

AHP Method to Support Decision Making for Sustainability

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Received: August 18, 2020

Accepted: October 27, 2020

Online Published: October 27, 2020

doi:10.5539/cis.v13n4p32

URL: <https://doi.org/10.5539/cis.v13n4p32>

Abstract

In these challenging times, finding a way to sustain the created value becomes a must. The fierce competition, the risk of disruption, the rise of customer awareness and the scarcity of resources, all these are few of many drivers that push companies to invest in sustainability. This paper is an attempt to enrich the literature about this subject. It mainly explores how to use the AHP method, a well-known multicriteria decision making technique, to decide about the right actions to implement, in order to reach sustainability. The paper is a continuity of a previous work that introduced a new framework that explained how companies could sustain their business models through information systems (IS). This approach was applied on a telecom operator, as a case study, to explain well how companies could choose the right actions to implement, in order to reach sustainability.

Keywords: Sustainability, AHP method, multicriteria decision making, information systems, business models.

1. Introduction

In this time and age, companies are facing huge challenges to sustain their ways of creating value. The real risk of disruption, the fierce competition among rivals, the change in the customer behaviors and the scarcity of resources, all these are few of many drivers that push companies to change their ways of doing business.

Finding a balance between their financial numbers, their social commitment and their negative externalities is the ultimate goal to achieve. Many studies are suggesting to work on business models, in order to sustain a given business as they fully describe how the value is created and captured. In many cases, managers and practitioners would be faced with different options: Should they change their customer experience? Should they reduce their costs or should they review their channels? ... These actions depend on the industry, the firm and its capabilities.

Decision making on sustainability involves complex interactions between ecological, economic and social aspects, as well as it requires active participation by all relevant stakeholders. Deciding on the right actions to adopt, requires the use of multicriteria decision making techniques that help to evaluate a set of alternatives in terms of a number of criteria. Among these techniques, the analytic hierarchy process, normally called AHP, is considered as one of the most used methods regarding project prioritization and selection.

This paper is a continuity of a previous work that proposed a theoretical framework that discussed how companies could use information systems to sustain their business models (El Hilali and El Manouar, 2020). Using AHP method will help managers to decide about the right actions to take to reach sustainability.

The article comprises a literature review section in which the concept of sustainability is defined and our framework is introduced. It contains also a methodology section where the AHP method is explained in details. The results of our qualitative study were displayed and discussed next. General conclusions were drawn at the end of the paper.

2. Research Question

Decision makers could face many options while implementing actions to sustain their firms' business models. Therefore, the primary goal of our study is to propose to managers a logical technique and steps to follow, in order to choose the right actions to adopt in their quest to reach sustainability.

3. Literature Review

- **The quest of sustainability**

The concept of sustainability is about finding an equilibrium between three pillars: economic, social and environmental (also known as the three Ps: profit, people and planet) (Beaton and Maser, 2016). Its focus is to

meet the needs of today without blowing future generations' chances to meet their own needs tomorrow (Spiliakos, 2018).

Sustainability, as a term, was first launched into the arena of common discourse in 1989 thanks to a United Nations publication known as the “The Brundtland Report”. Today, sustainable development has gained widespread business, political and public authority, as well as, it has arguably become “the common currency of almost all players in the environmental arena” (Barkemeyer et al., 2014).

Drivers and motivators to pursue sustainability differ from a company to another. Reputation, brand image, cost savings, innovation, employees’ ethics and stakeholders’ pressure are the major reasons companies implement sustainability. Table 1 summarizes the reasons for adhering to the sustainability mind-set from two different sources:

