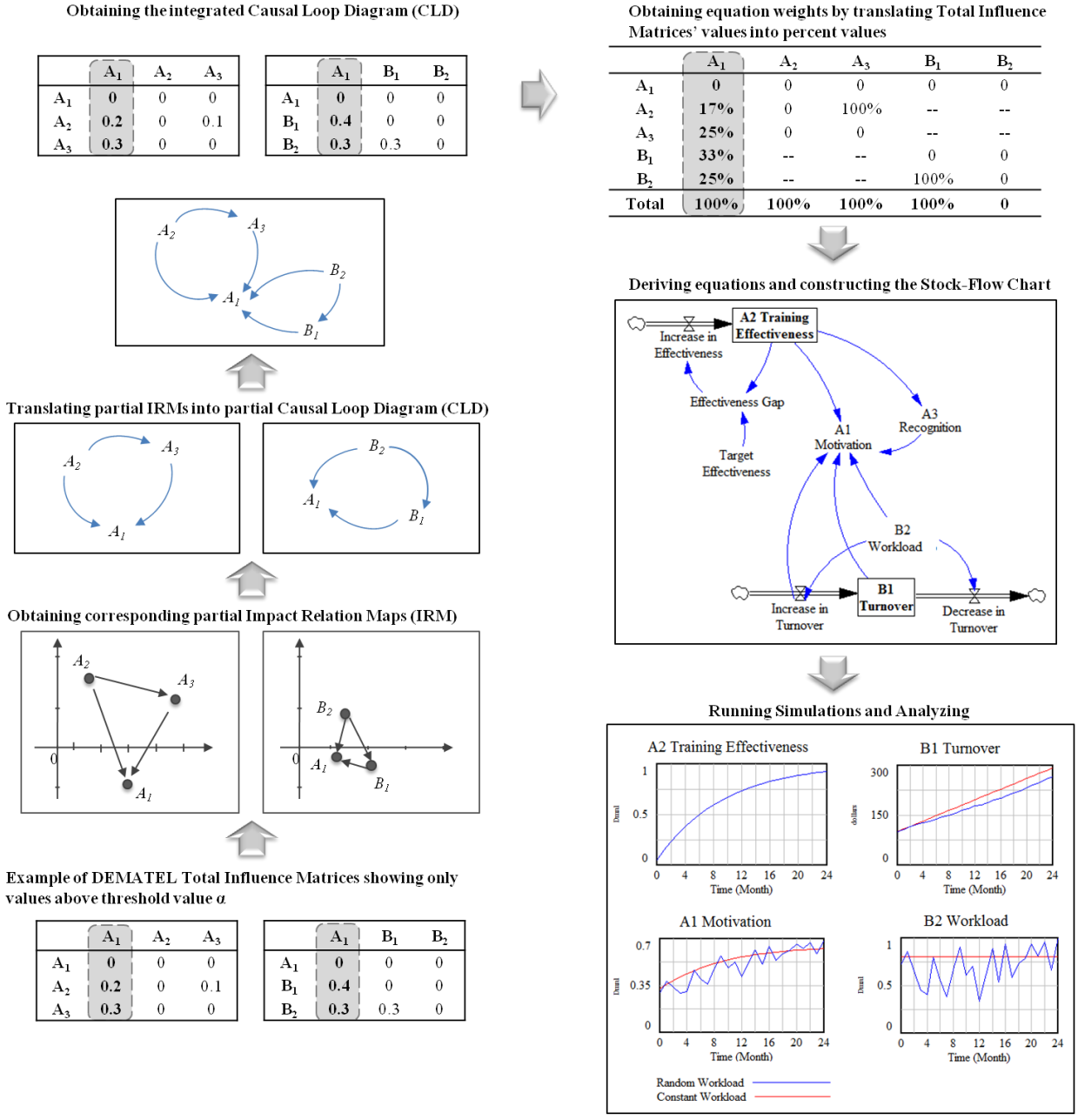
analysis. It is proposed thus to base the SD's Causal Loop Diagram (CLD) construction on DEMATEL's impact relation maps. As a result, the model enjoys both conceptualization robustness and dynamic time-bound simulation (Fig. 22).

Drawing on this very combination between DEMATEL method and System Dynamics, introducing the time dimension to the ASBSC corresponds to constructing the ASBSC as a SD model with appropriate inputs and calculated outputs. As such, the modeler can run simulations under various scenarios over time and observe how the ASBSC behaves over the short, medium or long term.

Combining the balanced scorecard and system dynamics has been explored by a few authors who propose introducing the advantages of SD modeling into the classical BSC (Akkermans & Van Oorschot, 2005; Barnabè, 2011; Rydzak et al., 2004) (see section 2.2.4). Nonetheless, the following shortcomings are noted:

- Most studies rely on the classical SD construction process which is fundamentally based on managers' mental models and perception of reality. Therefore, as Akkermans and Van Oorschot (2005) truthfully noted, the main limitation of such studies lies in the "*modelling of 'mental models', not of the 'real world'*" (p.939), which highlights the importance of the modeling methodology proposed in this thesis.
- All previous studies used the predefined BSC architecture as described byKaplan and Norton (2000). Besides the structural limitation that this confinement entails (as explained in Section 2.2.5.4), building the dynamic simulation model around the predefined rigid architecture puts higher weighting on the cause factors in the lower layers than those in the upper layers of the scorecard as the simulation unfolds, which might lead to an over estimation of the role such factors can play in the system.
- None of the research works combining SD and the BSC, to our knowledge, has addressed the sustainability aspect of the scorecard by systematically integrating the environmental, social, ethics and governance dimensions in the model.

The proposed methodology for dynamic SBSC construction addresses all the shortcomings above. The first step consists of deriving the ASBSC as described earlier in this chapter (Section 3.1). Then, the SD model is constructed based on the causal relationships highlighted in the obtained SBSC. The CLD's role is to provide a visual representation of the existing relationships between dimensions and indicators. Sometimes, depending on contexts and industries, it might be necessary to delve into a particular dimension and create additional indicators and links within. Technically, the cause-effect relationships among these blocks are constructed using fuzzy DEMATEL as well. For instance, if the model is constructed for a company operating in the extractive sector, such as the mining industry, it would be necessary to analyze more deeply the *processes* block and develop additional indicators and resulting cause-effect relations.



	A_1	A_2	A_3
A_1	0	0	0
A_2	0.2	0	0.1
A_3	0.3	0	0

	A_1	B_1	B_2
A_1	0	0	0
B_1	0.4	0	0
B_2	0.3	0.3	0

	A_1	A_2	A_3	B_1	B_2
A_1	0	0	0	0	0
A_2	17%	0	100%	--	--
A_3	25%	0	0	--	--
B_1	33%	--	--	0	0
B_2	25%	--	--	100%	0
Total	100%	100%	100%	100%	0

Fig. 22. Illustration of the proposed DEMATEL-SD combination-based method (Chaker, El Manouar&JanatiIdrissi, 2015)

3.2.2 The Stock-Flow Chart and Time Dimension under a SD Tool

On a System Dynamics (SD) tool, the modeler defines the model stocks, flow equations, and desired outputs. Equations are based on both the organization's internal data and factor weightings derived from DEMATEL.

The modeler decides on which inputs are set and which ones are calculated. In particular, each dimension of the scorecard is represented by a *Dimension Index* which reflects the score of the dimension in the model. We distinguish between the *dispatching* dimensions and the *receiving* dimensions based on the Sustainability Strategy Map (SSM). For dispatching dimensions, the Index is calculated as a weighted average of the dimension's indicators that have been prioritized earlier. In fact, AHP priority weights are used as the weighted average weights. For instance, in the *Environment* dimension, the *Environment Index* is calculated as a weighted average of the three main indicators *Waste_recycling*, *Water_recycling*, and *Energy_efficiceny*. If the corresponding Eigenvector resulting from AHP indicates the following respective priorities 40%, 40%, 20%, then the Environment Index is calculated as in Eq. 17. Dimensions' indices are used as the connecting points between dimensions (Fig. 23).

$$\begin{aligned} \textit{Environment Index} = {} & \textit{(0.4 * Waste\_recycling)} + \textit{(0.4 * Water\_recycling)} \\ & + \textit{(0.2 * Energy\_efficiency)} \end{aligned} \tag{17}$$

As for the receiving dimensions, the Index is calculated based on a weighted average involving DEMATEL weights (eg. Eq. 18).

$$\begin{aligned} \textit{Process Index} = {} & \textit{(0.25 * Learning\&Growth Index)} + \textit{(0.3 * Governance Index)} + \textit{(0.15 * Ethics Index)} \\ & + \textit{(0.3 * Environment Index)} \end{aligned} \tag{18}$$

Nonetheless, given the complex interactions existing in real-life organizational contexts, it is sometimes necessary to assess the evolution of a perspective of the SBSC in more detail. In this case, one aggregated index is not sufficient to highlight some important interactions taking place within the system dimensions. We thus suggest using Fuzzy DEMATEL as an effective technique to determine the relationships amongst indicators of the same dimension. The causal linkages construction would then slightly change as shown on Fig. 24.

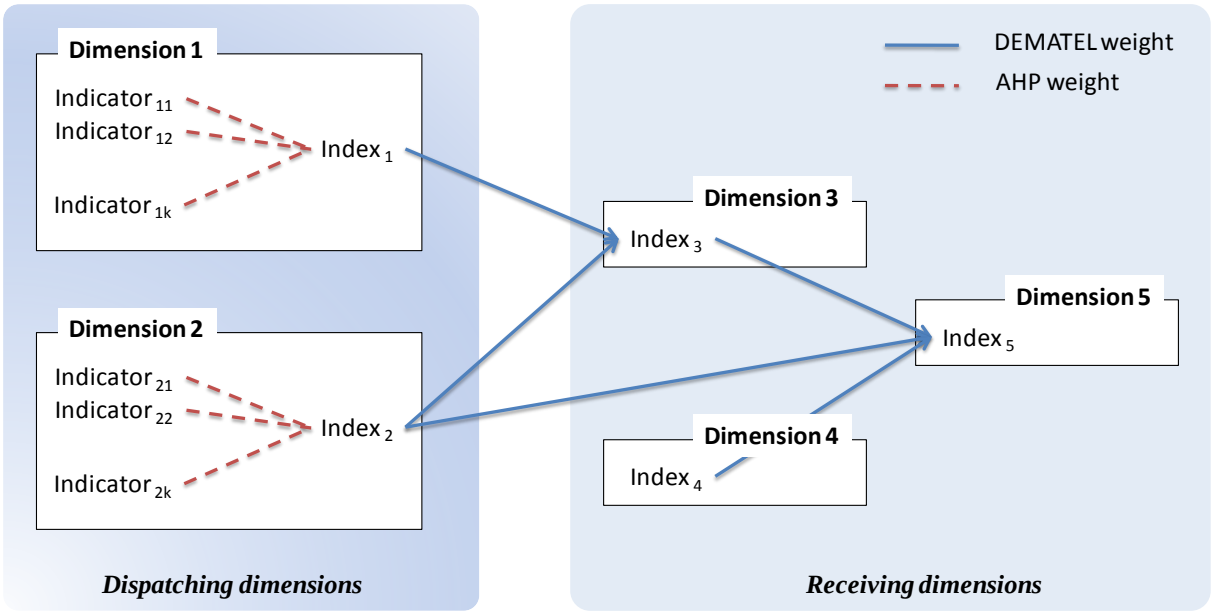


Fig. 23. Illustration of causal linkages construction in the ADSBSC

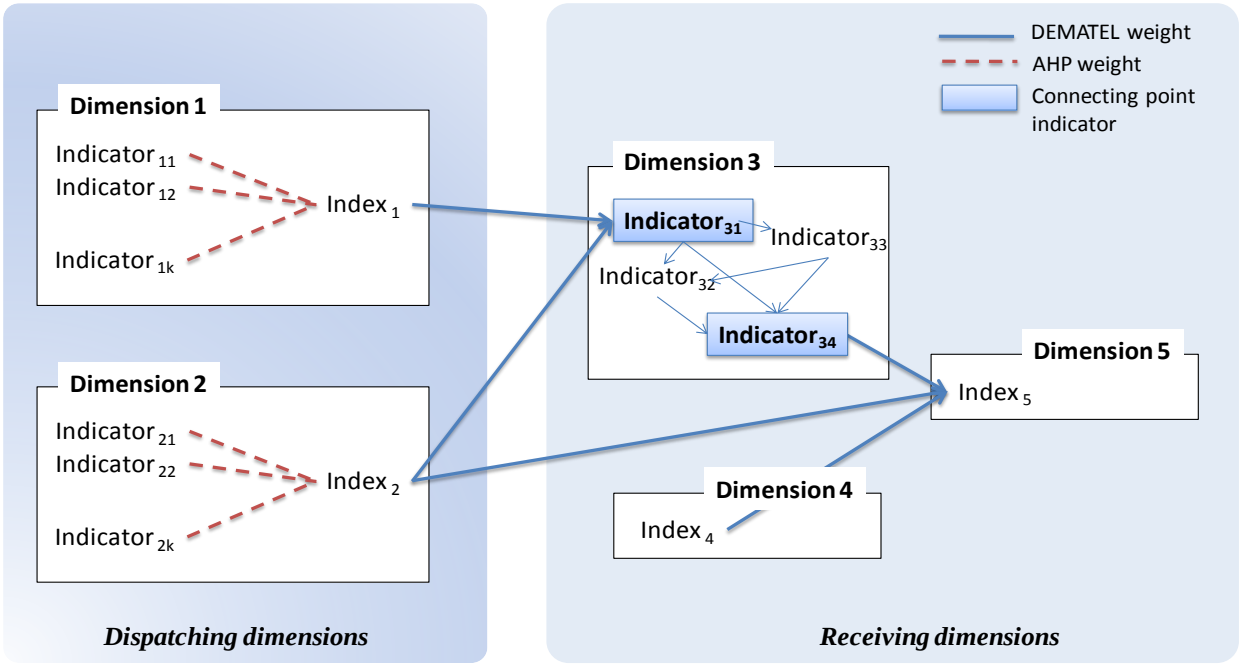


Fig. 24. Causal linkages with complex interactions

When the modeler is compelled to construct additional causal linkages in complex situations (eg.*Dimension3* in Fig. 24), he is required to determine the indicators, within the concerned dimension, which will serve as connecting points with the dispatching and receiving dimensions. We refer to this dimension as the *Complex Dimension*. To solve for this in a systematic manner, the source indica-

tor which receives impact from the aggregated indices of dispatching dimensions is the FIF with the highest impact produced within the complex dimension. The result indicator, which dispatches impact towards subsequent receiving dimensions, is the FIF with the highest impact received in the complex dimension. To illustrate, in Fig. 24, $Indicator_{31}$ is the source indicator of *Dimension3* (which is a complex dimension). It serves as the impact receiver from *Dimensions 1* and *2*, while $Indicator_{34}$ is the result indicator which will transfer impact to *Dimension5*.

More practically, on the implementation side, each dimension of the ADSBSC corresponds to a stock with an inflow and an outflow. Generally, an arrow representing a cause-effect relationship translates into an outflow from the cause factor, which, combined with other variables, constitutes the inflow of the effect factor.

Polarity in the model is determined based on research findings that explored the various relationships in the model. For instance, it is shown that trust has a positive effect on loyalty, that quality has a positive influence on satisfaction, and that higher customer satisfaction is associated with higher level of trust and leads to higher levels of loyalty (Chumpitaz Caceres & Paparoidamis, 2007). This polarity is highlighted in the model's equations using positive or negative correlations between the dependent variable and the independent variables.

As for the type of relationships found between the SBSC's dimensions, most literature works converge to linearity as a common pattern. Tournois (2015) uses regression analysis to examine the linear relationships in the value-satisfaction-loyalty-reputation chain in brand management companies. In a more general study, V. Kumar, Dalla Pozza, and Ganesh (2013) conduct a literature review where they find that, aside from a few exceptions, linearity is the most common relationship shape between the factors above. Therefore, in this thesis work, we assume linear equations to construct the ADSBSC model.

