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Summary

Regional analysis of financial barriers to innovation: A multilevel approach

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Abstract— **This article aims to highlight, using a multilevel model, the effect of the region on financial barriers to innovation in Tunisian firms. To do this, we used data on a sample of 620 firms observed by the Ministry of Higher Education and Scientific Research in 2008 covering 24 governorates. The results indicate that the impact of financial barriers on the innovation activities in Tunisian firms differs from one governorate to another. This dispersion is partly due to the economic particularity of each region and the specific nature of regional infrastructure in Tunisia.**

Keywords— **Innovation, financial barriers, region, multilevel model, Tunisia, firms.**

INTRODUCTION

The identification's approach of barriers to innovation is much more recent than that addresses the determinants of innovation [10]. The authors identify different types of obstacles in firms in order to know their nature, origin, importance and also their impact on the innovation process. This aims to measure the effects and consequences of these barriers on the innovation activities, which is not easy [1]. This approach also allows evaluating the effectiveness of public actions and identifying corrective measures to overcome or eliminate these obstacles.

Barriers to innovation are of different nature, and they can play a key role in defining characteristics of the external technological environment. They also influence in determining the attractiveness of a region for multinational and local companies. The decision to locate firms in specific areas and commit oneself in innovative activities could be affected by the assessment of the difficulties that will be encountered in the innovation process.

The main purpose of this paper is to show how the geography of innovation can benefit from the multilevel modeling. We provide a formal evaluation of the hypothesis that the geographical location of the company influences the probability of that to innovate and this, by facilitating access to resources or slowing and stopping its innovative activities.

The paper is organized as follows. Section 1 presents the literature review. Section 2 investigates the importance of financing innovation in Tunisian firms. In Section 3 we provide modelling and data and state empirical results. Finally, the last section concludes the paper and discusses policy implications.

I. LITERATURE REVIEW

There is no doubt that innovation is a necessary key to improve productivity, growth and sustainability of the firm. Given this environment, knowing the factors that raise innovation is the solution. This study identifies and point out the disparities of financial barriers to innovation perceived and experienced by Tunisian companies.

According to [15] innovation is something new. It's about creating something new through the processes of learning or knowledge. [5] found that innovation is widely recognized as a key factor in the competitiveness of nations and firms. Smaller companies that do not adopt innovation in their growth strategies run the risk of losing competitiveness because of their obsolete products and processes.

The study of innovation and firm's innovation attitude is relevant in this context given that innovation is becoming, increasingly, a critical factor for the sustainability and survival of firms. Moreover, it becomes even more important to target the causes that prevent companies realizing innovative activities. [2] stated that there are factors or obstacles that inhibit innovation. These factors, which place the obstruction or inertia in innovation, qualified as barriers to innovation, can occur for various reasons. The identification and categorization of these barriers are essential seeing that this will allow us to create mechanisms to reduce their existence, minimize, remove or convert them into facilitators of innovation.

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For most authors, they divide these obstacles into internal and external obstacles ([6], [2], [5], [24]). Internal barriers are those that occur within the firm and external barriers are those from the external environment of the company. [6] describes the lack of government support as an important barrier to innovation in the European country. [4] revealed two barriers to innovation in a study conducted in five Portuguese SMEs. These obstacles are the lack of qualified human resources or skills and a huge lack of external communication between knowledge generators (universities and investigation institutes). In France, as shown by [10], the Community Innovation Survey highlighted new obstacles to innovation that the major obstacle is the high cost of innovation followed by the lack of appropriate financial sources.

A general analysis of the work that address obstacles to innovation, shows a real lack of studies that focus on developing countries, especially in Arab and Muslim countries.

II. Financing Innovation

The innovation policy is unfortunately not rooted in many firms in Tunisia because of the lack of strategies and traditions. However, Tunisian companies can provide a concrete example of successful innovation activities, never the less technological, financial and trade gaps remain, and innovation continues to be overlooked in many firms. Unfortunately, many companies do not have the necessary, human and material, resources to adopt an innovation policy that will bring joy to creeping companies. This has led many entrepreneurs who believe in the local market and refuse all foreign competition, to constantly undergo competitive attacks, especially as they tend to react too late to new events in the local market.

The technological and commercial breakthrough cannot be achieved without a research and development (R & D) policy. The technological future of any country depends on its level of spending in this area. The more a country is rich, the more it invests in R & D activities. In recent years we saw that financing innovation is over taken the R & D spending. This is due to the support of capital venture that has become a source of finance to innovation.

When it comes to meeting the financing needs of innovations, innovative companies face many challenges. The risk for investors is very high, and funding is therefore very difficult to obtain. Funding sources generally come from business angels and personal funds of entrepreneurs and their families. The banks, for their part, are rarely active for small companies. Indeed, bankers are based primarily on the company's historical accounting, on repayment capacity and the guarantees offered.

When companies reported financial barriers to launch an innovative project, that is to say when they lacked appropriate funding sources, their risk of failure is higher. The lack of access to finance is the result of a fragile economic and financial health of a company. These barriers weigh more heavily on small firms. The largest, those whose turnover is important, are less affected.

In our survey, 62% of companies are innovative, 47% of them believe that the major barrier to innovation is the lack of funding. So given the importance of his obstacle for many firms, we conducted a mapping of Tunisia which helped us highlighting the perception of financial barriers by Tunisian regions (Fig1).

Tunisia has 24 governorates. We have divided them, in this analysis, into six regions namely: the North-East (includes 7 governorates), North-West (includes 4 governorates), Center-East (includes 3 governorates), Center-west (includes 3 governorates), South-East (includes 4 governorates) and South-West (3 governorates).

The degree of importance of the financial barrier is measured with a scale that goes from 1 (low importance) to 4 (very strong importance).

Fig.1. Financial barriers distribution within Tunisians regions

We can see from this map that the impact of the financial barrier on the innovative activity of firms differs according to over regions where firms are located. The darker the color is, the more companies in this region are facing financial barriers to innovation.

For the center-east, the problem of lack of sources of funding practically does not exist; it has a minor impact on the innovative activity of firms. This is due, in part, to the existence of: technology and externalities policy, investors who are willing to invest in such areas and proximity to suppliers, customers and skilled workforce.

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On the other hand, for the north-west region, the lack of funding sources seems to be a major barrier to innovation in this region, we can explain this by the lack of appropriate infrastructure to attract new companies, been far from ports and airports that facilitate exports, the lack of qualified workers and the specific and hard nature of this region.

Therefore, innovation is not fairly shared and distributed in Tunisian regions (difference between center and periphery, city and country, north and south, etc.). Indeed, some areas relatively suffer from having low manufacturing activities and innovative capacities. Hence the importance of the role that the State should play in boosting and fostering innovation, promoting regional attraction of innovation through appropriate policies and by giving companies and investors the same access to knowledge, regardless their geographical location.

Having shown, using mapping, the distribution of financial barriers across Tunisian regions and how these areas bear in a different way the weight of these barriers.

In the next section we will implement, using an econometric tool, the dispersion of financial barriers in Tunisian regions.

III. Regional Analysis of Financial Barriers to Innovation with a Two-Level Model (Random Coefficients)

The purpose of this section is to take into account the influence of the geographical dimensions on financial barriers to innovation.

The spatial concentration of actors, resources and other environmental factors conducive to learning and innovation performance influences firms more than their individual characteristics, such as size, experience or industry. Empirical work in this vision continues to use models at a single level. While multi-level modelling is the most appropriate statistical technique here. This modelling approach ([27] and [12]) is desirable because it allows taking into account the relationships between and among the hierarchical levels, taking into account the variability in levels.

Only the multi-level analysis is able to mount the regional effect. To do this, we adopt a model on two levels: the individual level (level 1) represented by companies and a regional level (Level 2) represented by the governorates. The endogenous variable representing innovation is "innovat" describing the intensity of innovation (no innovation, only one innovation, two innovations, three innovations or four types of innovation (process, product, organization or market).

This multi-level analysis allows relaxing the assumption that the weight of the perceived barriers to innovation (mainly lack of financial resources) is identical for all governorates. Thus, the coefficients are allowed to vary and, by specifying two levels: level 1 (firms) and Level 2 (governorates). We distinguish two models:

1) Model 1: The constants of the model are allowed to vary but not the slopes associated to the barrier: lack of source of funding

The formulation of the two-level model has the following form:

$$innovat_{ij} \sim N(X\beta, \Omega)$$

Level-1 model: $innovat_{ij} = \beta_{0ij} cons + \beta_{1j} Finan_{ij}$

Level-2 model: $\beta_{0ij} = \beta_0 + \mu_{0j} + e_{0ij}$

Where:

$innovt_{ij}$ is the dependent variable which refers to the intensity of innovation..

cons is a unit vector denoting the constant of the model.

$Finan_{ij}$ is a variable representing the financial barrier to innovation.

And μ_{0j}, e_{0ij} are random effects (normally distributed residual terms for each equation),

i is the firm (i =1...n)) and *j* is the region (j =1...m).

The estimation results of the first model are in the following table:

TABLE I
Estimation Results

	Average	**Variance**
Slopes associated to governorates	-0.34(0.051)	0.073(0.049)
Constants associated to governorates	2.289(0.171)	1.711(0.098)

We can see that the slopes vary between governorates when they are supposed to be identical; this proves that there is an effect of the region in the perception of barriers for firms specially the lack of financial sources for innovation activities.

2) Model 2: The constants and the slopes are allowed to vary

Model 1 assumes that the variation between governorates is due to constants. However, there is a possibility that the slopes also differ from one governorate to another. This implies that the coefficient of lack of sources of funding varies from one governorate to another. The formulation of the model takes the following form:

$$innovat_{ij} \sim N(X\beta, \Omega)$$

Level-1 model: $innovat_{ij} = \beta_{0ij} cons + \beta_{1j} Finan_{ij}$

Level-2 model: $\beta_{0ij} = \beta_0 + \mu_{0j} + e_{0ij}$

And $\beta_{1j} = \beta_1 + \mu_{1j}$

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Where:

$innovat_{ij}$ is the dependent variable which refers to the intensity of innovation.

Cons is a unit vector denoting the constant of the model.

$Finan_{ij}$ is a variable representing the financial barrier.