Table 1. Summary of Reasons for Implementing Sustainability

BCG/MIT Survey (Berns et al., 2009)	McKinsey Global Survey (Bonini et al., 2010)
Brand image 35%	Corporate reputation 36%
Cost savings 12 %	Alignment with business goals 21 %
Competitive advantage 10%	Operational and cost efficiency 19%
Employee morale 9%	Customers’ expectation 19%
Product or service innovation 8.5 %	New growth opportunities 17 %
Business model innovation 8 %	Strengthening competitive position 8 %
New source of revenue 7.5 %	Leadership 14 %
Effective risk management 5 %	Regulatory risk 14 %
Enhanced stakeholders’ relations 4%	Motivating employees 11%
Other 1%	Enhanced stakeholder’s relations 5%
	Pressure from NGOs 3%

• **Roads to sustainability**

Many articles were published in the literature, in order to discover the ultimate way to reach sustainability. Table 2 summarizes conclusions drawn by the respective authors regarding the most well-known roads to reach sustainability:

Table 2. Main articles discussing ways to reach sustainability

Authors	Year	Journal reference	Proposition
(Rothenberg, 2007)	2007	MIT Sloan management review	Sustainability through Servicing: Shifting from producing many products to selling services around a fewer range of products will lead to sustainability.
(Nidumolu et al., 2009)	2009	Harvard business review	Sustainability through innovation: Another way to reach sustainability is by encouraging innovation through research and development (R&D)
(Gray and Stites, 2013)	2013	Network for business sustainability, case study	Sustainability through partnership: The adopters are convinced that collaboration is one of the most important keys to sustain their businesses. They believe that acting alone will not have as much positive effect as acting collaboratively. In other words, through partnership, more value is created than one could alone.
(Eccles and Saltzman, 2011)	2011	Stanford Social Innovation Review	Sustainability through integrated reporting: Integrated reporting is an emerging concept that actuates companies to go beyond financial reports by publishing financial and nonfinancial environmental, social, and governance performance.
(Joyce and Paquin, 2016)	2016	Journal of Cleaner Production	Sustainability through business models: Adding two layers (social and environmental) to the business model canvas to cover the three dimensions of sustainability
(Abu-Tayeh and Myrach, 2016)	2016	Workshop of the International Conference on Information Systems	Sustainability Through Information systems (IS): 3 concepts: “Sustainability in IS”, a concept that aims to reduce the IS consumption of resources and its impacts on environment. “Sustainability by IS” that deals with the contribution of IS towards a sustainable development “Sustainability of information system”, which concerns the creation and the modification of IS in a way to optimize constantly their impacts.

- Our proposed framework to reach sustainability

In a previous article published in 2020, we proposed a framework that explained how to sustain a business model of a given company through information systems (El Hilali and El Manouar, 2020). We chose the canvas of Osterwalder & Pigneur’s as a basis to work on, in order to reach sustainability given the fact that it is the most used tool (Škerlavaj et al., 2016) to craft a business model.

The idea, as shown in Figure 1, is to regroup the 9 blocks of the business model canvas into 3 categories: blocks related to the economic dimension, those related to society and those related to environment. Sustaining a business model through information systems is assessed by analyzing their impacts on these three categories. Three main questions should be answered:

- How to increase revenues and reduce costs using IS?
- How IS could be used to enhance customer relationships, to segment effectively the customers and to warranty the adhesion of the key partners to sustainability mind-set?
- How IS could play a major role in reducing the environmental impacts of channels and key activities?