3.3 Discussion of the ADSBSC Framework

The proposed Adaptive SBSC framework brings some salient benefits:;

1. ***The scorecard's construction is adaptive:*** the cause-effect arborescence of perspectives will not be the same across organizations, industries and sectors. This flexibility allows to more precisely capture the structural differences that exist between organizations and across industries, which results in various priorities in strategic decision making.
2. The ASBSC is constructed based on an ***unbiased mathematical decision making*** technique (DEMATEL) which involves a group of experts as input providers. The use of this systematic method helps to clear away much of the modeling restrictions pertaining to subjectivity bias and mental models limitations.
3. ***The SBSC is encompassing***: It clearly identifies the dimensions of *ethics* and *governance* as standalone perspectives given the paramount importance they play in shaping business performance. This particular characteristic could prove highly useful for firms and organizations that wish to be well prepared for the various CSR or sustainability certifications.
4. In addition to systematically-drawn cause-effect relationships, the constructed ASBSC is further enriched with ***KPI prioritization within each perspective***, which provides managers with an additional decision making tool.

In addition, the dynamic component of the scorecard, or the ADSBSC, makes an important addition to research:

5. The ***time dimension in the ASBSC*** confers the scorecard all the benefits of system dynamics modeling, feedback loops and emergent self-organization, which are crucial elements that managers need to grasp in real life decision making.
6. The ***methodological construction of the System Dynamics part*** of the framework using a structured combination of multi-criteria decision making techniques constitutes ***a leapfrog*** that reduces to a great extent −if not eliminates− the mental models bias in system dynamics modeling.
7. When a perspective is deemed complex enough to be further explored, the model offers the possibility to structure causal linkages amongst indicators within that perspective, which enables ***better representativeness of reality*** and its complexities.
8. The overall proposed methodology offers ***simplicity of execution***: managers generally have little time and need efficient and easy-to-implement solutions in order to maximize the chance that the solution is adopted at all corporate levels and departments.
9. The proposed framework is ***stronger with technology***: the rule-based generation of the ASBSC, thanks to the novel graphical representation of DEMATEL outcomes, makes it possible to comput-

erize this generation process (see section 3.4), enabling thereby massive distribution and use of information technology while still respecting the particularities of each organizational context.

10. The proposed framework is ***a real instrument for decision making***: The combination of priority levels resulting from DEMATEL and simulation results permit to instantly detect the sustainability perspectives with the highest overall importance and influence on the business activity. For management, this translates into well-informed investment decisions and sound management practices at the business unit and corporate levels.

While the proposed ADSBSC construction method brings an important addition to sustainability management research, it raises, nevertheless, some questions that can translate into perceived limitations:

1. Ignoring TIFs in the ASBSC generation may lead to the omission of some useful information. At first glance, this rule might appear rather drastic. However, we respond to this question by the fact that the omitted dimensions are only those deemed least important for decision making (they have the lowest values of R+C). In addition, the ignored dimensions are the ones which are responsible for the least impact produced or received. Therefore, and for the sake of presenting to managers only the essential and most important information, the trade-off is made of removing TIFs from the scorecard even though this might come at a small cost.
2. The use of AHP method presupposes the absence of interrelations between KPIs. It is true that performance indicators can display, at times, some order of influence, thus suggesting the use of the Analytic Network Process (ANP), in which case comparison matrices would include both KPIs and their corresponding perspectives (T. L. Saaty, 2001). However, using ANP necessitates a large amount of evaluations to be made at the comparison matrix level, translating into a great amount of time to be spent by managers on the topic. Taking a simple illustration, with eight dimensions at hand, and assuming only three KPIs per dimension −which is quite conservative− ANP method would require a manager to make 552 pairwise comparisons each time she attempts to construct the scorecard. Coming from a managerial perspective, this solution seems unrealistic, and could therefore be quickly rejected by decision makers.
3. The formulae based cause-effect relationships in the System Dynamics model might overlook some additional variables that the modeler might feel compelled to add to the model, especially when there is particular need to further elaborate on a perspective of the scorecard. In such a case, the model might need to resort to a combination of decision-aid techniques (such as fuzzy DEMATEL/AHP) and her/his best judgment.

3.4 About the Automation of the ADSBSC Framework

As presented in the previous section, the ADSBSC can be an effective decision-aid framework for sustainability strategy creation and implementation. The aim of this section is to assess the extent to which our proposed framework can be technologically deployable and scalable.

Today's technological advances have made it easier to share large amounts of information instantaneously and at significantly low costs. While the ADSBSC can bring a valuable solution for sustainability strategy creation and implementation at the corporate level, its technological deployment can be even more appreciated as it will bring additional value both in terms of integration with organizations' existing IT infrastructure and in terms of gain in execution time and costs.

The technological deployment process of the ADSBSC system within organizations is inspired from the PDCA (Plan-Do-Check-Act) management cycle (Basu, 2004)and is customized for our needs with an augmented version (Fig. 25). The deployment process starts with understanding organizational needs and translating them into specific and measurable objectives. Next, data is collected, treated and organized into specific frames so as to deduce the SSM and the ASBSC. The dynamic model is then built around the resulting ASBSC, with cyclical checks and simulations until the resulting ADSBSC is satisfactory. Finally, analysts and decision makers interpret the final outcomes and decide on the choices to be made.

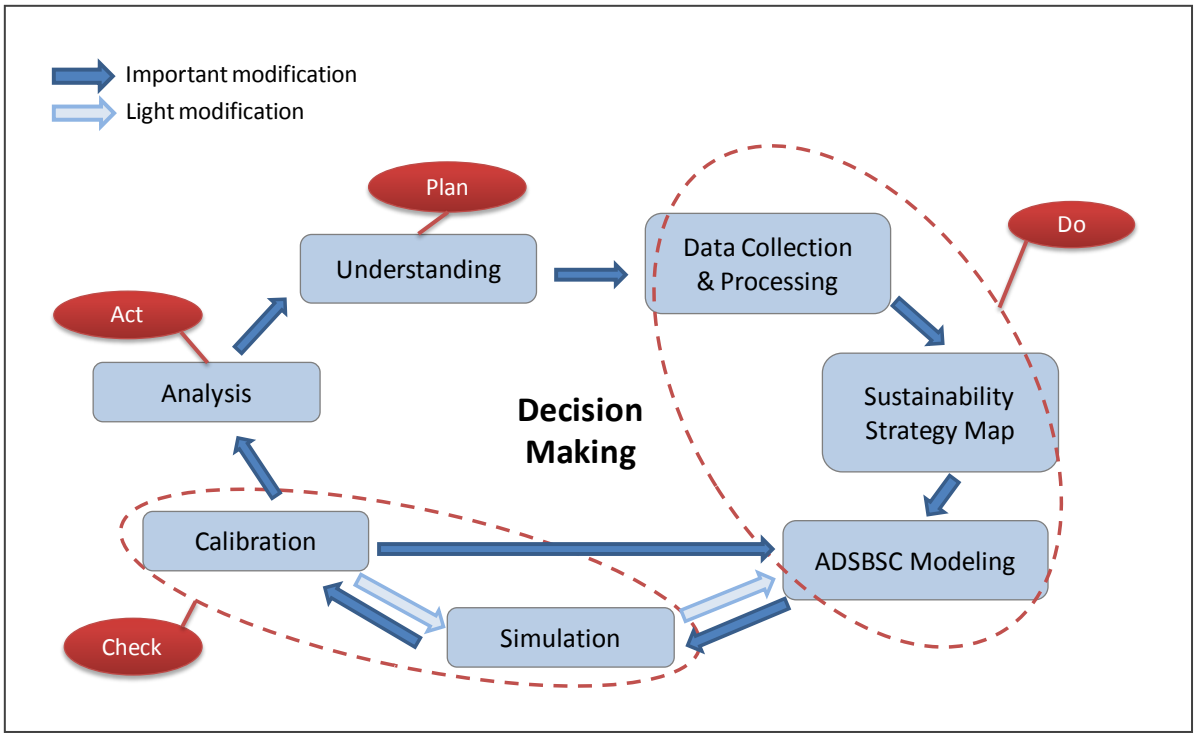


Fig. 25. Technological deployment of the ADSBSC

In this cycle, some components are readily automatable, while others are either semi-automatable or non-automatable (Fig. 26). The following section presents further detail on the automation possibilities of the ADSBSC.

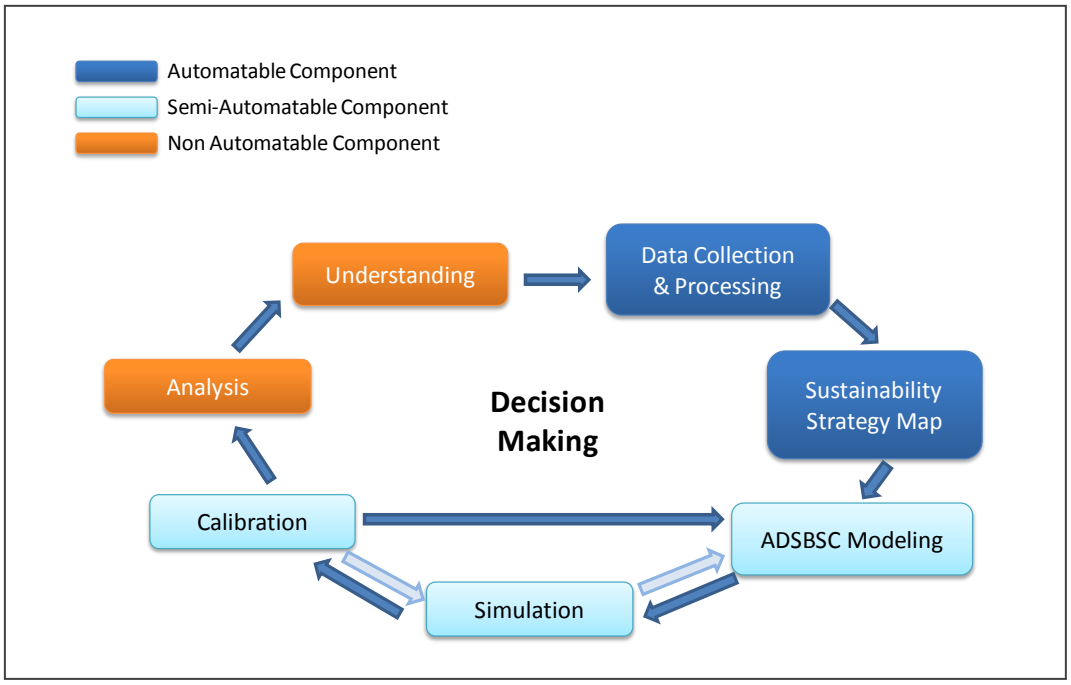


Fig. 26. ADSBSC's components automation

3.4.1 Automatable Components

The platform proposed to support the ASBSC is a solution aimed at helping firms and organizations in general create their sustainability strategy map and construct the corresponding ASBSC. It is an interactive platform through which the user can enter technical or non-technical information about the company, growth targets, measurements, and tie them to budget and execution agents.

In this section, the most salient system design elements are proposed, namely, platform users, processes and eventual deployment architecture.

3.4.1.1 Platform Users

The Platform offers users the possibility to actively contribute to the creation of their organization's sustainability strategy. The platform allows the end user to use the organization's existing indicators, or create new ones, and prioritize them by topical perspectives. Users are then invited to define specific measurement targets per KPI, along with a corresponding action plan (budget, time line, agents, etc.)

Because the methodology involved implies the contribution of many users, namely to construct the sustainability strategy map using fuzzy DEMATEL technique, the platform should allow a centralized management of inputs, calculations, and outputs.

The platform is handled by a lead user (LU) and a panel of contributors. The LU defines the initial environment and parameters which feed into the application such as company information, the contributors' contact information, the sustainability performance indicators, etc. The LU and contributors connect each to the platform in order to enter and submit their respective pair wise impact matrices. After all calculations have been carried out by the application to produce the sustainability strategy map (SSM), the LU and contributors are invited to define, or use existing, KPIs for each strategic perspective that appears on the resulting SSM. They fill in additional pairwise comparison matrices in preparation for the AHP process, in case the dimension is not complex, or the DEMATEL causal network, in case the dimension is complex. They submit input data to the application's calculation engine. The returned result is the ASBSC with systematically constructed cause-effect relationships between perspectives, with prioritized KPIs and/or causal network, and corresponding action plan windows (Fig. 27). The resulting ASBSC is shared with all contributors.

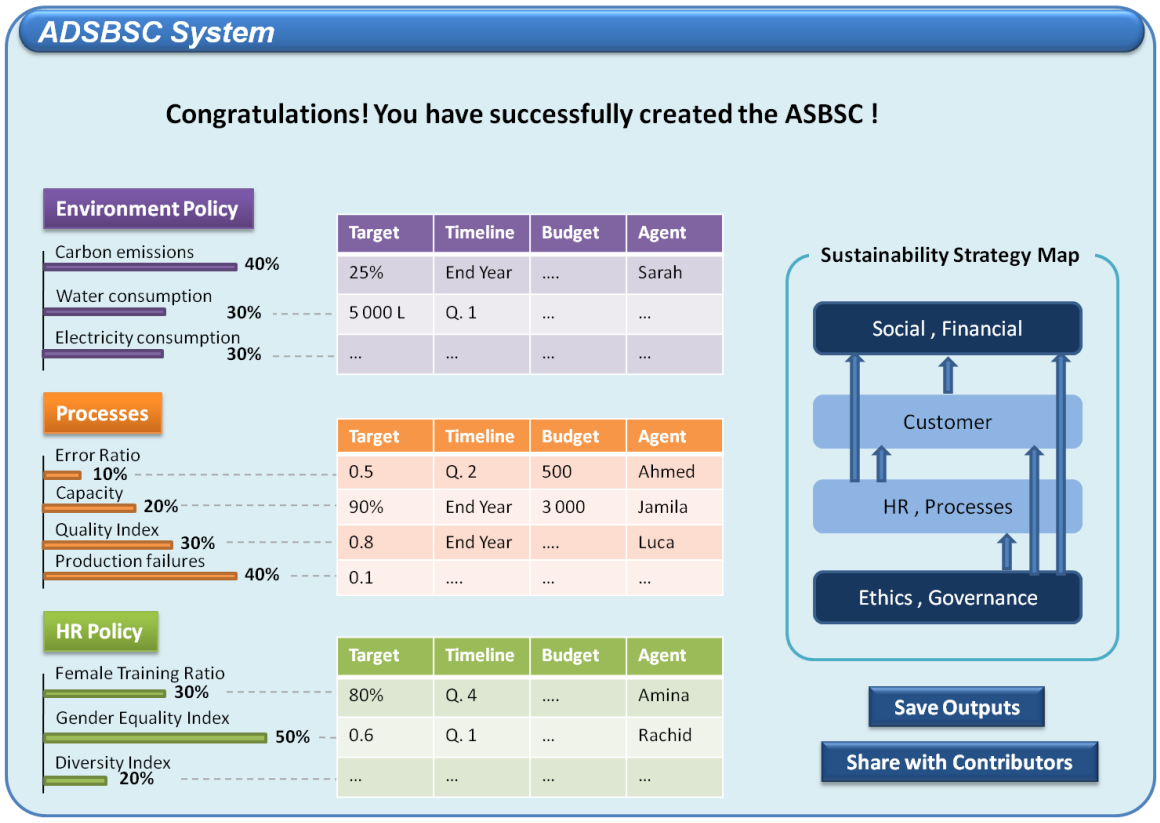


Fig. 27. Illustration of the final ASBSC showing details for three (non complex) dimensions

3.4.1.2 Processes

Users interact with the ADSBSC platform following a specific process (Fig. 28).