And $\mu_{0j}, e_{0ij}, \mu_{1j}$ are random effects (normally distributed residual terms for each equation) respectively to level 1 (firms), Level 2 (governorates constant) and level 2 (governorate, slope).

i is the firm ($i = 1...n$) and j is the region ($j = 1...m$).

The estimation results of the second model are given by table 2.

TABLE III
ESTIMATION RESULTS

	Average	Variance
SLOPES ASSOCIATED TO GOVERNORATES	-0.368(0.072)	-2.822(0.388)
CONSTANTS ASSOCIATED TO GOVERNORATES	2.409(0.225)	9.638(1.173)

The slopes and the constants vary. These results confirm our hypothesis: geographical location of companies influences their probability to innovate.

3) Implementing the governorate effect by a graphical representation of residues

To illustrate the difference of the regional impact on the financial barrier to innovation activities across Tunisian regions, we proceed to the graphical representation of residues of hazards constants and slopes, which have the following shape:

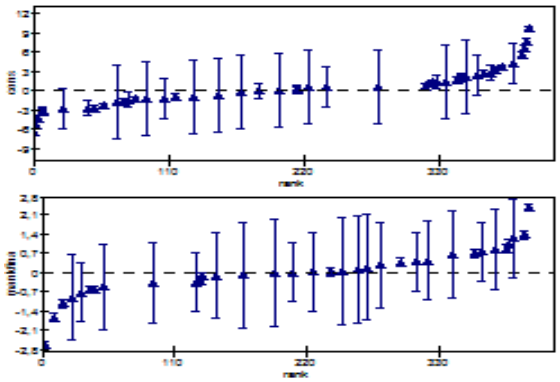

Fig. 2. Graphical representation of residues

We find that regional differences into financial barriers to innovation not only characterize the constants of the model, but also cover the slopes. Despite a generally positive correlation between the random components of the constants and slopes, the differences between these two components are not perfectly proportional. This confirms the existence of a regional disparity in terms of financial barriers to innovation in Tunisia.

The assumption is that firms located in the more developed regions are more likely to innovate, because they have all kinds of external economies geographically limited and agglomeration effects related to the production and the dissemination of localized knowledge. Moreover, the structural problems of the region, such as long-term unemployment and concentration of industries in declining, are expected to have negative effects on the frequency of firm's innovation and then inhibiting their activities.

IV. CONCLUSION AND POLICY IMPLICATIONS

This paper investigates financial barriers to innovation activities in the Tunisian context. The geographical location is crucial in the perception of obstacles to innovation. The existence of technological and strategic externalities favorable to innovation makes dispersion between regions evident. Indeed, the concentration of the national economic activity in the regions of Tunis, Sfax and Sousse can explain the level of innovation of firms in these regions through the facilities available to them (technology and information transfer, proximity to suppliers, customers and a skilled workforce).

Multilevel analysis allows taking into account the effects of regions, using random effects. They include the different levels by taking into account the hierarchical structure of the data in the estimation procedure parameters and their standard deviations.

The estimation results of the multi-level model show that financial barriers to innovation vary from one area to another. In other words, the lack of financial sources depends on individual characteristics (associated to the firm), but also on regional and sectorial characteristics (external factors to the firm).

Tunisia today goes through a transition phase, it is imperative seek is to reduce if not eliminate different types of barriers to innovation by assisting firms to reduce the economic and financial risk and making training programs to improve staff qualifications and skills, not forgetting to explore foreign markets.

To support innovation efforts in firms, the state has set up specialized structures throughout the country according to the specificities of each region: laboratories, technical centers, Upgrading Program (PMN), FOPRODEX (Exports Promotion Fund), FAMEX (Fund Access to Export Markets), but these incentives are still insufficient to mitigate the effects of difficulties in the process of internationalization of Tunisian companies.

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Challenges and Barriers to Women's Entrepreneurship Experience from Morocco

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***Abstract*— In the national marketplace, women's entrepreneurship is a vibrant and a growing contribution to the labour force. As the number of women self-employment is becoming a refuge in most countries and Morocco is no exception, particularly women entrepreneurs are still a small proportion of the total population. The present article highlights women's entrepreneurial work, typically in feminine cooperatives. It discusses the major triggers to choose this type of work as well as the main challenges they face in this sector of work. Barriers Moroccan women entrepreneurs are also surveyed. The conclusion drawn from the article includes the objective of increased self-autonomy as a central goal of women's entrepreneurial work regardless of the gendered, structural and socio-economic stumbling blocks confronted. Strong actions and policies to develop the situation of this proportion of society must be of any strategy of empowerment.**

Keywords: women, entrepreneurship, socioeconomic development, challenges, barriers.

I. INTRODUCTION

As the country moves towards economic development, important issues that influence the socioeconomic well-being of all Moroccans, with particular reference to women who are living in an unprivileged situation, need to be scrutinized. This portion of the Moroccan society relies on the creation of their own entrepreneurship and conduct small business activities in order to develop their socioeconomic situation. Development practitioners listed poverty reduction as one of the pillars of development objectives. They stressed on the fact that the women's creation of job opportunities is a means towards achieving development. In this regard, women's entrepreneurial work is considered as a tool of household poverty reduction. It is also reported that many of the women's small businesses contribute to the welfare of the household, the family and offer opportunities of employment for other workers.

However, their contribution to the quality and direction of the economic and social development of the region and the country in general is not achieved easily. The present paper provides an understanding of the situation of women entrepreneurs and the multiple barriers to investment and doing business that may be common for all investors and those that affect women entrepreneurs disproportionately.

The aim of the present research is to conduct an exploratory study to present the situation of women entrepreneurs in the region of Draa- Tafilalt- Morocco, particularly those working in feminine cooperatives. The results of the survey will allow us to identify the profile of women owned enterprises in the region, the main factors and motivational reasons to create their own businesses, and the barriers they face before, during the start-up and after the creation of their businesses added to the other factors outside the business environment that might affect women's entrepreneurship.

To achieve these objectives, the study tries to address the following questions:

1) What is the profile of women entrepreneurs in the region of Draa- Tafilalt- Morocco?

2) What are the factors contributing to the decision to become an entrepreneur?

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3) What are the gendered, structural, and socioeconomic barriers that women face while choosing entrepreneurship as a career?

II. THEORETICAL FRAMEWORK

A. Definition of Entrepreneurship

In the last decades, so much pressure on national governments to promote women's economic participation and to alleviate women's poverty generated from different bodies such as the United Nations, global conventions and women's organisations worldwide. In all these, the focus of many schools of thought has been on women's economic empowerment. The discussions tended to result in the promotion of income generating projects for women, especially those in vulnerable situations and in rural areas. This initiative has triggered the use of the new terminology "promoting women's entrepreneurship."

The word 'entrepreneur' is defined by the *Oxford Complete Wordfinder* as '*a person who undertakes an enterprise or business with the chance of profit or loss, person in control of commercial undertaking, a contractor acting as an intermediary*" (Tulloch 1993). Although this definition shows that it is neutral in terms of gender, in fact one may suggest that the social context in which men and women live may influence their ability to become an entrepreneur. For economists, the entrepreneur is a principal player in process of capitalist accumulation and expansion (Hebert &Link, 1988). Other scholars defined the term entrepreneur differently. For example, Hisrich & Brush (1985) viewed entrepreneurship as " *the process of creating something different of value by devoting the necessary time and effort, by assuming the accompanying financial, psychological, and social risks, and by receiving the resulting rewards of monetary and personal satisfaction*" (p.4). We adopt this definition which, as we demonstrate later in the article, is based on the idea of the establishment of businesses to assert the empowerment of women.

The silhouette of entrepreneurship for decades was masculine, and researchers have traced the contours of such gendered area (Fielden & Davidson, 2005). The nature of entrepreneurship is also argued by Bird and Brush (2002) as being gender neutral, but in fact based on the experiences of male entrepreneurs. However, regardless of these views of the masculine nature of the field of research, entrepreneurship is also seen as a form of empowerment for women.

B. Emergence of Women's Entrepreneurship

A definition of the concept of women's entrepreneurship in the literature is not easy to be found. For instance, in a study by Lavoie (1988), female entrepreneur is also called the owner-head of company is describes as "*a woman who alone or with partners has founded, bought or inherited an enterprise, who assumes the risks and financial, administrative and social responsibilities and participates in its day to-day management*." From this definition, one can assume that both buying and inheritance are acceptable means of establishing a self-employed economic activity. According to Fatimatou (2009), women's entrepreneurship can also be defined as "the process by which a woman or group of women creates or develops predominantly an economic and social structure comprising material and financial means and one or more persons working in an organized manner to provide goods or services. Services for the market (customers) in order to make a profit. Thus, a woman entrepreneur establishes her own business in order to gain a particular position in her community and society at large.

Women heads of companies are divided into different categories. According to Denieuil (2005), there are three types of this proportion of society:

- Women entrepreneurs: this category of women represents those who generally belong to wealthy families and possess of financial capital and/ or have a professional training. They are entrepreneurs because they have the capacity to own a business by taking over or transmission.
- Women working in income-generating activities: this category of women engages in individual economic activities to generate revenue to support themselves and their families due to their disadvantaged situation. The main aim behind their

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self-employment is to promote their financial independence and self-autonomy.

- Women who are economically active with limited professional training: women belonging to this category do not become entrepreneurs by choice but rather out of necessity in response to a social breakdown (divorce or widowhood) and/ or economic precariousness. The aim to do this type of work is obtain and fulfil the basic family needs.

C. Role of Women's Entrepreneurship on the Socio-economic Development

Female entrepreneurship has experienced significant growth in recent years. Women broke with their former role as a good housewife. The woman tends to assert her identity in the workforce. Her role has shifted from being a wife-mother to being an associate, self-reliant and career-oriented woman (BENAZZI. K, 2016). Currently, women entrepreneurs are found in all sectors of activity. Efforts are being made by the state and other actors to allow women entrepreneurs to leave the state of timidity in which they were in order to fully play their role as a lever for economic growth.