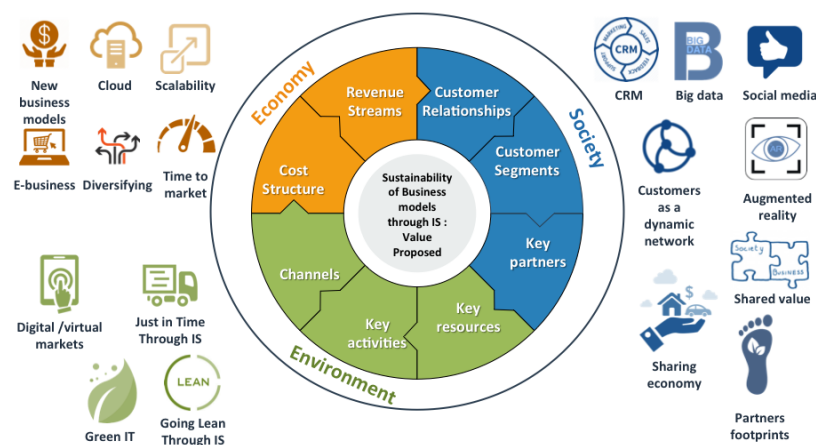


Figure 1. Conceptual framework explaining how to sustain a given business model through IS (El Hilali and El Manouar, 2020)

4. Methodology

One of the main challenges that organizations face today resides in their ability to choose the most correct and consistent alternatives in such a way that strategic alignment is maintained. Applying the previous framework (see Figure 1) could put companies in a situation where they are spoiled with choice. Combining the framework with a multicriteria decision making technique, such as the AHP method, will help the decision makers to choose the right actions that depend, in our point of view, on the industry, the firm and the general business climate.

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions based on mathematics. It was first developed by Pr Thomas L. Saaty in the 1070s (Saaty, 1980). This decision making method makes it possible to assign a value representing the preference degree for a given alternative. These values are used to classify alternatives, in order to choose the most suitable solution to a given problem.

Three features have led to AHP’s power and popularity as a decision making tool (Jamshidi et al., 2009): (i) its ability to handle both tangible and intangible attributes, (ii) its ability to structure the problems, in a hierarchical manner to gain insights into the decision making process and (iii) its ability to monitoring the consistency with which a decision maker uses his/her judgment.

The strength of this approach is that complex decisions are reduced to a series of one-on-one comparisons. According to (Saaty, 1980), the AHP method could be synthesized in three major phases: decomposition, comparative judgment and synthesis. In the first step, a hierarchy of goal, criteria, sub criteria and alternatives are established to present the problem in a very logical way. Next, the main stakeholders are invited to give their judgements by comparing pairs of criteria or alternatives. In order to express their preferences, evaluators use scale of values ranging from 1 (Equal importance) to 9 (Extreme or absolute importance), as shown in Table 3:

Table 3. Scale of Relative Importances (according to (Saaty, 1980))

Scale	Judgment
1	Equal importance
3	Moderate importance of one over the other
5	Essential or strong importance
7	Very strong or demonstrated importance
9	Extreme or absolute importance
2,4,6,8	Intermediate values between the two adjacent judgements

Based on preferences derived from the comparison matrix, the last step consists of conducting synthesis of priorities to calculate a composite weight for each alternative.

These three major phases could be more detailed in six steps (Maletič et al., 2016):

Step 1: Define the problem and determine the kind of knowledge sought

Step 2: Structure the complex decision problem as a hierarchy of goal, criteria and alternatives

Step 3: Construct a set of pairwise comparison matrices. Formally, the pairwise comparisons are collected into a pairwise comparison matrix, $A = (a_{ij})_{n \times n}$, structured as follows:

$$\begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix}$$

with $a_{ij} > 0$ expressing the degree of preference of x_i to x_j .

Step 4: Extract the relative importance implied by the previous comparisons to answer how important are the alternatives when they are considered in terms of the criterion? Saaty (Saaty, 1980) asserts that to do this, we should estimate the right principal eigenvector of the previous matrix. Given a judgment matrix with pairwise comparisons, the corresponding maximum left eigenvector is approximated by using the geometric mean of each row. That is, the elements in each row are multiplied with each other and then the n -the root is taken (where n is the number of elements in the row) (Triantaphyllou and Mann, 1995). The numbers are next normalized by dividing them with their sum.