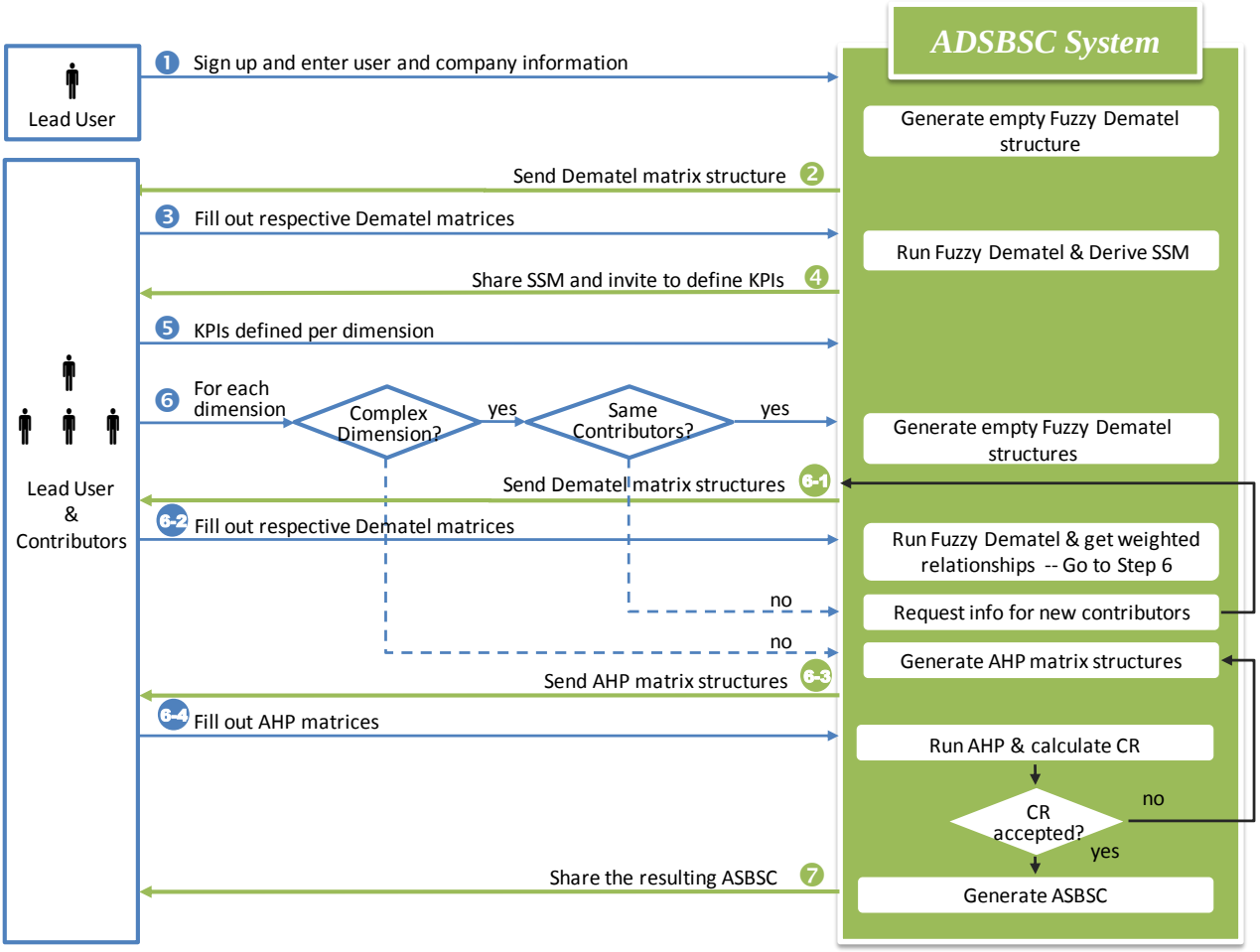


Fig. 28. The ASBSC generation process

First, the LU signs up or logs in to the application. She is asked to enter some information related to users and the company, and is immediately asked to start constructing the SSM. An explanatory window appears describing the steps involved in the creation process, and upon accepting the terms of use of the application, the LU starts filling out the first initial direct cause-effect matrix. Other contributors receive the same explanatory steps along with the matrix that they are invited to fill out.

Once data from all contributors is collected, the platform runs revised fuzzy DEMATEL method (as presented in section 3.1.2.1), uses the proposed graphical representation and derives consequently the adapted SSM.

This result is shared back with the LU who is then invited to specify KPIs for the perspectives that appear on the SSM. The LU discusses and validates KPIs with other contributors. This is important for two main reasons: first, contributors are generally managers who will be subsequent users and executors of the defined sustainability strategy, therefore, their contribution in the strategy creation process is paramount to guarantee a successful implementation and use of the solution. Second, taking into account various managers' viewpoints will help produce better outputs when it comes to defining discipline-specific KPIs. In fact, a financial manager would be more successful in defining the right financial targets than the environment manager would be, the latter, in turn, is more knowledgeable about emissions, recycling performances...etc.

After defining the right KPIs, the LU and contributors are asked to specify whether the dimension is complex, in which case they are presented with a set of fuzzy DEMATEL matrices to fill out, otherwise, they are asked to fill out a corresponding AHP matrix. AHP is used to define priorities and to validate them based on the calculated consistency ratio (CR). If the ratio is not acceptable (Section 3.1.2.2), the concerned contributors receive a notification inviting them to reconsider the weights entered in the matrix where the problem occurred. The calculations are carried out a second time and as long as necessary until an acceptable CR is reached. At that point, the system gathers all calculated data and generates a summative output screen showing the SSM along with graphically prioritized KPIs and corresponding areas where the decision makers can type in detailed action plan information. It is not necessary to show the complex dimensions' IRMs, if any, in the final ASBSC as they will be more useful in the dynamic part of the system (the ADSBSC). This resulting ASBSC can be printed out and distributed to key decision makers at various organizational levels within the company.

3.4.1.3 Architecture

The architecture we propose for the solution's implementation reflects both the achievable scope and desired scale of the platform. This platform should be both effective –by responding exactly to the predefined specifications– and technologically accessible by a large array of organizations in various industries and geographical areas. In this regard, we believe that a well-designed computerized system should easily respond to the sometimes complex mechanisms and calculations involved in the proposed method, thus achieving the effectiveness objective. We also suggest that a distributed architecture allowing monitoring flexibility and large enough scale will serve the accessibility objective.

In an era of high mobility, high risk and fluctuations, advanced technology is offering solutions which help mitigate uncertainty while maximizing efficiency. One of these solutions which had recently gained tremendous popularity is *Cloud Computing*. Thus, for our framework, we suggest building the automatable components of the ADSBSC around a Cloud-based platform.

Cloud computing is a new paradigm whereby a firm or organization outsources the management and provision of its computing needs to a third party who offers software, data access, storage, computing capacities, infrastructure monitoring and application services. It is a configuration where computing and data are taken away from desktop and local servers to distant data centers whose physical location or system configuration are not necessarily known to the client (Dikaiakos, Katsaros, Mehra, Pallis, & Vakali, 2009). Therefore, under this paradigm, users and companies are no longer strictly obliged to own and manage their own infrastructure, applications and data, instead, they are offered the possibility to have on-demand access to the type of service they wish without worrying about system design, maintenance and evolution. In cloud computing, users benefit from an array of advantages ranging from on-demand use to resource pooling and automatic elasticity (TABLE 12).

TABLE 12. COMPARING TRADITIONAL COMPUTING AND CLOUD COMPUTING

	Traditional Computing	**Cloud Computing**
Infrastructure	Privately owned	Shared resources
Resources	On premises	Third-party (or locally)
Scalability	Scale-up	Scale-out
Cost	Fixed	Usage-based
Reliability	Assume reliable infrastructure	Expect infrastructure failure
Maintenance	On site	Outsourced
Management	Traditional	Automatic

Generally, cloud computing is built around five key characteristics (On-demand self-service; Wide access; Resource pooling; Elasticity and Measured service), three service models (Software as a Service (SaaS); Infrastructure as a Service (IaaS); Platform as a Service (PaaS)), and four deployment models (Public, Private, Community and Hybrid (Mell & Grance, 2011) (Fig. 29 and TABLE 13).

TABLE 13. MAIN CHARACTERISTICS OF CLOUD COMPUTING DEPLOYMENT MODELS

	Public	**Private**	**Community**	**Hybrid**
Using organizations	Multiple	Single	Multiple with shared concerns	Single or multiple
Consumers	General public	Multiple within the organization	Multiple within the community	Multiple
Ownership, management, operation	Business, academic or government organization (or combination)	Organization or 3rd party (or combination)	One or more organizations of the community or 3rd party (or combination)	Single or multiple organizations
Location	On the premises of the cloud provider	On or off premises	On or off premises	On or off premises

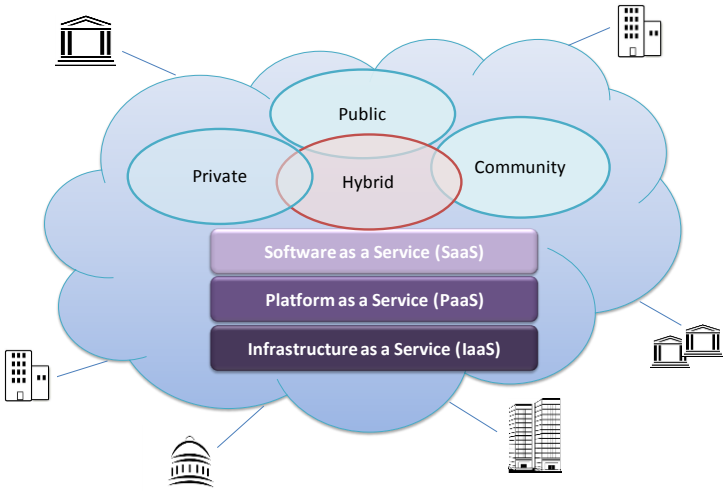


Fig. 29. Cloud computing descriptive scheme

The platform should be able to collect users' data, process them, and share back results in user-friendly interfaces. Since the application is expected to help respond to strategic planning needs which take place irregularly, the platform should also be able to manage the rise in demand for resources and capabilities. Finally, the architecture should take into account a safe storage area where consumers' data will be safe-guarded for the long run.

To respond adequately to these needs, we suggest that the solution be developed on a software programming language, then incorporated into a PaaS which will be supported by an IaaS environment. As for deployment, it is suggested using a hybrid configuration combining a private cloud and a public cloud (Fig. 30).

In the proposed architecture (Fig. 30), end users connect to the application via web browser. The application is embedded into a PaaS environment, itself supported by an IaaS. Both the application and the corresponding PaaS and IaaS are deployed on a secured public cloud to take advantage of resource pooling and reduce therefore deployment costs. Additionally, the number of users being highly elastic and fluctuating irregularly, it is not necessary to dedicate large CPU and processing resources on a permanent basis. The PaaS deployed on the public cloud automatically manages resource allocation depending on demand. Finally, since the application is used by consumers only on a punctual basis during specific periods of the year (the budgeting periods), there is no need to dedicate a private cloud to its deployment on a constant basis; a well-secured public cloud is more appropriate. A private cloud is however needed for important data storage. More particularly, organizing clients' data on a data warehouse could prove highly useful for future purposes. Therefore, such critical data needs constantly allocated space on a highly secured environment.

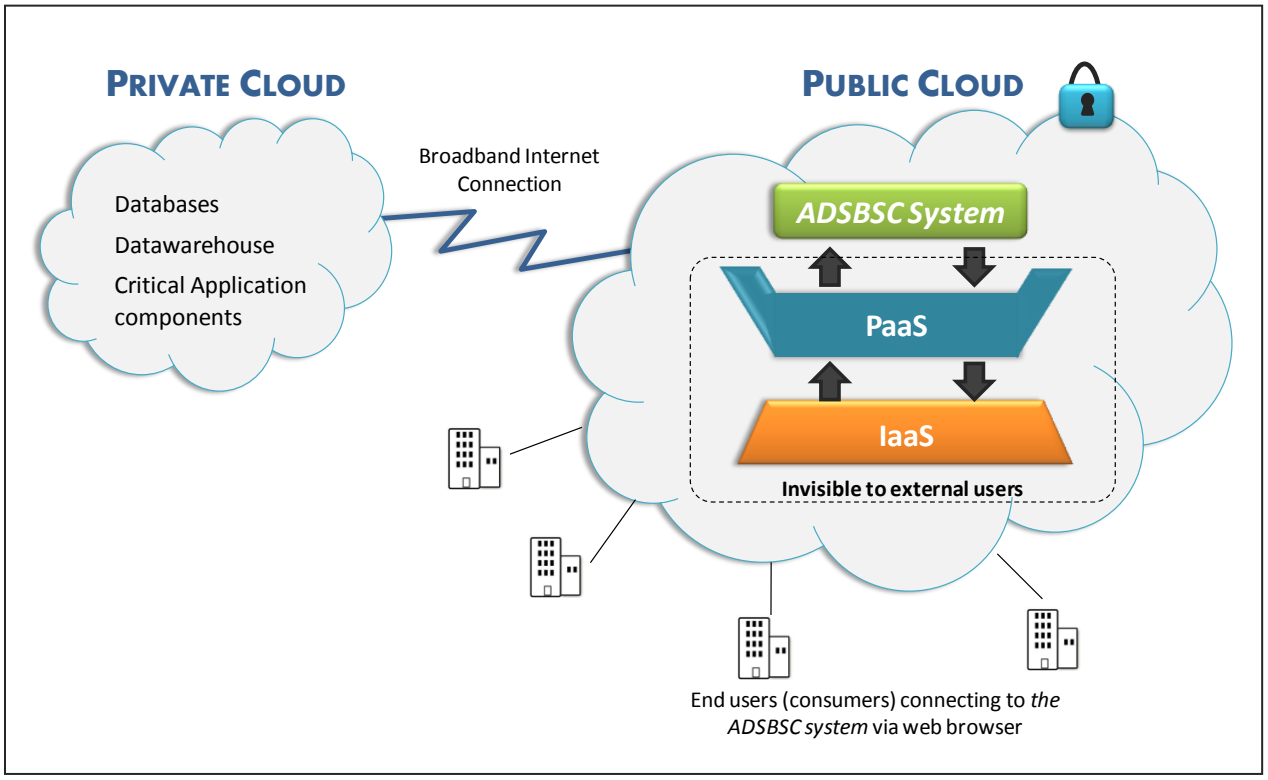


Fig. 30. Proposed hybrid cloud architecture for the ADSBSC system

3.4.2 Semi-Automatable Components

Thanks to system dynamics modeling, the ADSBSC is effective in conceptualizing and simulating the complex interrelations within organizational components. It allows managers not only to understand trends and the mechanics behind, but also to pinpoint the critical levers needed to trigger growth. However, constructing a system dynamics model involves a significant amount of manual configuration. Tasks and agents depend strictly on organizational contexts and can hardly be standardized, which requires the modeler to conduct thorough analysis and to make use of a high level of customization in order to create the different building blocks of the model.

There are multiple software that support system dynamics modeling (AnyLogic, Vensim, Analytica, Powersim, NetLogo, etc.) Like any platform which offers modeling and simulation, these software require the modeler to carefully define variables and distributions along with execution rules. It is therefore difficult to generalize objects and relationships linking them in a standardized fashion. In fact, each SD model is designed for a particular setting that is related to particular agents, with particu-

lar stories, information, and decision rules. This high level of particularity cannot be possibly captured in one general form consistent across organizations, industries, sectors, and geographical areas.

More technically speaking, while the ASBSC helps to automatically derive the source indicators and target indicators in a cause-effect chain, it does not specify the nature of these indicators (eg. stocks or variables), nor does it specify how reinforcing and balancing loops should be constructed within the model. There is, in fact, an important amount of customization to be made by the modeler in this process.

As far as simulation and calibration are concerned, the modeler is definitely an important agent who cannot be replaced by a automated process because of the subjective judgment involved in reading and analyzing simulation results. The modeler may add or remove components, rewrite some equations, and make as many changes as necessary until calibration is satisfactory.

While the above arguments are not exhaustive, they are sufficient to argue that system dynamics model construction cannot be automatically generated from an existing cause-effect map such as the ASBSC.

3.4.3 Non-Automatable Tasks

Once the model is deemed to be good enough for analysis, decision makers interpret results, draw conclusions and decide on the future strategy. These are tasks that only a human can perform, at least if seen within today's technological constraints.

CHAPTER IV:

ADSBSC IN ACTION: THE CASE OF UNILEVER MAGHREB

CHAPTER 4. ADSBSC IN ACTION: THE CASE OF UNILEVER MAGHREB

4.1 Problem Description

Unilever is a multinational corporation operating in the Consumer Processed Goods industry(CPG). It serves 2 billion people in 190 countries with products including food, beverages, home care and personal care agents. Unilever is the world's second largest CPG company after Procter & Gamble, with revenues of $54 billion from over 400 brands(Forbes, 2015; Unilever, 2015b). To bolster its growth strategy, Unilever introduced in 2010 the Unilever Sustainable Living Plan (USLP) which is the company's blueprint for achieving the vision to grow business while reducing environmental footprint and increasing social impact (Fig. 31). USLP sets stretching targets whereby the company collaborates and partners with others in business to transform the way its raw materials are sourced and how its consumers use brands (Unilever, 2017).