There has been a renewed interest in the women's entrepreneurship sector because of the important role and the increasing place of women in the socio-economic life of our country. It is now recognized worldwide that there can be no development without the full participation of women in the process. Women entrepreneurs play an important economic role in their ability to create jobs for themselves and others. Regardless of the country or type of economy, self-employment is an important employment option for many women, and perhaps more particularly for women living in the developing world (OCDE, 2004).

III. METHODOLOGY

The paper is based on a qualitative method research. We focused exclusively on women entrepreneurs as heads of feminine cooperatives. We have just retained women who have created along with other members their small businesses or taken over a legally registered cooperative and who participated in strategic decisions and day to day operations.

The regional Chamber of Commerce listening women's cooperatives in the region of Draa Tafilalt was used as a basis for the sample of our study. We were able to create a list of 80 potential respondents working in the following provinces: Midelt, Errachidia, Zagoura, Tenghir, and Ouarzazat.

Prior the fieldwork, potential respondents were contacted by telephone to make sure their willingness to participate in the survey and to count the total sample. A total of 50 women entrepreneurs accepted our solicitation.

Data collection was conducted using interviews based on an interview guide. Recorded semi-structured interviews lasted about one hour. They covered business information and life story information of these women. Questions were open-ended, which focused on different areas: motivation for becoming an entrepreneur, challenges, and barriers, The qualitative data collected from interviews, based on techniques of overlap, were interpreted using an in depth gender and socioeconomic analysis.

IV. RESULTS

A. The Socio-Demographic Profile of Women Entrepreneurs

The following section describes the socio-demographic profile of women entrepreneurs working in the region of Draa-Tafilalt in our survey. The main variable identified was age, civil status, educational level and professional training.

1) Age:

By examining the structure of women workers in cooperatives in Draa Tafilalt by age (see figure 1below), a relatively high rate of women aged between 34-40 years 45% is observed. Old women aged more than 40 years are involved in the market of cooperative employment with an estimated 30% share. Respectively, 25% is allocated to women whose age belongs to 26-33 years age group.

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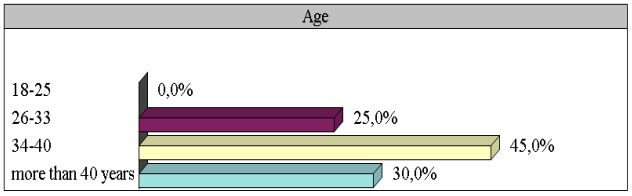

Fig1: Age group of the participants.

Data retrieved from the findings reveal the predominance of the adult active population. Most respondents consider the creation of job opportunities within the entrepreneurial sector as a viable solution regardless of their ages. Thus, age remains an important variable. It determines the major differences between women's age groups and their participation in this segment of work.

2) Civil Status:

With regard to the marital status, data from the region of Draa Tafilalt reveal that 25% are single, and the big majority has family responsibilities with a share of 60% for married women, 15% for divorcees.

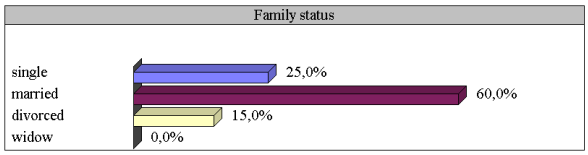

Fig2: Family status of the participants

Examining the distribution of women based on their marital status, it can be noticed that the issue of marriage is a significant factor. It determines women's participation in the entrepreneurial work. For instance, responses of the participants reveal that the highest rate is allocated to married women. They created cooperatives, possibly because they cannot rely only on a source of income provided by their partners or other male family members.

Analysis of the situation of women also shows the participation of single women in the entrepreneurial work in the region of Draa Tafilalt. Obviously, this category exercises different activities. These young females face often a difficult daily reality. The everyday problems are also affected by the residence of these women with their parents. This situation pushes most of them to exercise any activity to support them and help their families. For this reason, the parental home remains a productive place of work for these young ladies performing entrepreneurial activities, which are characterized by their fragility, uncertainty, scarcity of benefit, and absence of guarantee of permanence. Apart from the uncertainty of economic activities, fear of the future, the situation expresses obviously a certain inability to realize their own home and secure their own life outside their family circle.

Furthermore, responses show that divorced women consider the issue of "no husband" as a major cause for their involvement in such a type of work. Indeed, women who experienced divorce or separation from their spouses, generally, create their own units of living. Moreover, based on their unsuccessful experiences with marriage and cohabitation, the majority of divorced informants, regardless of their cultural backgrounds, declared that they would rely on their own resources to support themselves and their families.

The findings of the present empirical research cannot be complete without a discussion of the educational level of women workers in feminine cooperatives. Indeed, the data demonstrate that the only educational level is secondary among the target population in this region of Morocco.

3) Educational Level:

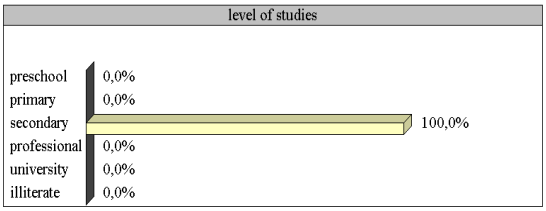

Fig3: Educational level of the participants

The educational level of women in this study is generally miserable. All the respondents did not complete formal schooling. The education level for those involved in the cooperatives work in the research area is not higher than secondary school level. These statistics indicate that the cooperatives are by so far the largest employment absorber of poorly educated women.

Statistical data indicate that most respondents are trained outside the formal system. This happens either at professional associations or via traditional

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ways with the help of a teacher who is mostly available in the craft's sector. These women transmit their expertise from one generation to another.

4) Professional Training:

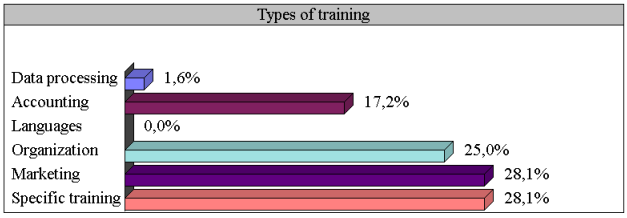

Fig4: Types of trainings women benefited from

The share of respondents who have access to vocational training is quite recognizable in the research area. Their main purpose is to improve their skills as reported by most workers as well as to improve their productions. For instance, most of the participants obtained certificates of participation in trainings related to marketing, accounting and specific trainings on how to manage their businesses. Others declared that they benefited from organization training sessions to better their managerial and organisational skills with an aim to develop the cooperatives and its members. This means that access to training may be effective at raising women's chances of work because women may be trained for the suitable kinds of jobs.

The subsequent section attempts to discuss the main reasons and motives that pushed women in the region of Draa Tafilalt to end up working as entrepreneurs, especially in feminine cooperatives.

B. Triggers of Women's Entrepreneurship

The entrepreneurial sector is being flued by women in the last few decades in Morocco. Women become active agents in creating businesses. However, there is little understanding of why this proportion of society chooses entrepreneurship as a career. The present section provides the main factors leading women work in cooperatives as a form of entrepreneurship.

As clearly demonstrated in figure 5, women's motivations to perform an entrepreneurial activity may be classified into different categories. Indeed, most respondents in the survey 31.2% stated that financial autonomy is the main reason for choosing to work in cooperatives. Moreover, 26.2% of them considered that the main reason simply lies in self-achievement while those who do not want to work with others represent 24.6% of the total number of workers. However, 9.8% saw that the need to finance the household expenses represent a reason behind their choice to select a job in cooperatives. This is followed by 8.2% of respondents who want local development as a main reason to practice their productive work in cooperatives.

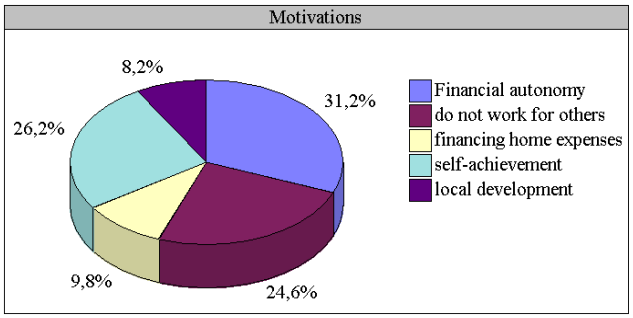

Fig 5: Motivational Aspects

Most participants selected various factors as their main reasons to work in cooperatives. They might be grouped as follows:

1) Autonomy

Women often lack the training and skills needed for employment in the formal sector, which push them to end up working in cooperatives. In other words, according to the findings, the respondents' participation in cooperatives is triggered by various factors, which are mostly relative to the rising of unemployment rates and lower wages in the formal economy. In this regard, women's autonomy is assumed to be achieved via women's access to the labor market. The findings show a certain level of autonomy cherished by the participants though it was after a long strike against traditions and cultural beliefs. As a vivid example, many respondents claimed that benefited from greater autonomy in economic decision making, ability to take care of self when sick and freedom of mobility when they became heads of the feminine cooperatives. In the same line of argument, one may assume that those women with higher levels of autonomy in their entrepreneurship work may have

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positive effects on their overall well-being and higher level of job satisfaction.

2) Financial Independence:

The economic reasons are the omnipresent in the research area. For instance, money represents a factor of prominent importance affecting women's choice of entrepreneurship activities. Moreover, unemployment and the need to earn money represent the most recognizable key factors with which women justify their choices of entrepreneurship in the research area.

3) Local development

8.2% of women aim, through the creation of their cooperatives, the development of their territories, ensuring a decent and stable income to the members, and consequently that of their families. Improved income levels enable members (and their families) to access education and health care. Cooperatives using local resources also participate in the development of their territories through the valorization of local products, the improvement of the intrinsic and extrinsic conditions of the product, the protection of the environment and the fight against the degradation of the environment and recycling (the case of cooperatives whose main activity is basketry by recycling the leaves of the palm trees.)

In sum, the main conclusions reached so far demonstrate different reasons behind women's work in cooperatives. On the one hand, the financial necessity pushes them to choose to work in this domain. That is to say, this is driven by women's own resort or their best option to gain a source of revenue. In other words, the materialistic reasons behind their work demonstrate the strong desire to satisfy their fundamental human needs. This finding is validated by the same argument in Benjelloun (1993, 96): "la motivation économique constitue la motivation general retenue par la grande majorité des femmes quelque soit leur catégorie socioprofessionnelle. » [The economic motivation constitutes the general motivation maintained by the vast majority of women, regardless of their socio-professional category.] Thus, women's economic necessity and self-achievement are crucial elements behind the women's search for a refuge in cooperatives in particular and in the entrepreneurial work in general. However, their access to the laborforce does not come easily. Many women in the sample experienced barriers before and after the establishment of their cooperatives.