Step 5: Verify the consistency of the comparisons. The Pairwise comparison matrix will be consistent if the following relation is true: $a_{ij} = a_{ik} a_{kj}$. However, perfect consistency rarely occurs in practice. The AHP method uses the consistency ratio CR to check the consistency of the pairwise comparisons in a judgment matrix, which should be less than 10 % (Triantaphyllou and Mann, 1995). To compute CR, the consistency index (CI) should be estimated. First, we multiply the sum of the column of the pairwise matrix with the normalized eigenvector to compute the maximum eigenvalue λ_{max} . CI is calculated by using the formula: $CI = (\lambda_{max} - n) / (n - 1)$.

CR is computed by dividing CI with the Random Consistency index (RCI) given in the following Table 4 (values depending on n) (JEDDOU et al., 2015):

Table 4. RCI values for different values of n

n	1	2	3	4	5	6	7	8	9
RCI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Below, Table 5 that sum up the step 5:

Table 5. Calculations to Obtain the Vector Criteria

Criteria	C1	C2	C3	Cn	Eigenvector	Criteria vector
C1	1	a ₁₂	a ₁₃	a _{1n}	$V_j = \prod_{i=1}^n a_{ij}^{(1/n)}$	$W_j = V_j / \sum V_j$
C2	1/a ₁₂	1	a ₂₃	a _{2n}		$W_j = V_j / \sum V_j$
C3	1/a ₁₃	1/a ₂₃	1	a _{3n}		$W_j = V_j / \sum V_j$
Cn	1/a _{1n}	1/a _{2n}	1/a _{3n}	1		$W_j = V_j / \sum V_j$
Eigenvalue λ_{max}	$(\sum_{i=1}^n a_{ij}) * W_j$				$\sum V_j$	$\sum w_j = 1$
Consistency Ration (CR)	$\frac{(\lambda_{max} - n)/(n - 1)}{RI}$					

Step 6: The synthesis step is taken. The priority vectors become the columns of the decision matrix. In order to obtain final results, all alternatives were multiplied by the global weight of the single decision criteria.

Furthermore, in order to explain well how could we associate the AHP method with the framework detailed in Figure 1, we chose to work on a telecom operator as a case study. The chosen company is the historical operator in Morocco, with more than 8000 employees and \$ 3.4 billion as revenue of 2018.

Case studies have in fact the merit of enabling theory building and development more than quantitative research approaches in the field of management (Tsang, 2014). Moreover, they are capable to explain complex connections between phenomena and their context (Dubois and Gadde, 2002). Furthermore, case studies offer the possibility of collecting and analyzing different form of data, allowing a more in depth understanding of the analyzed subject (McCutcheon and Meredith, 1993).

5. Results

Following the 6 steps detailed in Methodology section, our finding for the telecom operator could be presented as follow:

Step 1: The objective of this study is to choose the best alternative for a telecom operator to embrace sustainability. Investing in sustainability requires implementing radical changes at the business model level. In the digital era, these actions could not be done without having recourse to digital capabilities and information systems (El Hilali et al., 2020). Therefore, the objective is to sustain the business model of the Telco through information systems by working on the business models canvas elements.

Step 2: The objective of this study was decomposed in three criteria, which are economic development, social growth and environmental performance. 8 sub-criteria where identified from our framework as to form a hierarchical abstraction of the problem, as shown in the following Figure 2