Fig. 31. USLP guiding principles

In 2014, Unilever was already reaping tangible benefits from its USLP strategy. Sustainable living brands grew at twice the rate of other Unilever brands, and half of the company's growth, during the same year, was driven by sustainable living brands (Unilever, 2015a). However, growth trends were not similar across geographic areas. In Maghreb region, sales have not followed the same expansion as achieved worldwide. This seemingly controversial situation spurred our interest in understanding the underlying sustainability strategy, its functioning (or malfunctioning), and the plausible paths that could be followed for potential growth. More particularly, we were interested in understanding how sustainability is −and could be best− incorporated into the corporate strategy structure and its execution plan. For this aim, a case study was conducted with the leadership team at Unilever Morocco in order to build a conceptual and simulation model that is able to both describe the existing sustainability strategy and help draw the future one. The project started on September 2016 and results were delivered on January 2017.

4.2 Drawing the Strategy with the ASBSC

This section addresses the automatable part of the ADSBSC. It presents the generation process of the ASBSC for the Unilever case following the technical steps described in the previous chapter. This process starts with data collection, then SSM generation through fuzzy DEMATEL technique, and ends with defining and prioritizing/linking KPIs within each perspective. The result is a well-structured and populated ASBSC.

4.2.1 Data Collection

At Unilever, the ASBSC is used as an approach to appraise the current strategy and to help deduct the future one. For this project, the ASBSC is derived based on the methodology presented in CHAPTER 3. . Questionnaires were conducted with seventeen directors and managers inside and outside the company (see Appendix) to fill out two sets of DEMATEL pairwise comparison matrices with fuzzy extension. The first set describes pairwise comparisons as currently seen by participants, the second set describes the *"ideal"* situation for the company.

In addition, as the *Consumer* dimension has been identified as a *complex dimension*, a corresponding set of DEMATEL impact matrices was distributed to contributors from the Marketing Department.

4.2.2 Applying Fuzzy DEMATEL

The collected data served as the system input to run fuzzy DEMATEL and obtain the corresponding total direct-indirect impact matrices (See Appendix). IRMs are also deducted automatically from the total impact matrices and the new graphical representation allows depicting dimensions by importance and intensity of impact produced or received (Fig. 32 & Fig. 33).

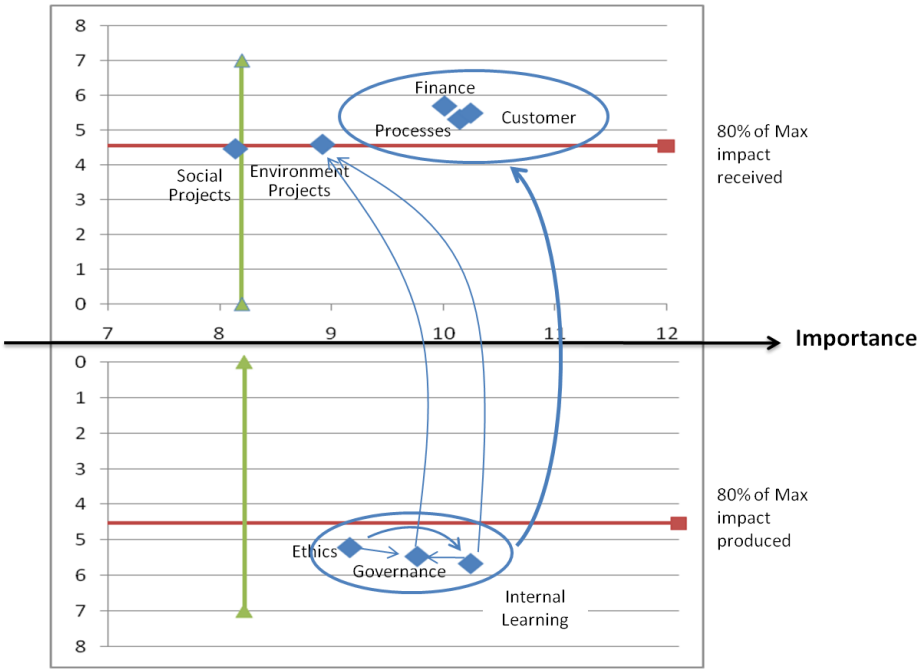


Fig. 32. Impact Relation Map for the existing strategy

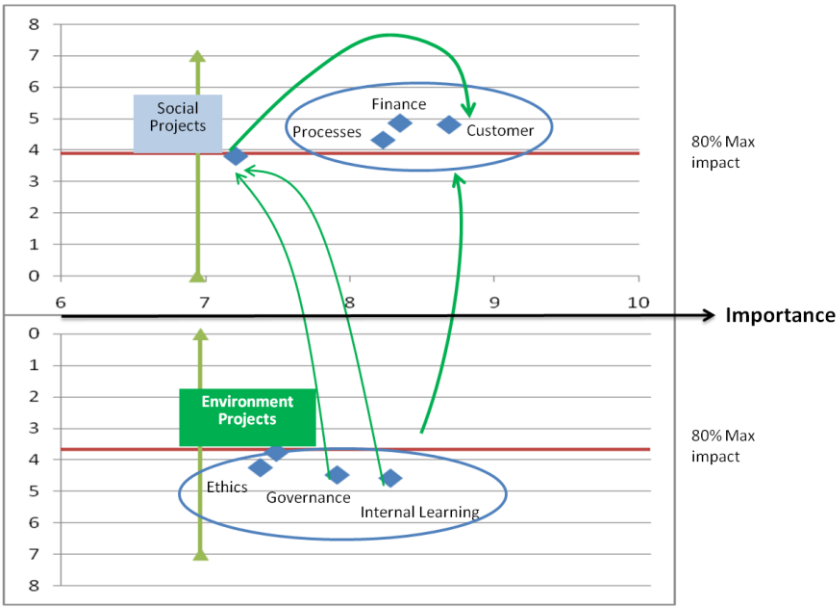


Fig. 33. Impact Relation Map for the ideal strategy

4.2.3 Deriving the Sustainability Strategy Maps

The strategy map is automatically derived from respective IRMs for both the existing and the ideal SBSC. By including specific targets and measures for each dimension, the respective SBSCs are obtained. Fig. 34presents the resulting maps / SBSC.

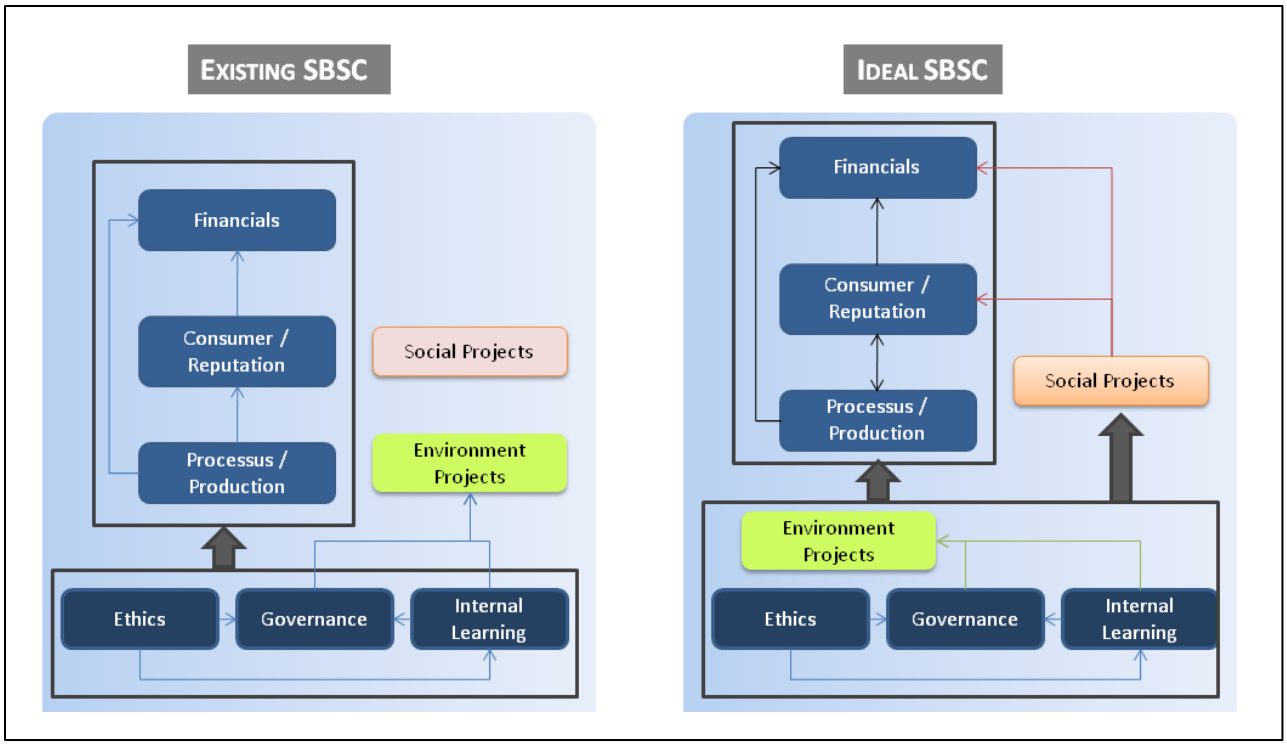


Fig. 34. Existing SBSC vs. Ideal SBSC

In the current conception of reality, managers and directors within the company describe the strategy's success as based on three pivotal elements: governance, internal learning and growth, and ethics.

Unanimously, these three elements appear to be the foundation for growth. They simultaneously influence production processes, consumer relationship, reputation, and sales. Environmental projects are driven by the existing governance scheme, the leadership and company culture. However, they do not impact upon financial return in any significant way. On the other side, social projects are there and ongoing, however, employees and managers don't seem to grasp the role they can possibly play in boosting financial performance. As described by the existing SBSC, they look like an island isolated from the system; they are not significantly influenced by existing factors, nor do they influence sales.

Ideally, managers and directors expect environmental project to be significantly shaped by ethics, governance and company leadership and culture. They also expect environmental endeavors to pay-off by being a major driver of production processes, consumer relationship, reputation, and therefore, sales. It is also expected that social projects become an important lever of reputation and financial performance as well as a direct result of strong ethics, governance, and internal leadership buy-in.

4.2.4 Defining and Prioritizing KPIs

The KPIs of the model are of two types: those belonging to a dispatching dimension, and those representing a receiving dimension (Chapter 3, Section 3.1.2.4). In this project, the four dispatching dimensions are Learning & Growth, Ethics, Governance, and Environment. For the first three, it was sug-

gested to allow the decision maker choose the dimension's index rating for each simulation. This choice is not impromptu; while it is possible to define a fixed priority order of indicators for these three dimensions using AHP method, a manual definition of the index value gives more flexibility to managers and helps them appraise the direct impact of any fractional change of performance in these areas. This is particularly useful when the company knows already its general performance in such areas as ethics and governance (thanks to a rating agency for instance). As for the Environment dimension, three KPIs are defined and prioritized using AHP, they are *Waste Recycling*, *Water Recycling*, and *Emissions Reduction*.

The remaining dimensions, the receiving ones, are represented each by a single calculated KPI that will be directly used in the System Dynamics model.

Given the paramount importance the *Consumer* dimension has for the company −we are in the consumer goods industry− and the extensive interconnectedness that exists between its indicators, it is identified as a *complex dimension* and is therefore subject to detailed cause-effect chain construction using fuzzy DEMATEL.

As for the Social dimension, two main KPIs are defined instead of a single one. These KPIS are *Social Impact_Brands*and *Social Impact_Unilever*. Each of the KPIs is an aggregation of the social impacts produced by all social projects under one of the two categories: Brand Impact and Unilever Impact. These KPIs are measured as presented in Section 4.4.1.This choice is explained by two motives. First, the company's managers were not comfortable giving a hierarchy order to social projects' criteria so as to use AHP as a ranking technique for projects, and deduce a single index, nor did they see the evidence for any possible linkages between the projects so as to build cause-effect chains within the social block. This is based on the statement that societal projects have distinct goals and concur together to achieving an overarching social aim, therefore they should not be prioritized, which leads to two aggregated indicators as opposed to a single one. Second, managers were particularly interested in appraising the impact of implementation of each social project on the financial bottom line. They did not have till then a method for tracking such an impact along the value chain, and modeling the SBSC via system dynamics had the capacity to offer the tool for this type of measurement and monitoring.

To summarize, Fig. 35 represents the KPIs used in the model and how they are calculated.

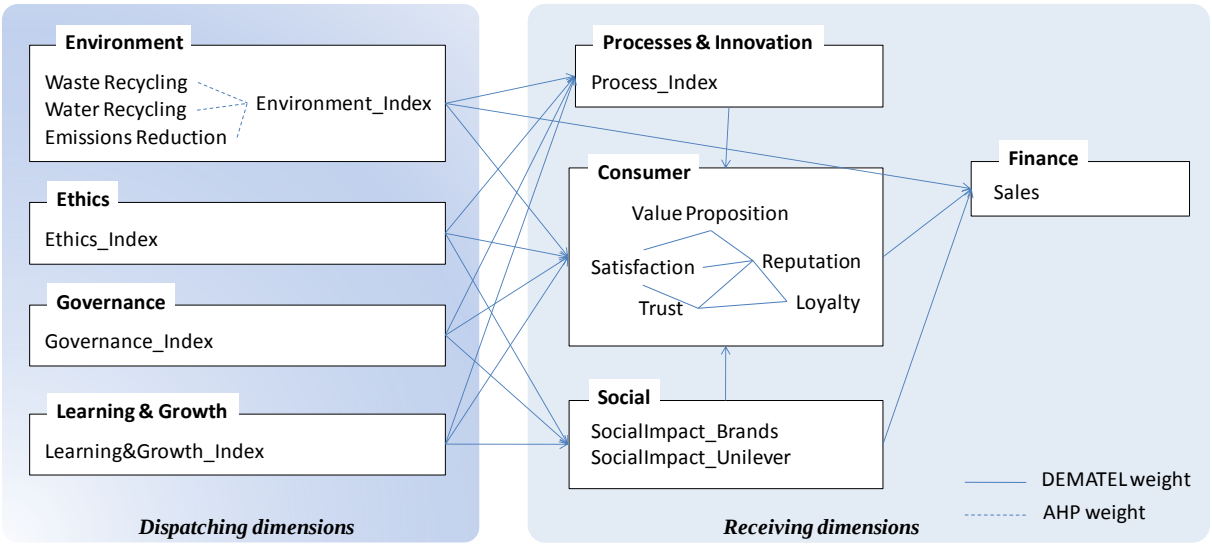


Fig. 35. KPIs used in the case study

After defining all indicators needed in the model and how they should be interrelated, the next question to be answered is: How to move from the existing situation to the ideal growth strategy? The System Dynamic's time-bound ASBSC −or the ADSBSC−is proposed to bring an answer .

4.3 Maximizing Growth and Social Impact with the ADSBSC

The Dynamic ASBSC (ADSBSC) represents the semi-automatable part of the system. First, the Causal Loop Diagram (CLD) is derived following a methodological process, then, the stock-flow chart is constructed on an appropriate SD tool. The modeler's intervention is particularly crucial in defining equations, correcting model errors, simulating, and calibrating the whole model.

4.3.1 The Causal Loop Diagram of the SD model

To bring an informed answer to the question posed above, the System Dynamics ASBSC model is used as a means to translate and simulate the existing strategy. This model also depicts the actionable levers which will enable bridging the gap between the existing strategy and the ideal one. The first step of model construction is the Causal Loop Diagram (CLD) (Fig. 36).

The CLD is a structured representation of the IRM. In the Unilever case, the SBSC's components are represented by either individual variables, such as *Ethics* and *Governance*, or block variables. Three blocks are found in the model: The *sustainability* block, which is comprised of the social and environmental activities, the *consumer* block, which unveils how product value proposition, consumer satisfaction, trust and loyalty, and brand reputation interplay and influence upon sales. The third block

corresponds to the *growth levers* that are proposed in this model as possible paths for the target SBSC. Note that the *consumer* block is more detailed than other blocks because this is a *complex dimension*, which puts the consumer at the heart of the firm's business, and requires therefore additional emphasis on that element in the model.