C. Barriers Experienced

Data based on the fieldwork in the region of Draa Tafilalt demonstrate that women working in cooperatives suffer from various obstacles both at the time of the establishment of their businesses and during their operation. The following section summarizes the major barriers reported by women that function as stumbling blocks to the women's development as well as their careers. These obstacles are divided into formal and informal ones. The former is linked to the difficulties women face so as to have access to decent work, and the unclear future threatening them in this type of activities. The latter is related to traditional principles and values, which are present in the social order and influence the woman entrepreneurship participation in the labor market.

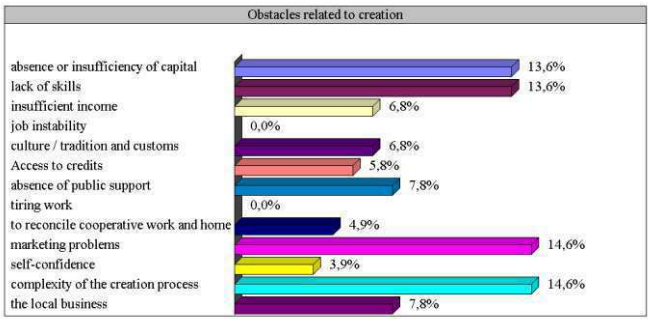

Fig 6: Barriers women face before the creation of the enterprise

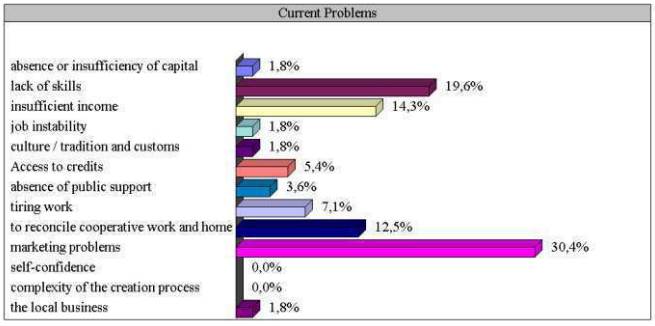

Fig 7: Barriers women face after the establishment of the enterprise

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Both types of barriers can be grouped as the following:

1) Socio-cultural Obstacles

The role women play in the economic development of Morocco meets several structural problems that block the advancement of women entrepreneurs. This reality can be explained mainly by the socio-cultural factors. For example, in the Moroccan culture, the role of women is supposed to be limited to the family unit often associated with reproduction. This notion is based on the socialization process and the inequalities based on gender tolerated in the Moroccan context.

In the present article, the gender inequalities refer to the socially and culturally fabricated differences between men and women. By this inconsistency, the interest is in how-as the sociologists put it: "*gender inequalities are structurally determined, not natural outcomes*" Strangleman and Warren (2008, 160). This means that at the heart of the sociological approach to gender is the conviction that men and women do not just face difference between them, but rather these differences show power imbalances. According to Strangleman and Warren: "*the idea of hierarchy is thus the core of [gender inequalities], with its categories of masculine and feminine reflecting hierarchical notions of strength/ domination and weakness/ subordination respectively*" (2008, 160). This means that discriminatory practices towards women are a prominent barrier to women's entrepreneurship. Approximately half of the participants felt that they directly experienced gender based discrimination.

Family circle also seems to be an obstacle although, Moroccan women are no longer obliged to ask permission from their father or husband, as for example in case of repetitive trips abroad or in case of meetings with customers. Many respondents revealed that they experience sexual harassment, lack of credibility and the reluctance of the various partners such as clients and product suppliers, especially during the periods of establishing the business.

2) Access to Finance and raw materials:

Based on the nature of their work, many of the respondents in the study experience other types of occupational difficulties when they initially want to establish their businesses. Most importantly, access to financial resources and raw materials are the major limitations confronted by these workers. In other words, the absence of a source of finance and difficulties in gaining credits from financial institutions weakens the chances of women's work in cooperatives and being an entrepreneur. A respondent in the research area claimed that banks are sometimes reluctant to support women who want to set-up their businesses and provide uncomfortably conditions that discourage them. In this respect, one may assume that the banking institutions are penalizing women either because of the gender based prejudices about the female entrepreneurs or due to the lack of financial skills in the female enterprise. Other informants justify the lack of access to finance by the absence of a guarantee that is required by the banking institutions in Morocco. They claim that the banks' decisions are not fare since they focus on the obligation of having a guarantee and ignoring other elements such as the degrees and professional experiences.

Moreover, interviewees who work as seamstresses declare that they face problems relative to the provision of raw materials such as sewing machines, thread, tissue, sewing accessories, to name but a few. Others women, especially those working in pastry or food industry require baking equipment, refrigerators to start or to continue the performance of their economic activities.

3) Professional Obstacles

One of the most important obstacles reported by respondents in the research area is related to professional problems. For instance, accessing the market demonstrates a crucial barrier to women's performance in the labor market. Indeed, according to our respondents, the access to the economic market remains a challenge to the majority of them due to various reasons. For example, some of them reported gender based discrimination as a source of this problem. In other words, entrepreneurial opportunities by women are confronted by

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discriminatory forces that decrease women's chances to access different markets.

The complexity in marketing the products produced by women in cooperatives remains a serious difficulty facing most of the respondents in the region of Draa- Tafilalt. Thus, sometimes the problem is not only attributed to the lack of marketing products, but also to the lack of information on ways of marketing. In this respect, lack of marketing skills and training was found out in the research area to be another serious impediment of business development for those women working as entrepreneurs.

4) Reconciliation between Private and Professional Life

Another obstacle faced by women workers in cooperatives in the region of Draa-Tafilalt is linked to their double work responsibilities. They suffer from a dual burden. All of them agreed that they never get rid of their domestic work responsibilities and their traditional gender based roles while working in the cooperative. The combination of work and household responsibilities, especially when children are young, represents a double burden for the women. Those women's situations may be in part due to widely shared beliefs that women are the responsible for child-rearing and are innately better than other persons at looking after them. Consequently, as it was argued by Bernadette, Allegra and Correll (2010) that both men and women may believe that any sacrifices in their careers for the sake of family benefits and the focus on the family's demands should primarily be made by mothers, especially to the extent that they associate women and family. Thus, a mother of young children may feel that she is not an adequate mother and opts to work less to have more time for her children. However, expectations that mothers should stay at home to take care of their children, as well as the traditional view that women are more responsible for child care than men, may lead to decisions such as to lessen their work time or to leave their productive work although a continuous employment history would develop women's earning opportunities and increase their potential and work progress. All in all, balancing home responsibilities and work represent a clear tension to the participants.

V. CONCLUSIONS

The present paper shows the extent to which women's entrepreneurship can function as a channel for the promotion of mechanisms that provide protection and security to women workers. It also demonstrates how the promotion of women's entrepreneurship contributes to productive employment and decent work for women they face uncountable stumbling blocks such as lack of benefit from the business development services, access to finance opportunities and scrutiny of awareness of economic opportunities for women. Hence, for better socioeconomic well-being of women entrepreneurs in Morocco, especially in the region of Draa- Tafilalt, which the Moroccan government grapples with, cannot be achieved without having a comprehensive policy for women's entrepreneurship and its workers.

Since the private sector is considered to be a refuge for many people deteriorating economic and employment problems, policy makers and stakeholders must come up with realistic policies and positive actions for small business activities and self-employment workers. In other words, the role of women in entrepreneurship must be taken seriously from support institutions in order to promote entrepreneurship and women as they are active contributors to the economy. Otherwise, a fundamental and vibrant sector of the Moroccan society with great potential could be excluded from the economic activity and development in general.

ACKNOWLEDGMENT

Our acknowledgment is extended to our female interviewees and respondents. We sincerely thank them for accepting to share their experiences, thoughts and dreams. We hope this paper can be as constructive for their individual situation, as their stories and experiences have been for our personal development. Our acknowledgments are extended to all the heads of the cooperatives in the region of Draa Tafilalt who openly received us.

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Evolution of assets valuation methods and convergence to IFRS: case of Algeria.

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***Abstract*— The Algerian accounting practices have evolved through time to much and suit the economic transformations and the globalised environment. The assets valuation methods is one aspect of the convergence of the Algerian accounting model to the IFRS. This article aims to explain the smooth harmonization of accounting valuation methods that the Algerian accounting model has witnessed.**

***Keywords*—** assets valuation, historical cost, inflation, assets revaluation, fair value, convergence to IFRS.

I. INTRODUCTION

Accounting information is a resource on which the entire economic environment is dependent. The accounting system is the basis for any production of economic information. It provides a form of representation of companies' transactions and all those who have contractual relations with them.

The presentation and representation of the economic events brought about by an accounting system depend on the standards and conventions that build it. However, the latter are not immutable and can be modulated according to the requirements of the actors and the political will.

The methods used to evaluate the items recorded in companies' balance sheets are at the origin of the existence of several accounting models. Positions remain shared between models built on a historical cost valuation, reflecting the concern for prudence and therefore, a nominalist logic. While the models built on a valuation at fair value aim at adjusting the patrimonial values to the rate of inflation and favour information oriented towards the needs of the investors.

This article aims to describe the evolution of assets valuation methods in Algeria. The work we present is a content analysis. The clarifications and explanations that we formulate are based on an institutional approach based on regulatory texts.

II. PRESENTATION OF THE HISTORICAL EVOLUTION OF THE ALGERIAN ACCOUNTING MODEL

Algeria is a developing country and part of the MENA region. It was a French colony from 1830 to 1962. It had inherited its economic system, its written law (positive law) and its general accounting plan of 1957.