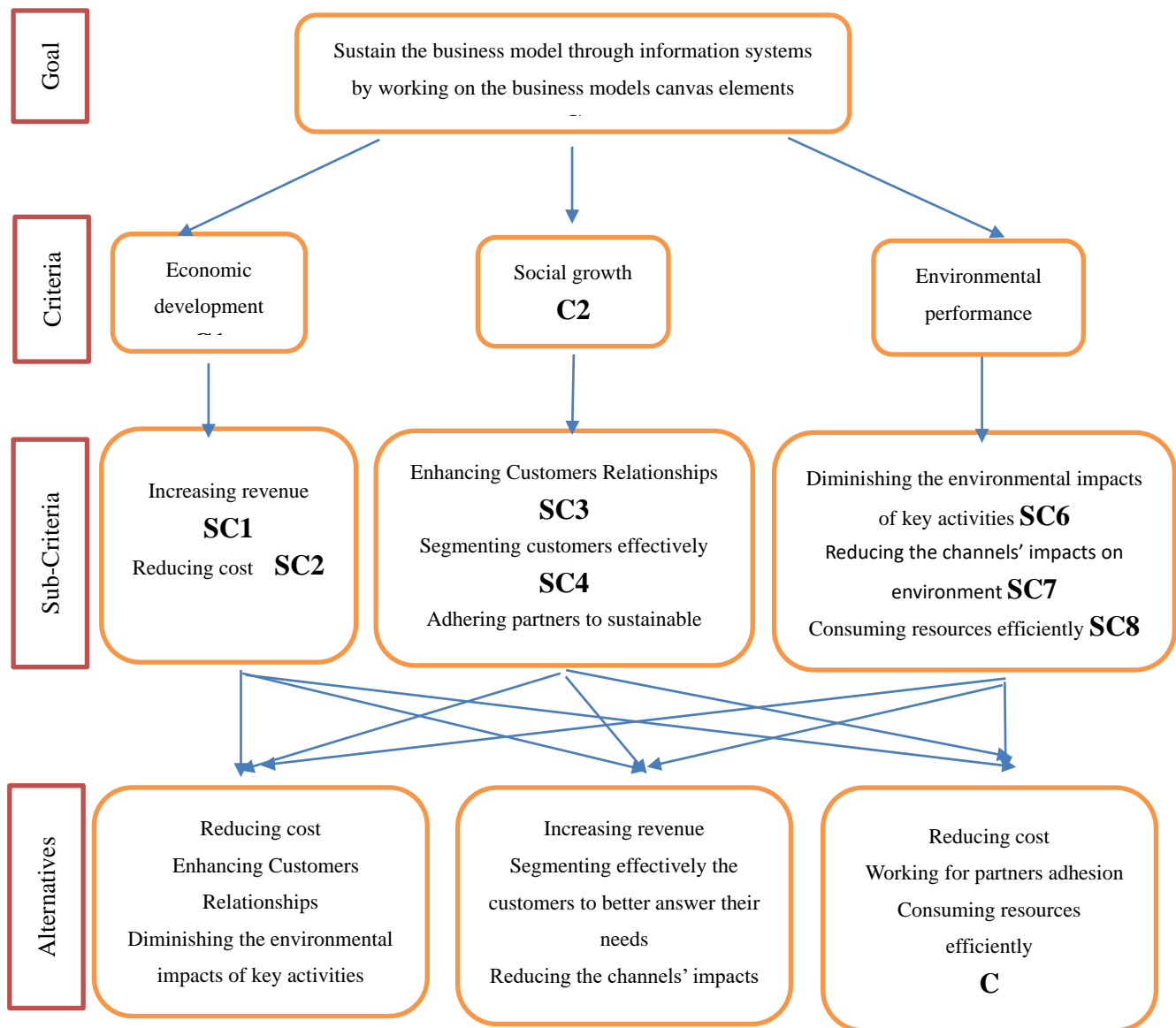


Figure 2. Criteria, sub-criteria and alternatives of the AHP method for the telecom operator

Steps 3 ,4 and 5: In this step, 10 managers with IT and managerial background that work in the telecom operator in Morocco were consulted, in order to collect their judgments. Pairwise comparison matrices were established as follow:

- **Criteria**

Table 6. The pairwise comparison matrix for the three criteria

	Economy	Society	Environment	Eigenvector	Normalized EV
Economy	1	3	2	1.82	0.54
Society	0.33	1	0.5	0.55	0.16
Environment	0.5	2	1	1	0.30