In the CLD of the model, the main reinforcing loop is the *"value creation"* loop. It is described herein: *Processes&Innovation → Value Proposition → Satisfaction → Trust → Loyalty → Brand Reputation →Processes&Innovation*. The main balancing loops found in the model are Goal-Gap loops which describe in this case *Consumer Satisfaction*, *Society Awareness*, *Social Communication* and *Environmental Communication*. For the sake of simplicity, these loops are not all represented in the CLD. They are more clearly apparent in the stock-flow chart (Fig. 38). In addition, most links are positively polarized except for the variable *Competition* with drives lower *Sales* as it increases.

A visually enhanced representation of the CLD is proposed in Fig. 37.

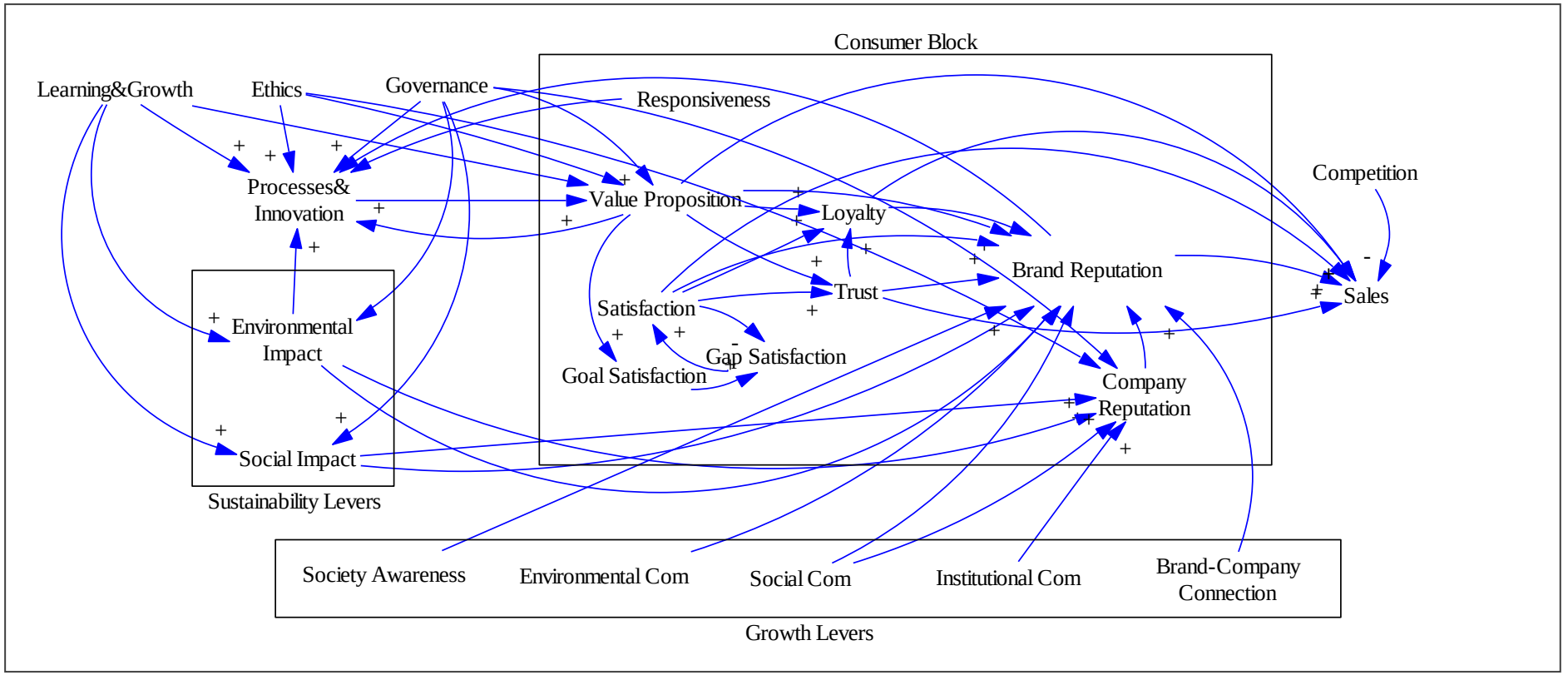


Fig. 36. Causal Loop Diagram (CLD) representing the SBSC

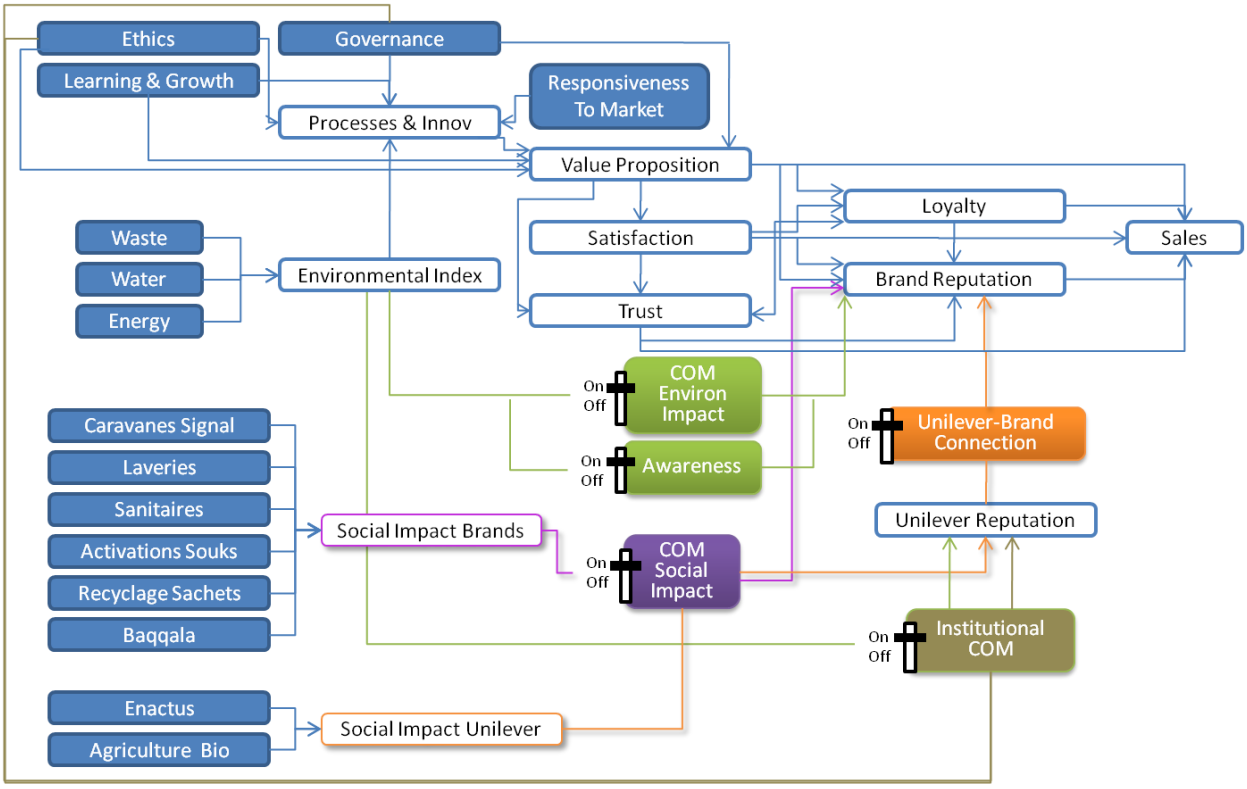


Fig. 37. Visual representation of the Causal Loop Diagram (CLD)

4.3.2 The Stock-Flow Chart

The stock-flow chart allows translating the SBSC's interrelations into mathematical formulae as described in Chapter 3 Section 3.2.1. Variables that are subject to increase and/or decrease at different periods of time and following random or specific patterns are represented by stocks. The stock inflow and outflow determine the evolution of the stock. Other variables are either constant or calculated at each time period of the game (Fig. 38).

The model is constructed on **NetLogo 5.1.0** interface. The choice of NetLogo is not impromptu. As opposed to other platforms, such as Vensim PLE, Netlogo offers the modeler a handy and ergonomic monitoring interface through which it is possible to define input variables as well as screen various types of outputs (calculated variables, stocks, and graphs). In this model, the user interface is shown on Fig. 39. The main inputs and outputs are described in TABLE 14.

TABLE 14. INTPUTS AND OUTPUTS OF THE MODEL

Inputs	**Comments**
Learning&Growth Index Ethics Index Governance Index	The values for these three elements are defined by the users (company managers) based on their evaluation of the firm. They could be calculated involving more complex variables, however, since the goal of the model is not focused on how they operate but rather on their impact, we opt to enter their values manually.
Waste Recycling Water Recycling Emissions Reduction	Along with *Water Recycling*, whose target is set to 1 with progressive evolution within the model, these three variable permit to calculate the Environment Index
Society Awareness	The user can define the current level of society awareness about environmental issues.
Responsiveness To Market	This variable reflects Unilever's responsiveness to consumer's requests and needs (through surveys and market studies)
Environmental Communication Social Communication External Communication Company-Brand Connection	These variables constitute the growth levers suggested in the model.
Social_Invest_Signal Social_Invest_Laveries Social_Invest_Souks Social_Invest_Sachets Social_Invest_Sanitaires Social_Invest_Baqqala Social_Invest_Enactus Social_Invest_AgriBio	These inputs correspond to the level of investment made in the different societal projects[16].
Outputs	**Comments**
Sales	The main output traced in the simulation is the evolution of sales in time.
Social Impact[17]	For each social or environmental project, the social impact is calculated.
Social Return On Investment (SROI)[18]	For each social or environmental project, the SROI is calculated.

[16] The social projects are described in the following subsection.
[17] See subsection **Erreur ! Source du renvoi introuvable.**
[18] See subsection 4.4.2

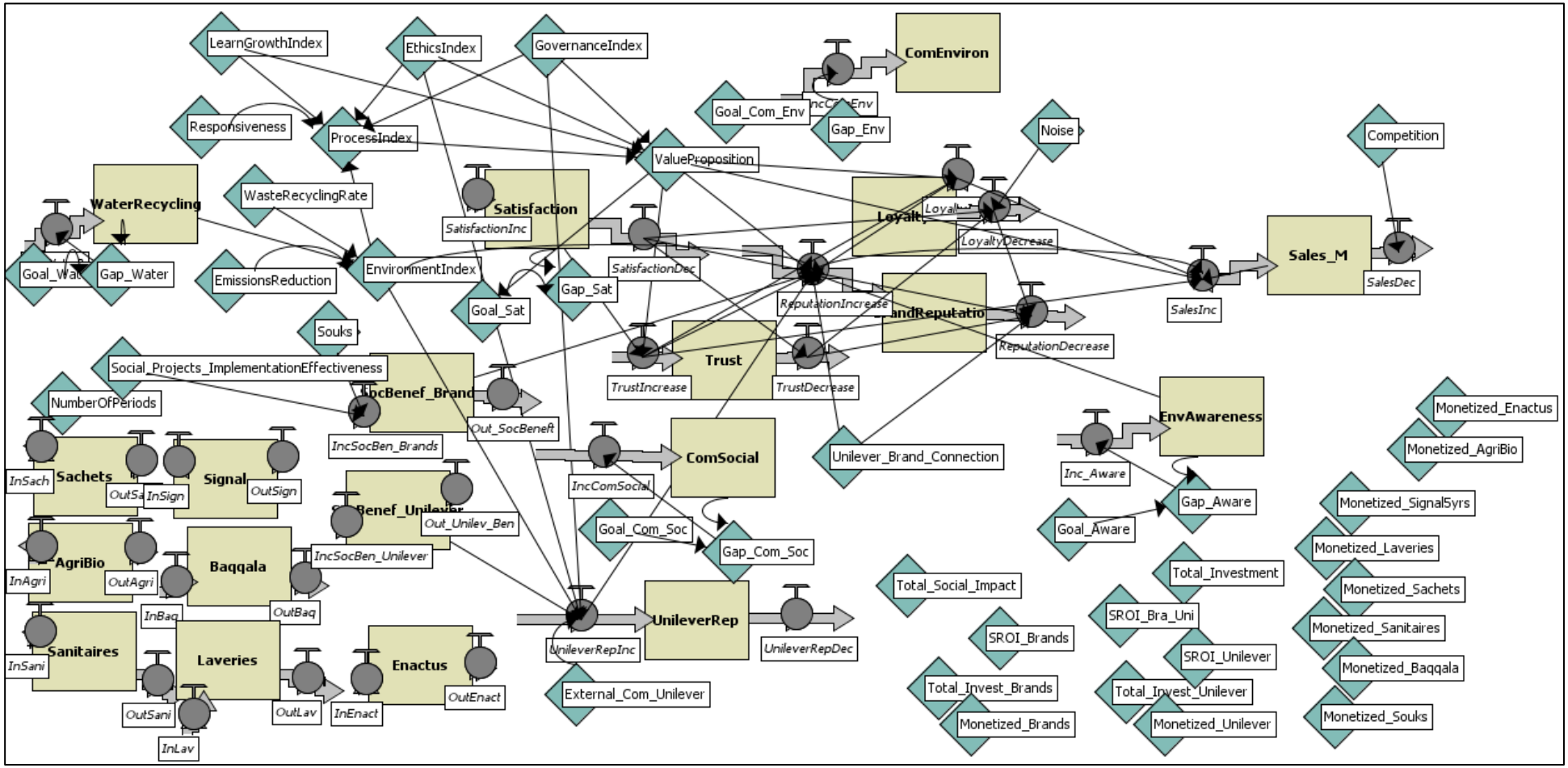


Fig. 38. Stock-Flow chart of the model

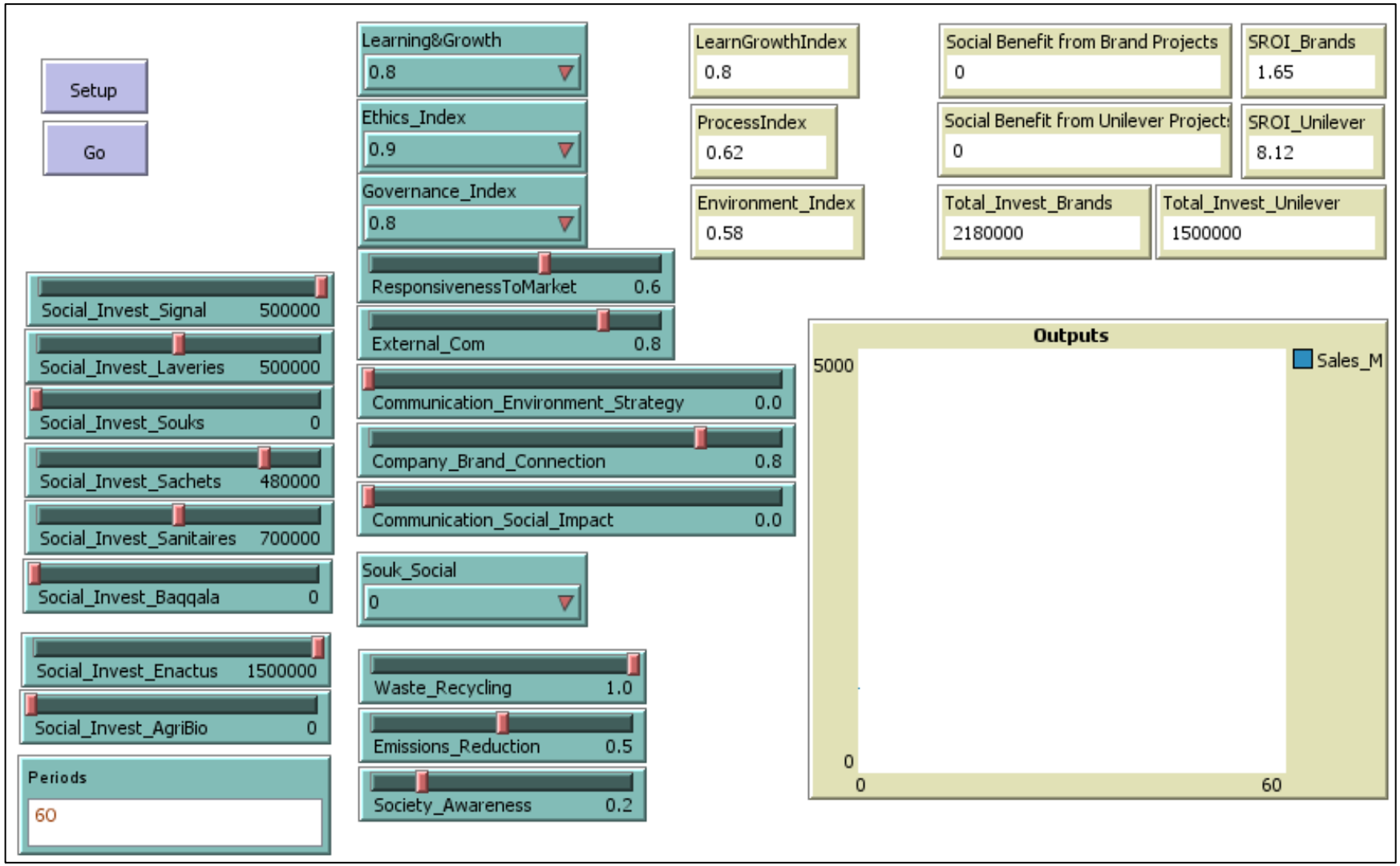


Fig. 39. Graphical Interface

4.4 Strategic Recommendations for Unilever

The model's results are derived not only from input variables (such as calculated dimension indices) but also from some complex inputs that are highly customized depending on the case at hand. In this project, namely, these inputs are the social impact produced by each societal project, and the Social Return on Investment (SROI) associated with that project. These two inputs are important components to the system and are calculated by the modeler and the project's team members.