In 1970 Algeria sets up a process to change to a planned economy. By changing the economic path, it was necessary to promulgate a new accounting model. "Economic changes have led to accounting institutional changes and accounting systems changes" Baker and al (2015). This is how in 1975, the Algerian regulation applied the National Accounting Plan (NAP). As reported by the presentation report of the NAP, (1974,p 9) "The emergence of the national accounting plan is part of a renewal of the instruments of economic and financial policy and which involves the systematic revision of techniques and accounting organization".

In a context of planned economy " the prices are controlled, but also artificially crafted " (Jaruga, 1991) company's accounting is held in an aim to control the realization of the plan, supply the databases statistics and has as sole addressee the central administration.

In 1986, Algeria suffered a severe economic crisis due to the fall in oil prices. As it sought loans from the international monetary fund (IMF), it

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imposes a number of constraints, including a stabilization plan and a structural adjustment program. This set of measures aims at openness; the restructuring of the economy and the reorganization of enterprises whose goal is to allow Algeria a transition to the market economy. The national accounting plan (NAP 1975) gradually adjusted to the new economic logic.

As explained by Baker and al (2015), the post-centrally planned economies have witnessed two general types of accounting changes : The first type of accounting changes includes accounting institutional changes, the second one, concerns changes in accounting systems (i.e. principles and standards, legislation). The Algerian case has followed the same path.

We can distinguish two main sources that modify and supplement the national accounting plan (changes in accounting systems). On the one hand, during the thirty years of the application of the NAP, five asset revaluations were carried out; on the other hand, there have been multiple regulatory sources that have complemented the national accounting plan on points that the 1975 ordinance does not address [1], so that it can be articulated with the new economic logic. (i.e. legislation for private companies; the adaptation of accounting definitions and nomenclature to the market economy; the implementation of capitalist accounting principles; transformation of accounting concepts such as capital, assets, profit, intangibles assets) Baker and al (2015).

The national accounting plan is conceived and built on a logic of planned economy. Unprecedented situations have emerged with economic reforms, restructuring and reorganization of companies. Restructuring and reorganization have brought out constraints in the processing of information and their accounting translations. The treatment of these new situations derives from an inductive approach and is carried out by regulation (the concern for formalism resulting from the tradition of written law). The advent of the sector accounting plans, the accounting of securities transactions, and the adaptation of the NCP to holding activities and the consolidation of accounts form the backbone of the adjustment of the accounting model. However, these changes were deemed insufficient by the public institution.

The NAP has been reformed and replaced by the financial accounting system (accounting institutional changes). This institutional choice was motivated by the desire to produce better, more reliable and more relevant accounting information, thereby ensuring financial transparency and improving corporate governance. The FAS is the normative reference and the instrument by which the quality of the accounting information is assessed. It clearly defines the conceptual framework and the rules to which the preparation of the financial statements must be submitted. The adoption in 2007 of the FAS is the result of the structural adjustment process contained in IMF conditionality's and is part of the international accounting harmonization movement. Moreover, in the publications of the Algerian Ministry of Finance, under the heading of major issues, it is stipulated that: "the FAS is part of the updating of instruments to accompany economic and financial reforms [...] it consists of converging the accounting rules applied by Algerian companies to IFRS standards [...] this new accounting framework takes into account most of the existing IFRS standards".

III. ACCOUNTING MODELS AND VALUATION METHODS :

In Algeria, methods of valuing corporate assets have evolved in tandem with the constraint of economic reforms and changes in accounting standards. This change in models and valuation methods responds to the need for coherence between the economic situation and its information system.

A. *The assets concept and valuation methods in the national accounting plan (NAP) of 1975*

The national accounting plan as an accounting information system in its component, object and methodology reflects the logical and coherent link that could exist between a planned economy and an information system. It covers both the microeconomic and macroeconomic fields. It allows to produce information to make systematic decisions in order to control the execution of plan decisions. Accounting is held as an instrument used by the central authorities

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for controlling budgets and consumption of state resources. It adhered perfectly to the underlying economic model (the planned model of De Bernis industrialising industry).

B. *Notion of fixed asset under (NAP) 1975*

Under the 1975 NAP, fixed assets are designated by the notion of investment. Only the assets which are the legal property of the company, and which are held and used for more than a year are eligible to be qualified as investment.

In a planned economy, prices are essentially administered, and as Bailey (1995) suggests there is an "absence of an effective price mechanism" which lead to no changing prices. As a result inflation is contained. In this context of inflation-free economy, the accounting model is built on the principle of historical cost.

C. *The historical cost*

The historical cost value is specified by various articles in the national accounting plan, which refers to the concept of acquisition cost. (Articles 18, 21, 23 of the Decree of 23 June 1975 on the implementation of the NAP).

For authors like Hendriksen (1982), Bignon and al, (2009), Miller and Bahnson(2010); the use of historical cost is justified by its objectivity, reliability, comparability, simplicity and lack of bias as a method of determining value, unlike valuation based on the market price.

D. *Historical cost limits*

In an economic environment where inflation is repressed, valuation at historical cost is relevant and is the rule because the currency is considered a unit that does not change and retains its purchasing power. On the other hand, in contexts of high inflation, the historical cost loses its relevance. It can become highly misleading (Blake and al, 1998).

The inflation is an economic motives of fixed asset revaluations. The high inflation led to large gap between asset's book value and there fair value. Which can mislead the judgement about the faithful representation of the underlying economics of the firm.

E. Revaluation of assets

Williams (1977), Barry (1980), Gensse (1985), Doupnique et Salter (1995), Sulucay (1992), Brown et al (1992), Raffournier (2000), Missonier-Piera (2007). Argue that inflation is a factor likely to influence valuation methods and accounting practices. It is an explanatory Factor for fixed assets revaluation.

Che and li (2011) explain that Inflation accounting is a kind of accounting procedure. Under inflation condition and according to the general price index it aims to adjusts traditional historical cost accounting in order to reflect and offset the influence of price rise on traditional accounting statement. In this scope, the revaluation of assets is used to countermeasure inflation

The high inflation experienced from 1988 to 1996, led the Algerian government to conduct four upward revaluation. Due to the legislative origin of accounting regulation, the four revaluations were initiated by decrees [2]. To avoid the direct costs of upward fixed asset revaluation. The Algerian public authorities have previously established revaluation rate for each year. The revaluation coefficient used is indexed to the inflation rate of the period. But it's also allowed that firm revaluate assets by using a professionally qualified valuers.

The assets revaluation laws, use the concept of assets, which at that time did not correspond to the jargon used in the 1975 NAP. It also insist on the fact that the revaluation of assets can't only relate to one element, but should concern the entire class of property, plant and equipment to which the asset belong. Which is in compliance with (IAS 16, §37).

The purpose of asset revaluations is at two levels:

- Informationally:

It allow accounting information to produce a faithful image that reflects the physical and economic reality of the business. The revaluation makes the balance sheet more realistic by avoiding the historical cost constraint on the dissemination of relevant information.

- Economically and financially:

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The revaluation offsets the effects of devaluation, currency erosion and inflation. The revaluation rates being indexed to the inflation rate, allows the constitution of working capital. When financial statements are restated according to current purchasing power, this eliminate the impact of inflation. Upward revaluation has a considerable effect on the financial statements' aggregates. Which as explained by Missonier-Piera(2007), Jaggi and Tsui, (2001), Lin and Peasnell (2000) , improves creditors' and foreign stakeholders' opinions about the financial health of the firm and thereby improve the firm's borrowing capacity.

Revaluations of assets therefore become legal practice and refer to an adjustment in the prices of the assets. These revaluations are standard practices and are recommended by international accounting standards. According to Raffournier et al (1998), Aboody et al (1999), Missonier-Piera (2007), Che and Li (2011), Dos Santos and Lopes Salgado Ribeiro (2014). A wide range of countries allowed this practice: Italy, Spain, Australia, Belgium, France, the Netherlands, Switzerland, the United Kingdom, Hong KongJapan, New Zealand, Brazil, and China. The revaluation is a discounting of value that allows fair value accounting.

Revaluation of assets is a method of determining fair value that responds to a replacement value logic based on the present value. Initially in Algeria, revaluation was made only on depreciable property, plant and equipment.

In 1988, Algeria carried out the first revaluation of assets including the laws of economic reforms and imposed the revaluation of corporate assets.

F. Revaluation of assets using rates

The revaluation of 1990 made no distinction between the different depreciable fixed assets. They were all reassessed at the same coefficient. Single indexing can create new distortions. However, the 1993 and 1996 reassessments take into account that fixed assets are not of the same nature and that they may suffer the effects of inflation and devaluation differently. Thus a distinction is made between equipment and plants and proprieties.

If the revaluation was only limited to depreciable fixed assets. Because it is considered at this initial stage more economically attractive. Due to its impact on cash flow. Upward revaluation was recorded as a revaluation surplus- which was untaxable- in the firm's equity capital and in addition to the net book value of its assets. . After being revaluated, assets were depreciated at their new value.

The balance sheets of the company's before revaluations showed:

-investments with a net book value of nil as they continue and will continue to be used,

- depreciated investments that have not yet been put into operation.

The discrepancy between physical reality and economic reality altered the image (information) conveyed by accounting. Monetary erosion and inflation require a correction of the value of the investments recorded on the balance sheets at their historical cost. (Investments / fixed assets) are undervalued. This undervaluation of the assets lead to calculate insufficient amortization, which did not allow for their replacement and renewal. The reason is: the accounting result calculated on this basis is incorrect and the taxable result is overvalued (Simon (1987)). The depreciation method used is exclusively linear (Consistency Theory). These elements penalize the company and did not allow it to constitute a sufficient cash flow and working capital.

G. Revaluation of assets using the replacement value or recognition at current price

Blake and al (1998), explained that the problem of inflation is circumvented by accounting research community with two alternative approaches:

a) A change to a current purchasing power by recording book value at current price.

b) A change to replacement value.

The Algerian approach to over-elaborate the effect of inflation integrated the two approaches.

To understand the notion of replacement value, it is first of all essential and useful to specify the

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content of the concept of depreciation according to the national accounting plan (NAP of 1975).

"Amortization represents the recognition of the depreciation of investments making it possible to reconstitute the invested funds".

- They are calculated so as to reconstitute, after a fixed period of time, the funds allocated to each category of investments,
- Amortization calculated from the moment an investment is acquired or completed, must be made every year, even in the absence of profit.