Lambda max **CI** **CR**
 3.009 0.0046 0.008

- **Sub criteria**

Table 7. The pairwise comparison matrix for the first sub-criteria

	Increasing Revenue	reducing cost	EV	Normalized EV
Increasing Revenue	1	2	1.41	0.667
reducing cost	0.50	1	0.71	0.333

Lambda max **CI** **CR**
 2.000 0.0000 0.000

Table 8. The pairwise comparison matrix for the second sub-criteria

	Enhancing Customers Relationships	Segmenting customers effectively	Adhering partners to sustainable mindset	EV	Normalized EV
Enhancing Customers Relationships	1	6	4	2.8 8	0.701
Segmenting customers effectively	0.17	1	0.5	0.4 4	0.106
Adhering partners to sustainable mindset	0.25	2	1	0.7 9	0.193

Lambda max **CI** **CR**
 3.009 0.0046 0.008

Table 9. The pairwise comparison matrix for the third sub-criteria

	Diminishing the environmental impacts of key activities	Reducing the channels' impacts on environment	Consuming resources efficiently	E V	Normal ized EV
Diminishing the environmental impacts of key activities	1	2	2	1. 5 9	0.493
Reducing the channels' impacts on environment	0.50	1	0.5	0. 6 3	0.196
Consuming resources efficiently	0.50	2	1	1. 0 0	0.311

Lambda max	CI	CR
3.054	0.0268	0.046

Step 6: final priorities will be computed as follow:

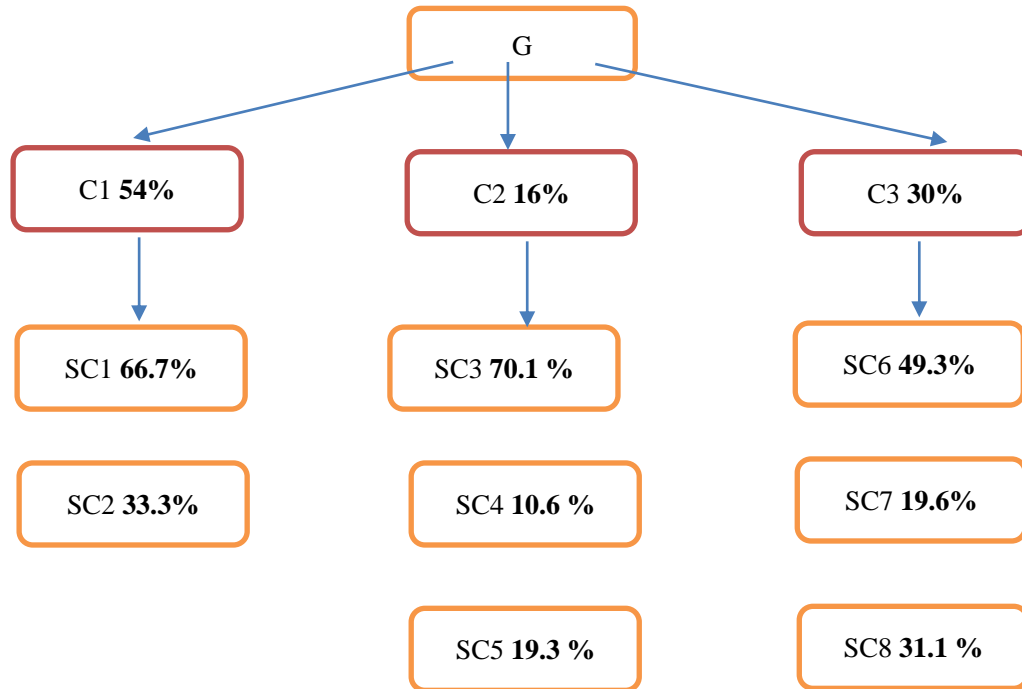


Figure 3. The computed final priorities

For alternative A, the final weight will be: $54\% * 33.3\% + 16\% * 70.1\% + 30\% * 49.3\% = 44\%$

For alternative B, the weight is computed as: $54\% * 66.7\% + 16\% * 10.6\% + 30\% * 19.6\% = 43.6\%$

And finally, the alternative C will have as a weight: $54\% * 33.3\% + 16\% * 19.3\% + 30\% * 31.1\% = 30.4\%$

6. Discussion

Sustainability is almost the quest of every company nowadays. Finding an equilibrium between the economic ambitious, the social and environmental footprints is what companies are looking for.