Before simulations are run, the project team decides on which combination of societal projects yields the highest social impact with an acceptable SROI. Results are then analyzed and decisions are made.

We note that this part concerns essentially the purely subjective judgments held by company managers, and can therefore not be automated.

4.4.1 Projects' Social Impact

Unilever undertakes a number of societal project, each of which requires various levels of investment and execution time (TABLE 15).

TABLE 15. SOCIAL PROJECTS AT UNILEVER MAGHREB[19]

Project	Description	Investment Frequency	Amount per Investment
Caravanes Signal	Health campaigns at the national level to raise awareness about dental issues and to teach children the proper way of tooth brushing.	1 investment / year	100 000 DH / Caravane
Laveries	Laundry microcenters established by Unilever in rural areas and entirely managed by women living in these areas.	1 investment / 3 years	500 000 DH / Village
Sanitaires	Project consisting of constructing sanitary facilities within schools in rural areas to contribute in restricting school drop-out, especially girls, in these areas.	1 investment / school /5 years	700 000 DH / School
Sachets Recyclabes	Project based on collecting Unilever's used plastic products (shampoo bags, detergent bags...etc), and empowering rural women to create useful crafts from the collected items, to be sold and become a source of revenue for them and their families.	1 investment / year	120 000 DH
Baqqala	Empowering "hanout" owners in rural areas through training in accounting and management principles, and offering in-kind assistance via space rehabilitation.	1 investment / year	200 000 DH

[19]The project AgriBio has been discarded by management for structural reasons (current partnerships with third parties). However, it is modeled in this project and can be activated as soon as it makes more sense to leadership. Similarly, the project Souks is put aside as a social project and can be reactivated when necessary.

Enactus	Supportive partnership with Enactus Morocco to introduce, every year, thousands of young students to entrepreneurship and help them achieve their projects via financial assistance.	1 investment / year	300 000 DH

Before investing in any societal project, the firm investigates the business case for it. As part of this research work, the business case for existing and future projects are drawn and verified with the company managers. These business cases lead to two major parameters: the social impact and the Social Return On Investment (SROI).

The social impact is calculated based on a combination of the number of people impacted by the project and the quality of impact (long-term, mid-term, or short-term impact) (Eq. 19).

$$\text{Social Impact} = \frac{(\text{Number of People Impacted} * \text{Quality of Impact})}{\text{Target Number of People}} \quad (19)$$

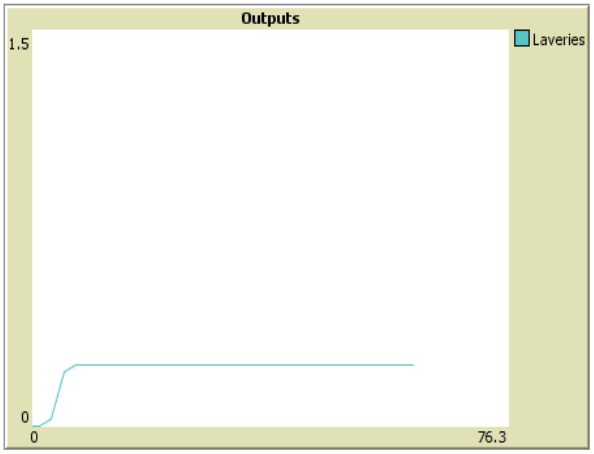
The quality of impact of a social project is determined based on the significance of improvement it brings to beneficiaries and the time period that this impact lasts. For instance, providing a food distribution campaign has a low quality of impact as compared with educating populations at risk. TABLE 16 presents the scale for various quality levels of Unilever's social projects.

TABLE 16. QUALITY LEVEL SCALE FOR SOCIAL PROJECTS

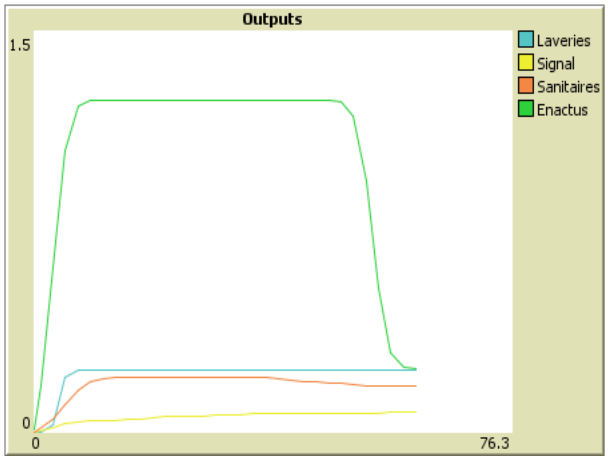
Scale	Quality of Impact	Comment
1% - 20%	Very weak	The project has not or has very marginally improved the population's welfare
20% - 40%	Weak	The project has marginally improved the population's welfare
40% - 60%	Average	The project has relatively improved the population's welfare
60% - 80%	Strong	The project has strongly improved the population's welfare
80% - 100%	Very strong	The project has very strongly improved the population's welfare

Based on the scale above, the social impact for each of Unilever's social projects is calculated, then plotted on a graph as described in Fig. 40. Detailed calculations are available in the Appendix. Next, these graphs represent an input data for the simulation system.

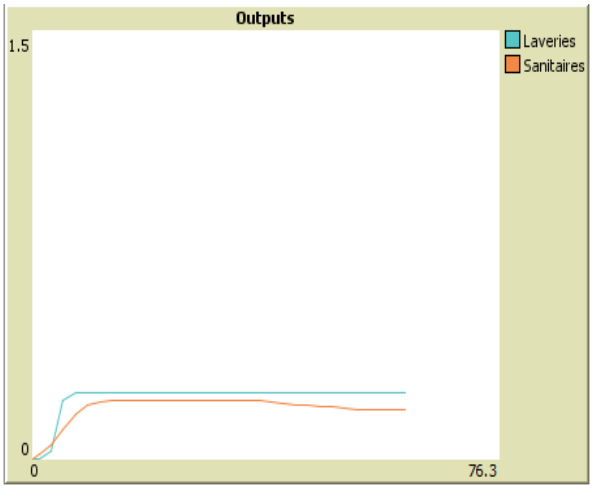
"Laveries" Project



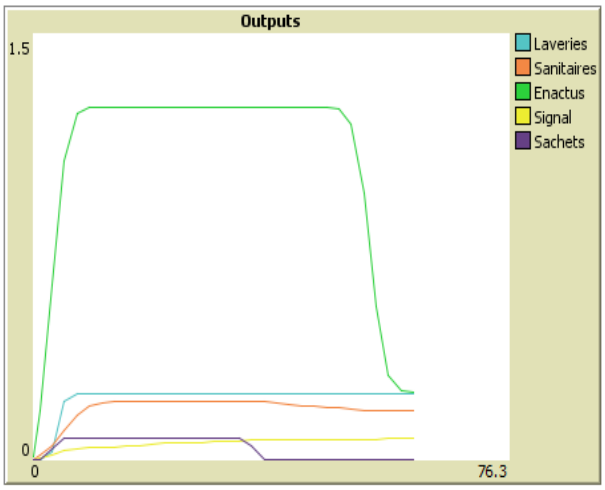
"CaravanesSignal" Project



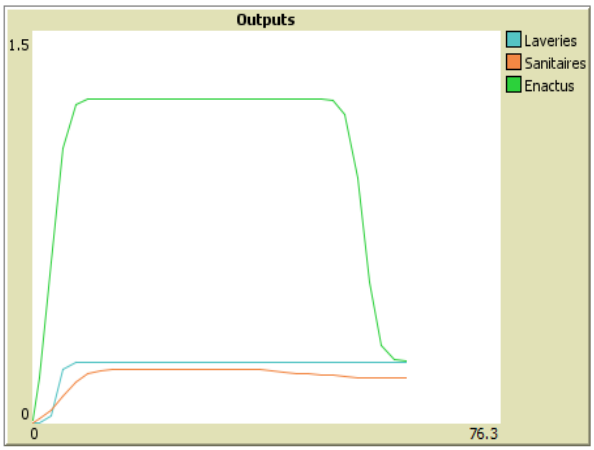
"Sanitaires" Project



"SachetsRecyclabes" Project



"Enactus" Project



"Baqqala" Project

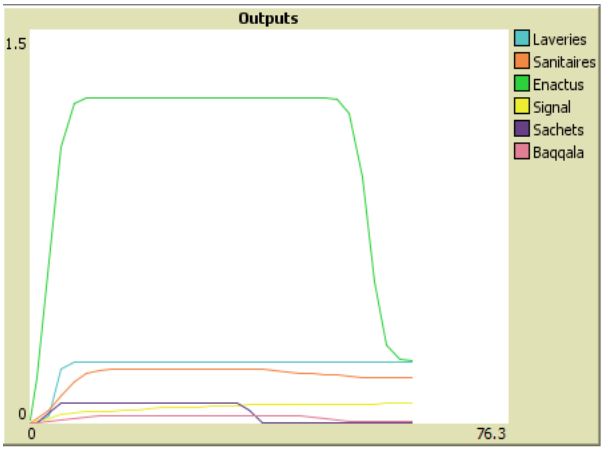


Fig. 40. Social Impact of Unilever projects

4.4.2 Projects' Social Return On Investment (SROI)

The SROI represents the benefit of the project to society reported to the investment made to reap that benefit (Eq. 20 and 21). The cumulative SROI is the return on social investments made on several consecutive periods of time (Eq. 22).

$$SROI = \frac{(MonetizedValueofSocialImpact - SocialInvestment)}{SocialInvestment} \quad (20)$$

where:

*Monetized Value of Social Impact = Output of social impact *Monetized value per output unit* (21)

$$Cumulative\ SROI\ (n) = \frac{\sum_{k=1}^{n} monetizedvalueofsocialimpact(k) - \sum_{k=1}^{n} Socialinvestment(k)}{\sum_{k=1}^{n} Socialinvestment(k)} \quad (22)$$

where*n* represents the year or time period.

Projects have different returns on investment. In addition, these returns evolve in time as the social benefit grows (or diminishes) while the initial investment is constant. Fig. 41illustrates the cumulative SROI over the 5-year investment plan.

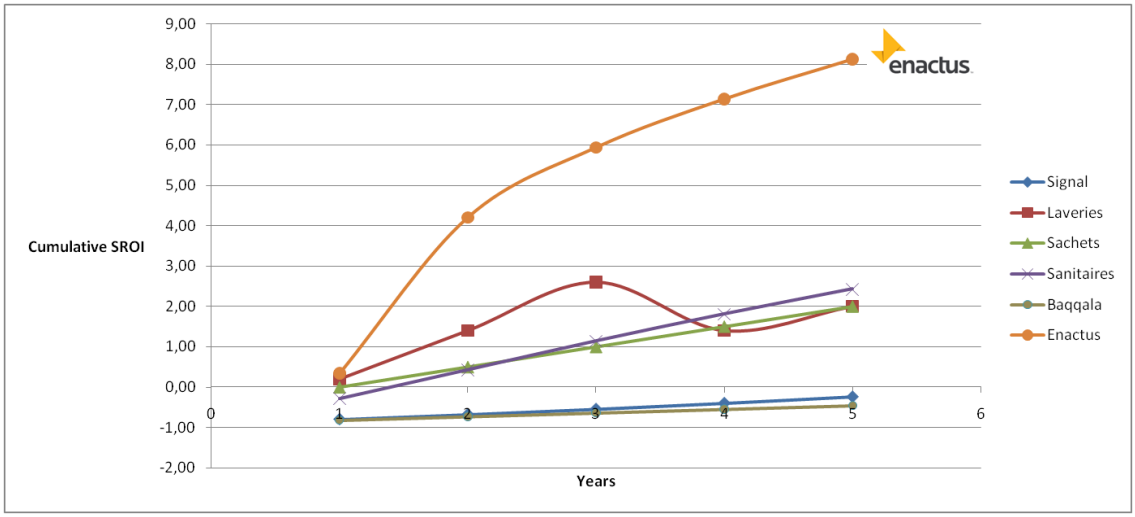


Fig. 41. Evolution of the cumulative SROI for Unilever Projects

In addition, the selection of the best investment portfolio relies on simultaneously assessing the social impact and the SROI. Projects with higher profiles are better candidates for investment (Fig. 42).

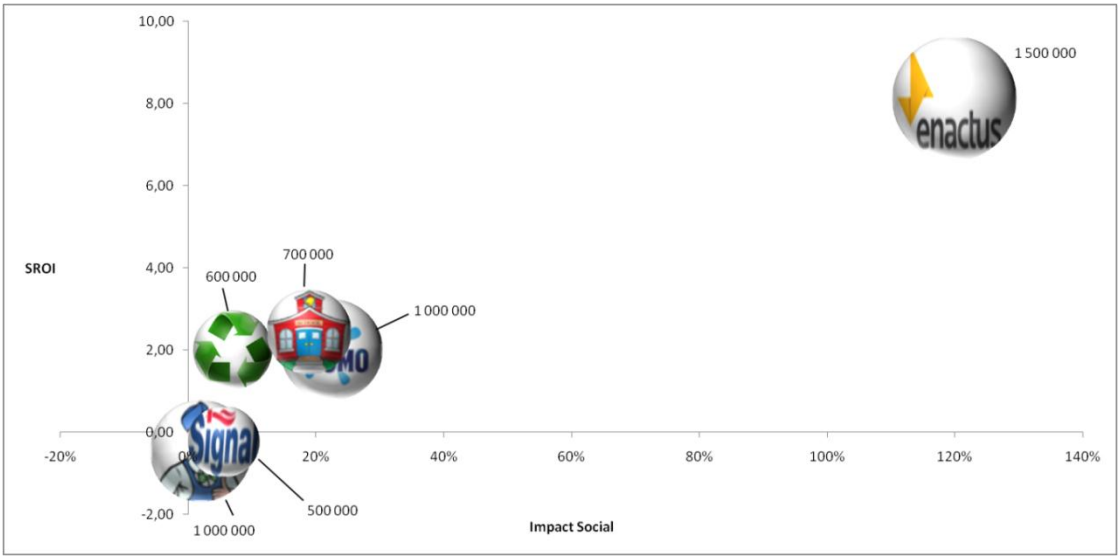


Fig. 42. Project mapping by social impact and SROI

However, there is no single best selection. Indeed, the company can choose whether or not to invest in any given project and by how much. It can also decide to invest only for a couple of years or extend the investment throughout the 5-year period. Therefore, it is necessary to sketch an overarching representation of all possible investment combinations, and select, based on that, the best portfolio(s). Fig. 43illustrates the positioning of 3880 investment combinations. The relative best combinations lie on the efficient frontier.