From this definition we understand that the depreciation is practiced to allow a maintenance of invested capital and an identical replacement of the assets (depreciable fixed assets). This logic converges with the definition provided by Friedman (1981) of the cost of replacement "replacement cost is the current cost to acquire the productive capacity which would provide the current level of economic services"

For Sulucay (1992), the replacement cost is based on the current buying prices of the assets which were acquired in the past. It is the basis for current cost accounting.

The financial nature of depreciation tends to ensure the replacement value of the asset based on its original value. The different revaluations of assets were calculated on their acquisition cost (the historical cost). By correcting the original value of the depreciable asset the future amortization will be correct and sufficient [3] (depreciation theory, Teemu (1991)). This allow at the end of the useful life of the fixed asset it replacement by a new fixed asset (by the amount of the accumulated amortization). The principle of revaluation is the recognition of a corrected value, which will subsequently allow the replacement of fully amortized depreciable property, plant and equipment.

The replacement value of the depreciable asset is determined on the basis of the current price of a similar new asset, with the same economic characteristics. This means that the new recorded value of the asset is a discounted one.

The discounted value is part of the revaluation, it is obtained on the basis of coefficients. It consists of a monetary adjustment tending towards a fair value. Article 11 of Decree 90-03 of 04/04/1990 qualifies revaluation rates as discounting factors.

H. Other ways of evaluating in the national accounting plan

- Exit value or liquidation value

This valuation relates to the balance sheets established in the context of companies in liquidation, bankruptcy. When the going concern principle is clearly in question. The balance sheets are carried out in this case on the basis of liquidation price and exit value. This exit value is estimated by the liquidator [4] with reference to market prices.

-Market price

The notion of the market price implicitly existed in Article 5 of Decree 90-103 of 04/04/1990 and Article 4 of Decree 93-250. It is established on the basis of the opinion of an expert. (This is a compliance to the professionally qualified valuers (IAS 16, §32)); or with reference to a comparable good. The value attributed is a fair value, a quoted price on the market.

The first time that the notion of market price is explicitly mentioned as an evaluation method in the Algerian legislation is October 15, 1997, Regulation 97-01 on securities operations of financial institutions in Articles 5 and 8.

The national accounting plan gradually converged on international accounting standards and financial accounting. Accounting in Algeria is not reset in the way of what was happening in the world. If in the United States the movement of accounting at current cost started in 1970. In Algeria the accounting at current cost began in 1988. The revaluations of assets were the initiation of the Algerian accounting model and logic to current cost accounting. As stented by Christensen and Nikolaev (2013) revaluations can serve the purpose of conveying information about the assets' current values. Muller and al (2008) Also stood that revaluation model is a fair value-type accounting treatment for investment and properties.

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IV. THE FINANCIAL ACCOUNTING SYSTEM THE CONCEPT OF ASSETS AND METHODS OF VALUATION

Before the application of the financial accounting system (SCF 2007), the public authorities carried out the last revaluation of the assets by the decree n 07-210 of July 04, 2007. But this one concerned the depreciable and non-depreciable fixed assets. As a result, the last revaluation affected all tangible assets. The purpose was to show the fair value of the property, plant and equipment of the companies before the entry into force of the new accounting model that converges with the IAS / IFRS international standards and of which it takes up most of the standards. The revaluation of tangible assets [5] is a change in accounting estimate that is justified by the change of circumstance, it aims to reveal more realistic and reliable information.

The financial accounting system has been applied by Algerian companies since January 1st, 2010. Inspired by international standards, it provides Algerian accounting with a conceptual accounting framework in which it gives priority to the economic substance over the legal reality. The law on the financial accounting system determines the rules for valuing and recognizing assets, but also liabilities, expenses and income. It uses the valuation method at historical cost. This principle [6] is used in the preparation of financial statements as a general rule. It corresponds for goods acquired for a consideration at their acquisition cost, for contributions in kind at their contribution value, for goods acquired for free at their fair value on the date of entry.

The financial accounting system for certain elements and under certain conditions, sets alternative methods of valuation at historical cost. These are the fair value (or current cost), the realizable value and the discounted value (or value in use). In addition, the SCF regulations refer to another concept, the recoverable amount.

A. *The concept of fixed assets under the SCF*

With the advent of the SCF, the notion of asset evolved and the definition that is formulated is that of IFRS. An asset is "the resources controlled by an entity because of past events and from which it expects future economic benefits"

Non-current assets are those that are intended to be used on a continuing basis for the purposes of the entity's operations, such as property, plant and equipment, intangible assets or that are held for long-term investment purposes or that the entity does not intend to carry out within twelve months of the closing date of its financial year ". With the application of the substance over form principle, legal ownership is no longer a condition for classification as a fixed asset, and capital assets under finance lease contracts have been included in the balance sheets of Algerian companies since 2010.

B. *fair value (or current cost*)

As explained above, the fair value measurement of capital assets is not a new method in the Algerian accounting. This evaluation already existed at the time of the NCP. If at that time it could be practiced only in time of revaluations or reserved to the accounting of the financial sector to the securities of investments. Under the SCF, fair value measurement is mandatory [7] for biological assets (convergence to IAS 41), investment properties (convergence to IAS 40), available financial instruments (for later sale, convergence to IAS 39, IFRS 9). But if reliable fair value is not available for those items, companies record at the historical cost.

The fair value is defined in the SCF in the same way as it is defined in IFRS 13 prior to 2013. The definitions and treatment of the valuation of fixed assets are identical to those set out in IAS 16 in paragraph (6, 7, 14, 28, 29). Effective January 1, 2013, IFRS 13 provides a different definition of fair value that is: "the price that would be received for the sale of an asset or paid for the transfer of a liability in a normal transaction between stakeholders". Market on the valuation date ". This definition of fair value is identical to the definition provided by the SCF of the net selling price of an asset (exit value) and is also consistent with the definition of the realizable value.

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C. The realization value

The financial accounting system defines the realizable value as the "amount of cash that could currently be obtained by selling the asset on voluntary retirement". This definition is included in the accounting literature as the output value.

D. *Present value or utility value (discounted value)*

The Financial Accounting System defines present value or value in use as "the present value of the estimate of future cash flows expected from the continued use of the asset and its disposal at the end of its life utility ". This value is an estimation value which is assessed according to the market and the utility of the good for the company. It refers to two concepts of value: market value and value in use. Since an asset is an element that generates future economic benefits. Value in use is based precisely on this notion. Discounting the value of the property is the current estimate of future economic benefits that will result from the use of the property in question. The fair value of a good is determined either by reference to the market price if it exists for the benefit of an active market or by discounting using a discount model or discount factor, or on the basis of the expert opinion. (The same logic of value determination as that of revaluation).

For the items mentioned above that are required to be recognized at fair value. The changes in value have an impact on the result and are recorded either: in charge in the case of capital losses or in income -which is taxable- in the case of capital gains.

E. *Assessment of fixed assets: Another authorized treatment*

For other fixed assets, recognition is based on the historical cost principle. However, they may be re-evaluated. The purpose of the revaluation is to correct the value entered in the balance sheet if it no longer represents reality and does not allow a fair presentation of the company. The value to be disclosed by the revaluation is the fair value of the asset at the date of the revaluation. For these fixed assets, the revaluation difference appears on the balance sheet under the revaluation difference item.

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- Articles 121-16 to 122-5 of the SCF Annex containing asset valuation rules [7]

V. CONCLUSIONS

In Algeria, since 1988, the methods of valuing fixed assets have changed. This trend tends to follow the current cost accounting movement that emerged in the United States and around the world in the 1970s as a result of high inflation. In order to take into account the impact of inflationary phenomena and to ensure that the faithful image reflected in the accounts does not deviate from reality and is not distorted. The national accounting plan (NCP 1975) gradually converged towards a logic of financial accounting and consequently towards international accounting standards. In terms of valuation methods, the financial accounting system (SCF 2007) does not introduce any significant new developments. It introduces the obligation of fair value measurement for specific assets. Although the Algerian government has embarked on a process of convergence with international IFRS standards, but IFRS foundation does not comment on the Algerian accounting model.

Measurements of assets allow the recognition of fixed assets at fair value on which inflation has had a significant impact. Successive re-evaluations, whether based on coefficients or

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on replacement or market values, are only monetary adjustments without any impact on the economic environment, it performance, efficiency or simply

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Improving health coverage systems through simulation

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***Abstract*—Health coverage is considered and promoted as one of the main funding mechanisms to improve access to health services, while providing protection against financial risks.**
By exploiting the technique of simulation with the aid of software ARENA, we proposed some alternatives to improve the services provided by the latter.

***Keywords*—Health coverage, Discrete event simulation, Performance**

I. INTRODUCTION

Coverage is designed to alleviate the financial cost caused by an alteration in health, whether caused by an illness or accident.

The coverage product is sold by the coverage companies in the form of a contract usually entered into between the insurer and the insured. However, this contract may involve other parties, both in terms of training and execution.

Health coverage can be defined as a contract by which the insurer, in exchange for a premium, promises, in the event that the insured person is, during the guaranteed period, affected in his own person by an illness or even by an accident, on the one hand to pay him certain sums, especially during his incapacity, on the other hand to refund to him all or part of the medical and pharmaceutical expenses necessitated by the realization of the risk.

The aim of this reform is to provide all insured persons with the same benefits, to improve the quality of care and to rationalize healthcare expenditure. A new restructuring of the disease coverage was initiated by the application of a new scheme, represented by a new organization, namely the CNAM National Health Coverage Fund. This system aims to improve the coverage, equity and financing of the health system.

Today, coverage is more than just a response to the diversity of risks, as the techniques developed in coverage have made it possible to develop various types of products trying to meet the concerns of customers.

This was reflected in a set of measures taken to implement a program to modernize and upgrade coverage companies, which aims to improve the financial base of coverage companies, quality of services, developing their human resources, modernizing their internal management methods, diversifying coverage products, renovating their communication channels and, above all, adapting them to the needs and expectations of the customers.

This institution is constantly being criticized by citizens. Due in particular to the continuing high inflows, the limitations of reception, the lack of equipment and the narrowness of the waiting room and, more importantly, the non-optimized use of resources.