Deciding on which actions to take could be very difficult in case of unanimous decisions. Offering logical decision making steps and tools to help to choose the best option will be welcome. Actions will depend on industries, companies and their ways of creating value. Working on business models, in this case, may help decision makers in their quest of sustaining their business.

Our framework is based on the AHP method, a well-known multicriteria decision making technique that helps decision makers to select a choice between alternatives. The framework was applied on a telecom operator as a case study, in order to explain it in clear way.

For the Telco, three scenarios were kept by the questioned managers in order to increase the firm’s sustainability footprints. Scenario A is primally based on reducing costs, enhancing customers relationships and diminishing the environmental impacts of key activities. Scenario B proposes to the Telco to increase revenue, segment effectively the customers to better answer their needs and to reduce the channels impacts on the environment. The proposed scenario C takes account reducing costs, working on the adhesion of the partners and consuming resources effectively.

Scenarios A and B were by far the preferred choices to the company. Choosing between reducing costs and increasing revenue is a recurring question for business owners. Experts and practitioners believe that deciding on

cutting costs or increasing revenue often depends on the company and the industry in which it operates (Maverick, 2020). Any decision should increase profitability and especially the profit margin that measures how much, out of every dollar in sales, a company actually keeps in earnings. In some cases, increasing revenue can result in higher costs and lower profit margins, while cutting costs can result in diminished sales and also lower profit margins if market share is lost over time. Companies should focus on branding and quality, in order to sustain higher prices on sales and ensure higher profit margins.

Regarding the social part, both the scenarios A and B privileged customer centricity. In fact, Firms these days are putting customers at the heart of their organization (Fader and Toms, 2018). They are privileging providing a positive customer experience before and after sales, in order to enhance customer loyalty and to improve business growth (Giménez, 2018). Moreover, our telecom operator is following the trend by thinking customer first. In the highly competitive telecom industry, customer service and customer experience are critical factors in building and maintaining a competitive advantage (McShane and America, 2012). In addition, the telecom operator decided to not be left out. On the one hand, enhancing the customer relationships through customization, personalization, focusing less on the sales and adopting new mindsets, such as shared value and circular economy, will enhance the social foot print of the telecom operator. On the other hand, segmenting effectively the customers will help the Telco to better understand what customers want and what they do not want, in order to address their social needs. As regards to the environmental actions, scenario A suggests to prioritize diminishing the impacts of the Telco key activities. Free cooling technics, digital marketing, adopting lean/just in time approaches to manage inventories. These are few of many actions that can be adopted by the operator to reduce its carbon footprint. Scenario B, however, proposes to reduce the impacts of the channels. In fact, with selfcare solutions through websites, mobile applications and customer service ChatBots deployed on the main social networks used in Morocco (Facebook messenger and WhatsApp), the operator could reduce significantly its channels impacts on the environment as it will minimize the necessity of a customer to visit a brick and mortar salespoint.

7. Conclusion

This paper was an attempt to enrich the literature on the subject of sustainability and multicriteria decision making techniques. It introduced a new approach, based on our already published framework and the AHP method that offers to decision makers a logical technique to choose and implement the best options regarding their quest for sustainability. This approach was applied on a telecom operator as a case study, in order to explain it well.

As future research directions, we could explore the use of other multicriteria decision making techniques and other sustainability frameworks, in order to give firms more flexibility and options while searching for the ultimate way to reach sustainability.

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