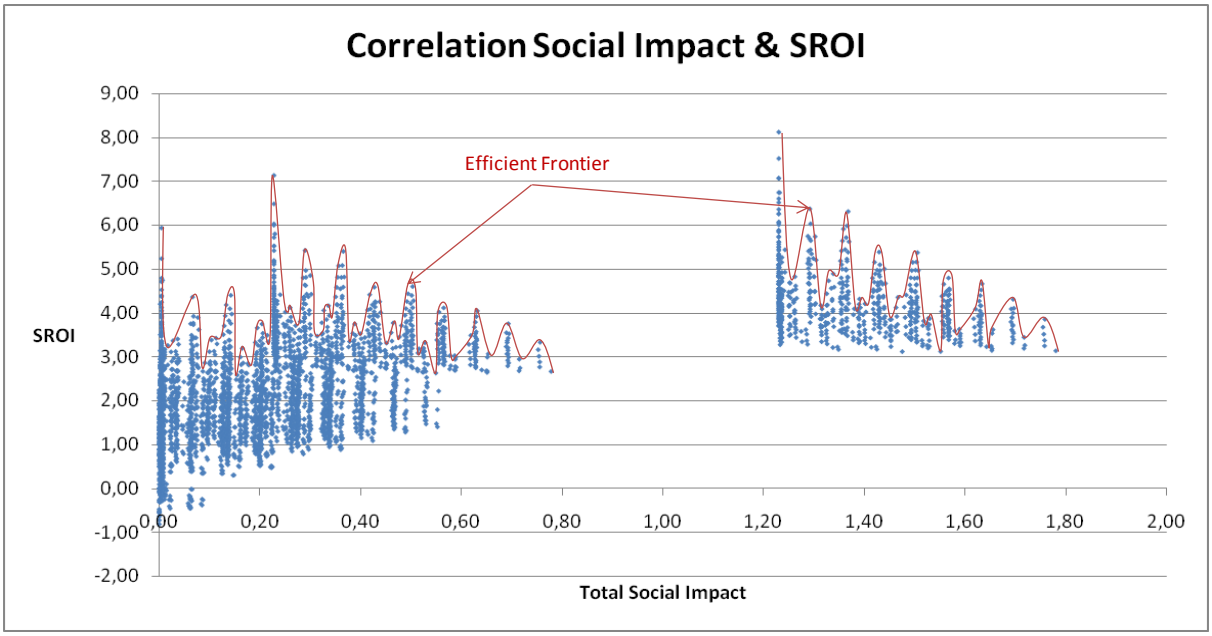


Fig. 43. Social impact and SROI of possible investment portfolios

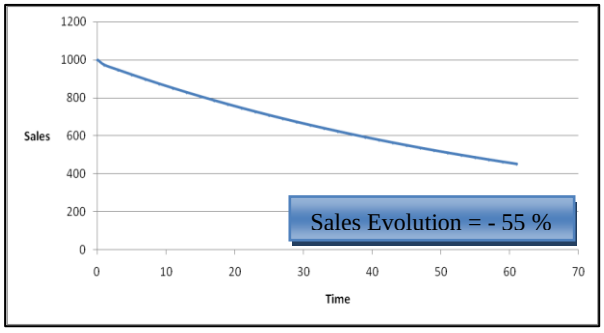
To run simulations and track sales evolution, it is necessary to select one investment scenario. In this case, the choice is made for the data point (SI x SROI) = (170% x 4.3) which corresponds to a full

investment in the portfolio [*Enactus, Laveries, Sanitaires (2 schools), Sachets*]. We refer to this portfolio as *the Efficient Portfolio*.

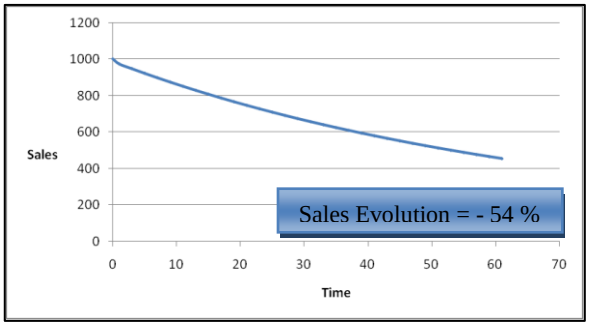
4.4.3 Simulation and Sales Evolution

Simulations are run for the *Efficient Portfolio* over 60 periods corresponding to 60 months of the firm's activity. Various scenarios are considered: no communication, social communication, environmental communication, company-brand connection, and institutional communication. Sales evolution results are presented on Fig. 44. Results show a variation in sales evolution depending on scenarios. Indeed, regardless of the amount of investment made in social, environmental, or institutional communication, sales growth shows only with an established company-brand connection. In the absence of this connection, the model predicts a sales decline over time.

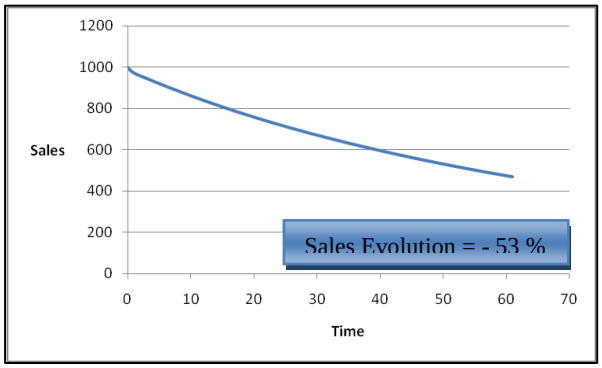
Scenario 1: No Com



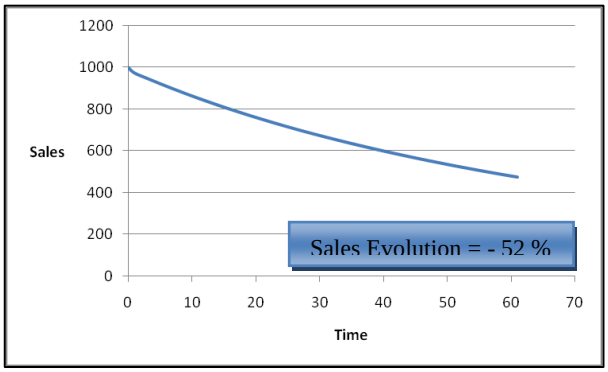
Scenario 2: Environmental Com only



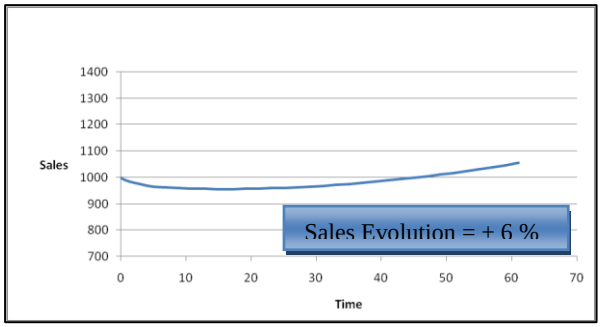
Scenario 3: Social Com only



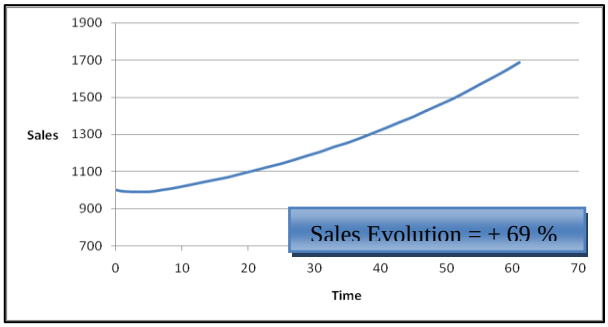
Scenario 4: Social & Environmental Com



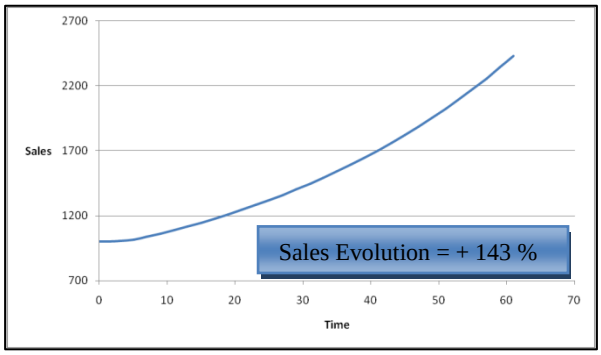
Scenario 5: Soc-Env Com & 50% Connection



Scenario 6: Soc-Env Com & 80% Connection



Scenario 7: Soc-Env Com, 80% Connection & 80% Institutional Com



Summary of all scenarios

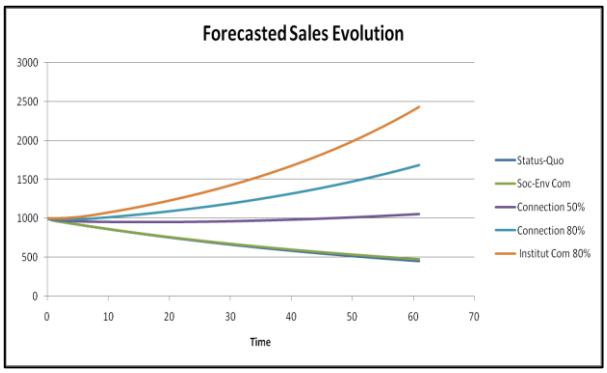


Fig. 44. Sales evolution under various simulation scenarios of the efficient portfolio

4.4.4 Discussion

The model presents some interesting results. In scenarios 1 to 4, the company is unable to make any significant improvement in sales even though investments in social and environmental communication are significant. At first glance, these results seem surprising to some extent. However, a further analysis of the underlying elements unveils some explanations. Firstly, from the environmental perspective, although Unilever has made substantial strides in waste recycling, namely through the project Zero Waste to Landfill, a very tiny stripe of the population is aware of such endeavors. Conferences and seminars in 5-star hotels are typically the venues where the company communicates about its environmental strategy. While definitely applauded by many institutional bodies and private firms, this "good student" has not been successful enough in reaching out to the larger Moroccan population who buys the products and who still features a very low awareness about environmental challenges. The problem here is therefore two-fold: do people know about these environmental projects? and do they care enough about them to choose Unilever brands over other brands?

Secondly, from the social perspective, Unilever has been an assiduous supporter of the vastly impactful Enactus project. To-date, the company has featured its social investments' successes through standard communication channels including mainly the company website, seminars and press conferences, which has indisputably earned the company a strong reputation as a social enterprise. However, these efforts and successes are not reflected on sales for the pivotal reason that Unilever's name is not necessarily associated with Unilever brands in the minds of shoppers, which creates an imperceptible yet profound gap between doing good and doing well for the company.

Thirdly, institutional communication does not seem to be strongly helpful in boosting sales in the first four scenarios. This is due as well to the supposed disconnection[20] between the company name (logo and history) and the company brands (products on the shelves).

These elements concur together in explaining why sales growth is negative regardless of the traditional communication tools and channels employed by the company. This trend reflects actually a reality that the company has been faced with over the past few years.

Our ADSBSC model allows introducing new elements which are able to inverse the trends and visualize first-hand the impacts of the various types and levels of investments.

The most important variable that is suggested as a growth lever in the model is the *company-brand connection*. In scenarios 5, 6 and 7, company-brand connection is set to various levels (50% and 80%) and seems to readily readjust growth trends. In Scenario 5, 50% coverage of company-brand connection pushes up sales growth so as to break-even towards the end of the fourth year. This growth is even more important when company-brand connection reaches an 80% coverage, which enables the company to reach a 69% growth rate by the end of year 5. The last scenario shows the potential of the connection factor especially when it is conjugated with institutional communication. Indeed, in this scenario, in addition to the connection benefit gained earlier, the company reaps the benefit of its strong institutional image as an ethical and employee-caring firm. This reputational asset is now transmitted to brand reputation, which explains the 143% growth rate by the fifth year. Basically, the connection parameter gives Unilever the potential to leverage its reputation as a company in order to strengthen its brands' competitive positioning and gain, therefore, more market share (Fig. 45).

[20] As of today, there is no formal survey conducted by the company or another party to highlight the connection levels between Unilever (as a company) and its brands. However, an informal questionnaire that was conducted with a sample of consumers has shown that this disconnection is overwhelmingly present in the minds of shoppers.

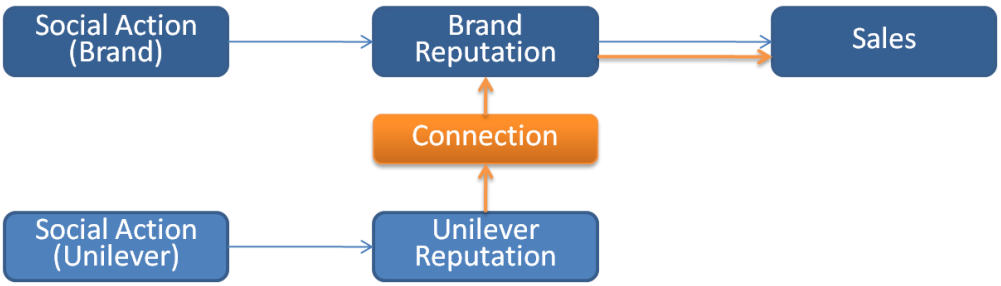


Fig. 45. Impact relationships between social actions and sales

CONCLUSION
&
PERSPECTIVES

CONCLUSION & PERSPECTIVES

In a globalized world where the planet is torn between phenomenal economic growth and staggering social and environmental failures, it is crucial to take a deep breath and rethink the way we have managed resources, growth and prosperity. If adopting operational Corporate Social Responsibility (CSR) programs has not yielded the expected long-term triple bottom-line balance, then it is time we admitted the importance of adopting a different, more encompassing view of management, based on the tenets of sustainable development.

Aiming to enrich the reflection and contributions to the development of systemic approaches to sustainability management, this thesis proposes a system thinking based decision-aid framework reinforced with operational techniques. More specifically, we combine the accuracy of multi-criteria decision making with the strategic insights from the Balanced Scorecard (BSC) approach and System Dynamics simulation.

Following a structured methodology, this work tackles initially the adaptability problem of the BSC through a top-down approach combining fuzzy Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Hierarchy Process (AHP), and resulting in a Sustainability BSC (SBSC) architecture that varies across firms, industries, sectors, and contexts. This framework is referred to as the Adaptive SBSC (ASBSC). Then, the dynamic power of System Dynamics modeling and simulation is integrated into the ASBSC to surmount the static feature of the classical SBSC. A systematic method is proposed so as to overcome the cornerstone limitation posed by mental models influence. The resulting framework is denoted as the Adaptive Dynamic SBSC (ADSBSC). Later, the framework is implemented and tested on a real-life setting with the case of a multinational corporation in the consumer goods industry. Results show that the proposed framework is able to predict with sufficient precision future trends in sales growth depending on societal investment scenarios and input data.

This work makes some important contributions:

1. From a decision-aid conceptual perspective, the framework overcomes some cornerstone conceptual limitations:
    a. The proposed framework addresses the structural limitations of SBSC architecture design methodologies which have long been debated: It brings a **technically precise answer** to *how* sustainability dimensions –including ethics and governance, in addition to environmental and social ones– should be integrated into the scorecard based on analytical decision aid techniques and fuzzy logic. The resulting framework is therefore **highly adaptable** to contexts and industries, and **less intuitionist** thanks to systemic mathematical methods.

   b. The proposed framework takes it a step further not only by integrating **time dimension** into the SBSC using System Dynamics, but also by employing a **structured mathematical process for creating linkages and defining equations** in the causal loop diagram and stock-flow chart, which has not been explored in earlier studies. Following an ordered methodology, the modeler can take the SBSC onto a simulation platform to transform it from a static "best picture of the organization" into an encompassing and dynamic decision making tool.
   c. The highly analytical methodology that has been proposed to construct the ADSBSC makes it prone to **computerization and technological scalability** using appropriate information systems. This, in itself, could potentially contribute to revolutionizing the way sustainability management is undertook, especially in emerging countries where the largest focus is still being put on functional CSR programs as opposed to strategic and systemic sustainability thinking.