Consequently, these institutions must seek strategies for:

• Improvement of the quality of service by the concerned operational staff.

• Optimizing the allocation of available resources to best meet the needs of the population.

In order to clarify matters and bring solutions together, we take a real case to study it deeply: this is the case of the "National Health Coverage Fund of Gabes".

We see that the latter can serve better. Indeed, the main objective of our research is in fact organizational, that is to say, it deals with the reorganization to make a decision to achieve an improvement, and several researchers have

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developed various methods for improvement performance of public services.

It should be noted that simulation modeling has become an increasingly attractive tool to assist health decision makers in evaluating the alternative system in order to improve the performance of health coverage funds. Also the model translates and implements with the simulation software "ARENA".

The overall objective of our research paper is the combination of computer tools for solving a management problem with decisional dimensions. It is the development of a simulation model to explain the health coverage system and propose a set of solutions to improve the current system.

The evaluation of the current coverage reform made it possible to identify several investments and necessary preparatory steps for the improvement of the national health coverage fund:

- Increase the remuneration of health care providers to improve their morale and make them more responsible.
- Invest in physical infrastructure, as most health centers require renovations.
- Modernize administrative procedures, which in their current state make the system vulnerable to corruption.
- Changing the public's perception of the government's responsiveness to its needs and its ability to provide services adequately.

For a country that now wants to finance its health coverage system, its financial capacity depends on its current and future economic situation, the size of the formal sector of the economy that can be imposed, or which can bring about contribution in the form of a health coverage scheme for employees, the effectiveness of the current health system and the current level of health expenditure, some of which can be used to finance health coverage.

This paper is outlined as follows: In the next section we present a brief literature review on the application of simulation in health care. Section 3 describes the system of health coverage. Section 4 includes an improvement of the existing system.

II. Effectiveness of simulation technique to identify and resolve medical coverage problems in the literature

Medical simulation reinforces knowledge through field experience, but above all it will help to understand the barriers in their implementation.

The importance of simulation in decision making is manifested in:

- The model has an explanatory role: It must help to understand the functioning of the system over time, by reproducing the mechanisms underlying problem situations, and to make the complexity intelligible. They simulate past situations, but they are primarily developed to support future decisions, tactical or strategic. They are a support to guide the decision makers in the management of projects.
  - The model must be a support for reflection and action, share a common knowledge and an understanding of the system functioning between the actors.
  - Simulation can lead to change our perception of reality or its representation.

- Through scenarios, the model is used as a kind of laboratory, not only to reproduce and analyze past situations, but also to test scenarios that are never produced (What would happen if ... ?)

- Highlighting possible actions such as strategies, management. The model is a flexible decision-making tool that can be used for strategic and prospective purposes.
- These simulation models, based on a systematic and interdisciplinary approach, make it possible to create educational tools to assist decision-making in environments that are becoming more and more complex for the decision-maker, with problems in which the financial, Social and environmental issues become more interdependent.

The simulation is a tool for analyzing offers submitted by coverage companies. Reimbursement rates vary according to the demand, needs and financial means of the applicants. Simulators can assess the amount of reimbursements for ophthalmological or dental benefits, and even hospitalization expenses. It also possible to do a mutual simulation family or civil servant. It is also quite possible to get rates for teenagers or the elderly.

The simulation of the services of the health coverage funds, arising from the needs arising from the increasing complexity of these services. It is a discipline whose objective is to be able to model, in our case, the process of the flow of the insured.

III. Description of the health coverage system

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Health insurance is a product that covers both cash and in kind benefits. Its potential benefits are:

- Prevent households from getting poorer because of high health costs that they would have to pay for themselves.
- Increase accessibility and use of services for which payment is normally required when needed.
- Influence provider behavior and the user to improve the quality, efficiency and effectiveness of the service.
- Use the skills of private providers to achieve national health goals.
- Generate additional and stable resources for health.
- Increase resources for priority health services and expand access to disadvantaged populations.
- Assist in the redistribution of health resources to address socio-economic and geographic inequities.

The health insurance is based on three fundamental principles:

- Equal access to care: it must be guaranteed to all, regardless of income and place of residence, which presupposes the existence of a public and universal health insurance system.
- Quality of care: the care offered by health professionals must be of a very good standard.
- Solidarity: everyone must contribute to health insurance according to their means and receive according to their needs.

In August 2004, a reform of the health insurance was launched to:

• Preserve these three principles
• Fight against waste and abuse
• Allow everyone's effort to lead to a balanced social protection system

In concrete terms, the reform is structured around three main axes:

- The personal health record that contains health information; made up and updated by the doctor, it is computerized in strict respect of medical confidentiality.
- The care path coordinated with the attending physician chosen by each insured person of 16 years and older to be cared for, followed and oriented in the health care system
- The new vital card, carrying a photograph of identity, is the key to access the personal medical file.

The CNAM's mission is to manage health coverage schemes, compensation schemes for work-related injuries and illnesses in the public and private sectors and the granting of sickness benefits.

The insured person is covered by one of the three care means:

• The public sector: outpatient care is provided in public and semi-public health facilities, as well as in the social security clinics with payment of a user fee.

• The private sector: ambulatory care is carried out according to a path which consists in consulting a family doctor first chosen in accordance with the mode of the third-party payer, the insured having only to pay the user fee.

• The reimbursement system: the insured person can access all the healthcare providers agreed with payment of all the services and reimbursement later according to conventional rates.

CNAM has imposed compulsory health coverage on all CNRPS affiliates, which are public sector officials and CNSS affiliates, which are semi-state, and private sector officials more than two million and half of affiliates.

CNAM's mission to prevent occupational risks:
• Development of statistics
• Technical assistance to companies
• Means of inciting and encouraging prevention
• Affiliation and registration

IV. TERMS OF COVERAGE

Outpatient services: In order to obtain the reimbursement of services performed on outpatient units, that is to say out of hospitalization, the insured must seek

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treatment and obtain his medication from a structure approved by the CNAM.

For outpatient care such as consultations, complementary examinations and medications, the insured is reimbursed by the CNAM on presentation of prescriptions, original invoices and sheets of care filled and sealed. These documents may be filed directly by interested parties to the CNAM sent by their related entities.

For the hospitalization which is in an approved structure. The insured will only pay the user fee based on the CNAM pricing.

Sanitary evacuation abroad: The conditions of medical evacuation abroad are fixed by the decree of the law.

The evacuation procedure is as follows:

• The patient presents the observation summary signed by the pathology specialists' staff accompanied by a medical file and a photocopy of the health insurance booklet or insurance card at the CNAM.
• The CNAM checks the file and the affiliation.
• The CNAM sends the file to the National Health Council.
• The CNAM provides care to a foreign provider, a ticket and a provision whose amount varies depending on the country and whether it is the first evacuation or an appointment of control.

The evacuee does not make any payment for the care relating to the pathology that is the object of his evacuation. The country of destination and the provider are chosen by the CNAM according to a transparent and fair procedure that takes into consideration the quality of care.

Relationships between healthcare providers and the Fund are governed by a general agreement and sectoral agreements that organize the contractual relations between the CNAM and health professionals.

They determine:

• Conventional fees
• Payment terms
• Dispute resolution
• The commitment of the members on the medical control of expenses:

- Coordination of care
- Medical references
- The medical file ...

We have seen that there are various important factors to be managed for the proper functioning of the CNAM. In particular, we are interested in simulating the cycle time of the insured's journey in order to reduce the waiting time. To do this, we need to put in place a rational approach, using appropriate methods and tools for the development of performance indicators that structure the information needed to decide what actions to take to achieve the objectives.

V. IMPROVEMENT OF THE CURRENT SYSTEM

The reform of the health coverage system has been imposed with the objectives of unifying mandatory schemes and ensuring adequate coverage of all risks, maintaining complementary forms of coverage, extending health insurance to offer private care.

The reimbursement rates applied by the Tunisian health insurance reform:

• 80% for consultations and additional examinations such as analysis and radiological imaging.
• 90% for hospitalization and functional rehabilitation.
• 100% for medical evacuations abroad and hemodialysis.
• 67% for medication.

The CNAM is organized into regional structures charged the granting of services and central structures mainly responsible for monitoring the activity and its evaluation. The CNAM has regional and local centers, taking the regional center of Gabes as an example of study in our research.

The results provided by the output of the ARENA model are summarised in the following table:

TABLE 1.SUMMARY OF ALTERNATIVE RESULTS ACCORDING TO DIFFERENT CRITERIA

	Criteria			
Alternatives	Number of served insured patients	Waiting time	Rate of resource utilization	Total cost
0	285	274.32	0.41	326
1	283	264.44	0.57	326
2	291	251.08	0.48	326
3	314	203.03	0.51	391
4	320	165.21	0.62	456
5	320	161.03	0.72	522
6	320	161.03	0.85	464

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VI. CONCLUSIONS AND FUTURE SEARCH

In this work, we have improved the performance of the current system by exploring the possibilities of adding resources using ARENA software. By the simulation of some alternatives, most of the performance measures were improved. This project demonstrates, despite the complexity of both the data requirements and the simulation program itself, that simulation techniques can be used successfully in such a decision support system.

This work opens the way to various research opportunities that are on two levels: a deepening of the research and an expansion of the research. Expansion of research: the field of enlargement action can be:

- Generalization of the work on all coverage institutions (health coverage, social coverage and pension and social security coverage)
- More alternatives are evaluated or deepening the research through the use of standard, normalized or fuzzy goal programming.

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TOPSIS-based OptQuest for strategy selection in Tunisian social security establishment

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***Abstract*—Social Security refers to a set of mechanisms and institutions whose function is to protect individuals from social risks. This activity deserves to be well studied in order to choose the best strategy that provides good social coverage. The choice of the best strategy is based on four criteria: waiting time, the number of served insured patients, rate of resource utilization and the total cost. It obtained from TOPSIS method after determining the importance of performance criteria by optimisation via simulation using OptQuest of ARENA: The experimental results show the efficiency of our approach.**

***Keywords*—Social security, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Optimisation via simulation OptQuest**

I. INTRODUCTION

Security is more than a simple answer to the diversity of risks because the developed techniques in insurance have made it possible to set up various types of products trying to meet the concerns of insured.