2. From a managerial perspective, this thesis constitutes a starting point in the new path we ought to adopt in our management of sustainability:
   a. The proposed ADSBSC constitutes a **roadmap for managers** who can use it to describe both the existing state of the art in terms of strategic priorities and the ideal priority order. Consequently, managers can identify the appropriate levers which will enable the organization to move from the existing situation to the ideal one.
   b. These very **levers** can be **measured, tested** and **readjusted** automatically thanks to the dynamic simulation platform, resulting in a real planning and forecasting platform for sustainability decision making.

Some remarks are, nonetheless, noteworthy. Concerning the decision-aid framework conception, the modeler might feel sometimes compelled to act outside the boundaries of the proposed framework. More precisely, while the systematic analytical model construction methodology is a particular strength of the framework, it might be perceived sometimes as being limitative given the complexity of management and System Dynamics modeling. Indeed, the modeler might be required to create additional links or variables within a given block that is of particular interest to the industry subject to study. In such a case, the modeler might be compelled to make a combination of methodical techniques (eg. fuzzy DEMATEL) and personal best judgment.

Another conceptual constraint posed by the present framework pertains to the strong dependency that the upper layers of the scorecard have on the lower layers based essentially on calculated cause-effect functions. This feature is actually true to the Balanced Scorecard approach in general, and can be perceived as both a limitation and strength.

As for the implementation side, the dynamic part of the framework that is related to simulation cannot be automatically derived. As presented in earlier chapters, this phase requires human intervention for model construction, testing, calibration, and result interpretation.

This constitutes a starting point for some future perspectives:

1. As for the automation of the dynamic component of the system, two options can be considered:
    a. The ASBSC generation platform could be directly interfaced with one of the existing simulation platforms (such as NetLogo or Vensim) to ensure a seamless uploading of variables and main linkages automatically into the model. Then the modeler would only have to complete with necessary equations and some additional variables.
    b. The other way would be to design a comparable stock-flow based simulation platform, build the software that supports it, and integrate it with the already developed ASBSC to ensure a perfect integration of the two sides.
2. Another future perspective for this research is to deploy the framework with multiple firms and organizations from various sectors and industries. It would be highly valuable, in fact, to analyze how the resulting ADSBSC differs across industries, organization types and cultures. The resulting collected information can constitute a powerful data warehouse for sustainability management and policy making that could be tapped into by firms, institutions and governments.

Finally, this thesis work adequately fits within the new world dynamics that are constantly redefined by changing demographical, economic and technological patterns. Indeed, if the previous eras of globalization dealt with relentless successions of dominance, power and imbalances, the new era to come is one of coexistence and new equilibriums. By the year 2100 , these equilibriums are expected to lead, for the first time in history, to a more balanced wealth redistribution and greater mutual understanding across the globe (Sachs, 2015). Nonetheless, achieving this global ecosystem balance on a sustainable planet can happen if business leaders and policy makers urgently adopt the right systemic approaches for sustainability management. It is now a moral question.

APPENDIX:

UNILEVER PROJECT DATA

APPENDIX: UNILEVER PROJECT DATA

A. Synoptic view of the project (for Unilever Board of Directors)

FICHE SYNOPTIQUE

Aide à la Décision en Stratégie de Durabilité via le Balanced Scorecard et la Dynamique des Systèmes : Cas d'Unilever Maghreb

CONTEXTE

Ce travail est élaboré dans le cadre d'un projet de recherche doctoral axé autour de l'élaboration de méthodes innovantes d'aide à la décision en matière de durabilité et de responsabilité sociétale. Ces méthodes sont implémentées sur des cas d'entreprises marocaines et internationales.

OBJECTIFS

A. Mise en place d'un Sustainability Balanced Scorecard qui permettra de :

1. Prioriser les axes stratégiques et les indicateurs de suivi de la performance en durabilité au sein de l'entreprise.
2. Etablir des relations de cause-à-effet entre les différents axes stratégiques, et visualiser la structure d'impact des investissements en durabilité sur les résultats financiers.

B. Dérouler le Sustainability Balanced Scorecard dans le Temps :

1. Simuler l'évolution dynamique de la stratégie de durabilité dans le temps à l'aide d'un système de modélisation et d'aide à la décision.
2. Ajuster les décisions stratégiques sur la base des forecasts établis.

DEROULEMENT

Etapes	Besoins
1. Réunion de cadrage : ○ Présentation du projet ○ Compréhension des besoins en stratégie de durabilité.	○ Durée: 45 min ○ Présence du Directeur Général et des responsables sustainability (Réalisé)
2. Déroulement de la méthode de recherche avec un groupe de directeurs/managers.	○ Durée: 30 - 45 min par réunion ○ Réunions individuelles ou en groupe par fonction.
3. Construction des relations de cause-à-effet et du Sustainability Balanced Scorecard. Validation de la structure résultante.	○ Réunion de validation avec les contributeurs. Durée: 45 min
4. Construction du modèle de simulation dynamique en collaboration avec les managers (Processus itératif).	○ Réunions individuelles avec les managers. Durée: 30 min
5. Simulation, analyse, et recommandations.	○ Présentation des résultats. ○ Discussion et validation.

RESULTATS ESCOMPTES

1. Mettre à disposition d'Unilever un outil efficace d'aide à la décision dans sa stratégie USLP.
2. Produire des publications scientifiques dans des revues internationales indexées (résultats anonymes).

B. Pairwise comparison evaluation forms

B.1. Comparison of the SBSC dimensions

Thank you for taking the time to fill out this form! Your point of view is very important!

Scale:

Very Low Impact	**VL**
Low Impact	**L**
Medium Impact	**M**
High Impact	**H**
Very High Imapct	**VH**

Dimensions:

Ethics	Learning & Growth
Governance	Processes & Innovation
Social	Customers
Environment	Finances

	Ethics	Governance	Social	Environment	Learning & Growth	Processes & Innovation	Consumers/Reputation	Finances
Ethics								
Governance								
Social								
Environment								
Learning & Growth								
Processes & Innovation								
Customers								
Finances								

Ethics: refers to the level of coworkers' awareness about ethical issues and dilemmas

Governance : ability to preserve principal's interest (respecting rules and avoiding conflicts of interest)

Social : refers to external projects (ex: hygiène bucco-dentaire, Enactus..)

Environment: refers to projects undertaken by the company to preserve environment (water recycling, waste to landfill…)

Learning & Growth : HR, training, leadership, culture, Information Systems (HR capital + Organizational capital + Information capital)

Processes & Innovation: Ability of the firm to manage internal production processes (returns, defects, error rate time to market..) + Ability to Innovate

Customers : aspects which create value for customers (price to quality, brand name, reputation, ease of use, confidence…)

B.2. Comparison of the Consumer block indicators

Thank you for taking the time to fill out this form! Your point of view is very important!

Scale:

Very Low Impact	**VL**
Low Impact	**L**
Medium Impact	**M**
High Impact	**H**
Very High Imapct	**VH**

Dimensions:

Value Proposition
Satisfaction
Reputation
Loyalty
Trust
Sales

	Value Proposition	Satisfaction	Reputation	Loyalty	Trust	Sales
Value Proposition						
Satisfaction						
Reputation						
Loyalty						
Trust						
Sales						

Value Propostion: the value that customers/consummers see in the products (price to quality, brand, …)
Satisfaction: consumer satisfaction
Reputation: amongst consumers and in society in general
Loyalty: Consumer loyalty
Trust: Consumer trust in the products (the brands)

C. DEMATEL Total Matrices

TABLE 17. TRIANGULAR FUZZY TOTAL IMPACT MATRIX (FOR THE EXISTING SBSC)

	Ethics			Governance			Social			Environmental			Learning & Growth			Processes			Customers			Financials		
Ethics	0.244	0.389	0.742	0.448	0.588	0.92	0.384	0.568	0.946	0.385	0.56	0.96	0.415	0.581	0.96	0.425	0.604	1	0.524	0.689	1.05	0.523	0.695	1.05
Governance	0.403	0.549	0.904	0.285	0.451	0.816	0.367	0.567	0.968	0.403	0.59	0.99	0.416	0.588	0.98	0.521	0.686	1.08	0.544	0.716	1.09	0.606	0.764	1.11
Social	0.176	0.326	0.686	0.168	0.34	0.711	0.143	0.301	0.666	0.222	0.39	0.78	0.183	0.358	0.75	0.258	0.433	0.83	0.307	0.48	0.86	0.282	0.471	0.86
Environmental	0.230	0.401	0.763	0.217	0.409	0.783	0.321	0.495	0.856	0.203	0.38	0.75	0.240	0.436	0.83	0.395	0.566	0.95	0.380	0.565	0.94	0.374	0.57	0.94
Learn & Growth	0.378	0.543	0.924	0.419	0.592	0.968	0.359	0.579	0.987	0.400	0.6	1.02	0.324	0.498	0.89	0.585	0.741	1.11	0.592	0.759	1.13	0.634	0.792	1.14
Processes	0.208	0.392	0.779	0.259	0.454	0.836	0.298	0.502	0.892	0.357	0.54	0.93	0.354	0.531	0.91	0.344	0.505	0.88	0.525	0.682	1.03	0.567	0.715	1.04
Customers	0.231	0.403	0.786	0.275	0.457	0.836	0.306	0.5	0.89	0.317	0.5	0.9	0.328	0.502	0.9	0.460	0.619	1	0.341	0.509	0.88	0.550	0.697	1.03
Financials	0.191	0.337	0.727	0.269	0.433	0.808	0.254	0.441	0.842	0.273	0.45	0.86	0.302	0.461	0.86	0.408	0.558	0.95	0.394	0.557	0.95	0.322	0.476	0.85

$\alpha = 0.642$ (75% of max values)

Ři			Či			Ři+Či			Ři - Či		
3.350	4.678	7.622	2.061	3.339	6.311	5.410	8.017	13.933	1.289	1.339	1.310
3.544	4.9107	7.942	2.339	3.725	6.678	5.883	8.636	14.620	1.205	1.185	1.265
1.738	3.1016	6.148	2.432	3.952	7.047	4.171	7.054	13.195	-0.694	-0.851	-0.898
2.359	3.8182	6.814	2.559	4.019	7.192	4.919	7.837	14.006	-0.200	-0.201	-0.379
3.691	5.1056	8.17	2.561	3.955	7.066	6.253	9.061	15.236	1.130	1.150	1.103
2.912	4.3208	7.302	3.397	4.712	7.799	6.309	9.033	15.101	-0.486	-0.391	-0.497
2.807	4.1898	7.228	3.608	4.957	7.948	6.415	9.147	15.176	-0.800	-0.767	-0.719
2.412	3.7162	6.841	3.856	5.18	8.026	6.269	8.896	14.866	-1.444	-1.464	-1.185

TABLE 18. DEFUZZIFIED TOTAL IMPACT MATRIX (FOR EXISTING SBSC)

	Ethics	Governance	Social	Environmental	Learning & Growth	Processes	Customers	Financials	***R + C***	***R - C***
Ethics	0.458	0.652	0.6326	0.635	0.651	0.676	0.756	0.756	9.12	1.313
Governance	0.619	0.517	0.6339	0.662	0.66	0.762	0.785	0.827	9.71	1.218
Social	0.396	0.406	0.37	0.466	0.431	0.507	0.55	0.536	8.14	-0.81
Environmental	0.465	0.47	0.5575	0.444	0.502	0.636	0.629	0.628	8.92	-0.26
Learn & Growth	0.615	0.659	0.6417	0.673	0.57	0.813	0.827	0.856	10.2	1.128
Processes	0.46	0.516	0.5642	0.608	0.6	0.576	0.746	0.775	10.1	-0.46
Customers	0.473	0.523	0.5651	0.575	0.575	0.692	0.578	0.761	10.2	-0.76
Financials	0.418	0.504	0.5122	0.528	0.54	0.64	0.633	0.548	10	-1.36

TABLE 19. TRIANGULAR FUZZY TOTAL IMPACT MATRIX (FOR THE IDEAL SBSC)

	Ethics			Governance			Social			Environmental			Learning & Growth			Processes			Customers			Financials		
Ethics	0.170	0.282	0.594	0.348	0.459	0.762	0.316	0.4612	0.809	0.298	0.439	0.794	0.319	0.452	0.79	0.318	0.464	0.83	0.441	0.577	0.92	0.433	0.571	0.91
Governance	0.312	0.429	0.748	0.200	0.331	0.66	0.311	0.4694	0.835	0.312	0.462	0.824	0.317	0.456	0.81	0.401	0.539	0.91	0.459	0.604	0.96	0.504	0.633	0.97
Social	0.153	0.276	0.597	0.149	0.29	0.622	0.145	0.2725	0.599	0.203	0.342	0.69	0.176	0.315	0.66	0.258	0.394	0.75	0.363	0.492	0.83	0.323	0.463	0.8
Environmental	0.185	0.323	0.644	0.171	0.326	0.662	0.308	0.4407	0.761	0.163	0.297	0.631	0.195	0.352	0.71	0.335	0.471	0.82	0.385	0.529	0.86	0.348	0.5	0.84
Learn & Growth	0.284	0.415	0.759	0.313	0.452	0.797	0.295	0.4675	0.842	0.299	0.461	0.837	0.228	0.364	0.72	0.452	0.581	0.93	0.488	0.63	0.98	0.509	0.643	0.99
Processes	0.143	0.287	0.628	0.183	0.337	0.678	0.244	0.403	0.754	0.271	0.414	0.762	0.267	0.408	0.75	0.246	0.374	0.71	0.433	0.566	0.89	0.452	0.577	0.89
Customers	0.169	0.304	0.637	0.203	0.347	0.684	0.267	0.4157	0.762	0.249	0.394	0.747	0.253	0.391	0.74	0.363	0.492	0.83	0.276	0.414	0.75	0.449	0.572	0.89
Financials	0.134	0.247	0.587	0.200	0.33	0.661	0.211	0.3583	0.716	0.204	0.346	0.704	0.229	0.355	0.71	0.318	0.439	0.79	0.320	0.459	0.82	0.243	0.369	0.71

$\alpha = 0.53$ (74% of max values)

Ři			Či			Ři+Či			Ři - Či		
2.642	3.706	6.414	1.549	2.563	5.193	4.191	6.269	11.608	1.093	1.143	1.221
2.815	3.9231	6.712	1.766	2.873	5.526	4.582	6.796	12.238	1.049	1.050	1.186
1.770	2.8452	5.548	2.097	3.288	6.079	3.867	6.133	11.627	-0.328	-0.443	-0.530
2.090	3.2388	5.924	1.997	3.156	5.989	4.087	6.394	11.913	0.093	0.083	-0.065
2.867	4.0149	6.852	1.983	3.094	5.886	4.851	7.109	12.738	0.884	0.920	0.966
2.237	3.3651	6.063	2.690	3.754	6.567	4.928	7.119	12.630	-0.453	-0.389	-0.504
2.228	3.3292	6.045	3.164	4.271	7.01	5.393	7.600	13.054	-0.936	-0.942	-0.965
1.858	2.9041	5.695	3.261	4.327	7.003	5.120	7.231	12.698	-1.403	-1.423	-1.309

TABLE 20. DEFUZZIFIED TOTAL IMPACT MATRIX (FOR THE IDEAL SBSC)

	Ethics	Governance	Social	Environmental	Learning & Growth	Processes	Customers	Financials	***R + C***	***R - C***
Ethics	0.349	0.523	0.5288	0.51	0.522	0.537	0.647	0.638	7.36	1.152
Governance	0.496	0.397	0.5384	0.532	0.528	0.615	0.675	0.702	7.87	1.095
Social	0.342	0.353	0.3391	0.412	0.385	0.466	0.56	0.53	7.21	-0.43
Environmental	0.384	0.387	0.5033	0.363	0.418	0.541	0.592	0.564	7.46	0.037
Learn & Growth	0.486	0.521	0.5347	0.532	0.437	0.655	0.7	0.713	8.23	0.923
Processes	0.352	0.399	0.467	0.482	0.475	0.443	0.629	0.64	8.23	-0.45
Customers	0.37	0.411	0.4815	0.463	0.461	0.563	0.481	0.637	8.68	-0.95
Financials	0.323	0.397	0.4287	0.418	0.43	0.517	0.532	0.441	8.35	-1.38

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