Social security coverage for workers is provided in Tunisia by two funds: the National Social Security Fund (CNSS) for the private sector (workers in the private sector in the agricultural and non-agricultural sector) and the National Fund for Retirement and Social Welfare (CNRPS) for the public sector (civil servants and public sector employees). Employers hiring staff are required to affiliate, self-employed workers can voluntarily insure.

These funds offer social benefits to their members except in the field of health coverage: health insurance, maternity, occupational accidents and occupational diseases. Students are systematically affiliated with the CNSS when they register at a university institution, paying the sum of 5 dinars.

The benefits offered by the CNSS are family benefits such as family allowances, the increase of the single salary, the allowance for birth leave, the contribution to nursery fees, ..., family insurance such as allowances and death benefits , old-age, disability and survivors' pensions with the refund of contributions and the supplementary scheme.

The offered benefits by the CNRPS are pensions, survivors' pensions and death benefits. But it also intervenes in the field of social housing by granting these affiliates credit at low interest rates.

Social security reimburses only a part of the health costs, the rest not being paid for. Even if the excess fees, free fees, dental and optical care increase the bill, the rest of the sum remains the responsibility of the insured.

Social security institutions are of great importance in our society because all citizens almost today are affiliated with social security funds. So we must direct our research to improve the different services provided by them.

II. DESCRIPTION OF THE SOCIAL SECURITY SYSTEM

Tunisian social security covers salaried workers against all risks, including unemployment.

A. STRUCTURE

The applicable social security schemes differ according to the occupational category:

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• In the non-agricultural sector, there is a general scheme, a complementary scheme and a scheme for the self-employed;

• In the agricultural sector, employees and operators are covered.

Agricultural employees, operators and self-employed persons in the agricultural sector and the officials benefit from separate provisions.

B. AFFILIATE

Employers are required to join the National Social Security Fund (CNSS) and declare the employees that they employ within one month from the date of engagement.

The registration application file must be submitted to the regional or local fund of the CNSS with territorial jurisdiction.

Then, a social insurance card with the registration number is sent to the insured person within one week.

In the event of the employer's default, the employee has the right to apply for registration himself.

C. ADMINISTRATIVE ORGANISATION

Under the supervision of the Ministry of Social Affairs, two funds administer the reform:

• The National Social Security Fund (CNSS), which is responsible for old age, invalidity, survivors, death and unemployment insurance, and which provides family benefits,

• The National Health Insurance Fund (CNAM) which manages health, maternity, occupational accidents and occupational diseases insurance.

The compulsory contribution of the work accident and occupational diseases scheme is the responsibility of the employer only; it varies between 0.4% and 4% depending on the sector of activity (this contribution may be, if necessary, adjusted according to employer failures to safety rules, or its prevention efforts).

Basic contributions are paid on the full salary. For the supplementary pension, only employees who receive a salary exceeding the ceiling equal to 6 times the SMIG pay contributions. Contributions are paid to the CNSS.

Social insurance consists of:

• Health care,

• Cash benefits in case of sickness, maternity or death.

Entitled to benefits in kind, the insured person:

•Employee,

• Self-employed worker,

• Pensioner

• Social assistance recipient,

Is considered as entitled:

• The spouse,

•The child up to the age of 20 in the case of continuing university studies, or without age limit if he is disabled,

• Dependent ascendant who has no health care coverage.

Dependent is an ascendant at least 60 years of age, to whom the worker provides effective and permanent accommodation, food and clothing.

To benefit from cash and maternity benefits in kind and in cash, the insured employee must have at least 50 days of work during the last 2 calendar quarters or at least 80 days in the last 4 quarters. .

Pensioners of the CNSS benefit from sickness cover under the same conditions as salaried employees.

The holder of a Resident's pension and his beneficiaries are entitled to a free care card issued by the competent local services of the health insurance on the basis of a list of beneficiaries established by the National Fund for Retirement and the Social Provident - CNRPS, public pension fund.

Certain categories of insured persons benefit from a card (valid for one year and renewable) entitling to the treatment at reduced rates:

• The worker dismissed for economic reasons,

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• The dependent ascendancy of an affiliate who remains 1 or 2 years before benefiting from the health cover issued at age 55,

• Seasonal or temporary worker,

• The unemployed higher education graduate after the expiry of a full year of graduation without benefit from unemployment benefits.

The poorest families benefit from a free care card granted by a regional commission created at the level of each governorate, as part of the national program to help families in need.

III. SELECTION OF THE BEST SOLUTION

After generating several alternatives by simulation tool to improve the current social security system, we use the TOPSIS method to choose the best alternative.

A. TOPSIS METHOD

Founded by Hwan and Yoon 1981, the TOPSIS method is one of the most used methods in multi-criteria decision support whose goal is to rank in order of choice a number of alternatives based on a set of positive or negative criteria.

Its principle consists in determining for each alternative a coefficient between 0 and 1 based on the distances between each alternative on the one hand and the favorable or unfavorable solutions on the other hand. The basic concept of this method is that the selected alternative should have the shortest distance to the positive ideal solution and the farthest distance from the negative ideal solution [1].

The TOPSIS method assumes that each criterion tends toward a monotonically increasing or decreasing utility [2]. Therefore it is easy to define the positive ideal and negative ideal solutions. The Euclidean distance approach was proposed to evaluate the relative closeness of the alternatives to the ideal solution. Thus, the preference order of the alternatives can be derived by a series of comparisons of these relative distances. The distance between the ideal point and each alternative can be calculated using. Using the same separation measure, the distance between the negative ideal point and each alternative can be determined [3].

$$s_{i+} = \left[\sum_{j=1}^{n} (v_{ij} - v_{+j})^2 \right]^{0.5} \quad (1)$$

$$s_{i-} = \left[\sum_{j=1}^{n} (v_{ij} - v_{-j})^2 \right]^{0.5} \quad (2)$$

The relative closeness to the ideal point can be calculated by (3).

$$c_{i+} = \frac{s_{i-}}{s_{i+} + s_{i-}} \quad (3)$$

Where v_{-j} is the weighted standardized criterion value of the ith alternative that is calculated by multiplying standardized criterion value by the corresponding weight, and v_{+j} is the ideal value and v_{-j} is the negative ideal value for the jth criterion.

Despite being simple to apply, the TOPSIS method is sensitive to the weights of the criteria (w_j) which must be fixed a priori. Moreover, poor allocation of magnitudes criteria can lead to a bad choice by this method. In order to adapt the TOPSIS method to the characteristics of the studied problem, we propose to determine the weighting values associated with different criteria by optimisation via simulation.

B. Determining the importance of performance criteria by optimisation via simulation

Several methods of optimization via simulation can be applied to this type of problem [4][5].

The OptQuest add-on is an additional module optionally available with Arena, being a product OptTek. The OptQuest engine integrates into a single method consists of meta-heuristics, mathematical programming and neural network [6] to identify the search for good solutions to simulated systems optimization problems. This method is not disclosed for commercial reasons.

In this work, OptQuest Arena is used to determine the importance of the criteria. This technique allows the user to specify the upper and lower limits and the suggested values for each variable to be optimized, which represent the

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optimizing starting point. It helps to use multiple replications. More details about OptQuest can be found in the work. It is used to find the best inputs for the production of a desired simulation output. It finds the combination, the

order that produce the highest expected value of earnings, minimum variance or the highest value likely produced using the least amount of resources.

OptQuest lets to define various system inputs and desired system outputs. OptQuest then guides the process of selection of system inputs, and then executes the model by running several scenarios for each set of inputs in order to achieve the desired system outputs.

If you are looking for the best combination of weight values to achieve a certain goal, so the weight must be defined as controls, specifying the range of each weight. Thus OptQuest will test all possible combinations and rank in the descending order of magnitudes according to the goals.

The application of OptQuest with Arena in our model gives us the determination of weights of the four performance indicator's as follows:

TABLE 1. DETERMINATION OF WEIGHTS

Criteria	C_1	C_2	C_3	C_4
w_j	0.21	0.24	0.27	0.28

After running this method, the classification of the five proposed alternatives is represented as follows:

TABLE 2. CLASSIFICATION OF ALTERNATIVES OBTAINED BY TOPSIS METHOD

Alternatives	0	1	2	3	4	5	6
S*	0.042	0.121	0.212	0.631	0.705	0.625	0.707
Distribution coefficient	1	3	8	21	23	21	23
Rate choice	7	6	5	3	2	4	1

So it is remarkable that the alternative 6 take the greatest importance score. It selected as the best solution to improve the current social security and that manifests itself in the addition of add three windows service to the current system with the change of working time to the current system to the social insurance funds of Gabes, Tunisia.

IV. CONCLUSIONS AND FUTURE SEARCH

In this work, we have improved the performance of the security social system by exploring the possibilities of adding resources using ARENA software. After generating several alternatives, the application of the TOPSIS multicriteria method suggests choosing the alternative that adds three windows service to the current system with the change of working time which is manifested by the change in the opening time of the security social funds, instead of 8 am to 7 am. In this case, most of the performance measures were improved.

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Convergence to IFRS: Reliability and usefulness of accounting information. Case of Algeria

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Abstract —**in a perspective of convergence to the International Financial Reporting Standards (IFRS), Algeria's decision makers decided to adopt a new accounting system that is the financial accounting system (FAS) instead of the old one that was the national accounting plan (NAP). This new accounting framework is fully inspired from the international accounting standards for the purpose of improving the accounting and financial information quality in the country.**

In This study, we investigate the quality and the reliability of the accounting information issues. Therefore, we survey a sample of twenty companies to measure their degree of compliance with the new established framework. The results reveal a high degree of non-compliance and call into question the reliability attribute of the financial accounting information for the companies in the sample.

Keywords - Accounting information quality, reliability, convergence, FAS, IFRS.

I. INTRODUCTION

Toward the convergence to the international accounting standards/ international financial reporting standards (IAS / IFRS) since 2007, Algeria has adopted a new Accounting framework FAS that replaced the National Accounting Plan (NAP) of 1975. This reform sprang from the decision of Algeria's public authorities whom declared that the latest accounting framework perfectly converges and is in conformity with IAS/IFRS which aims to promote the financial accounting information's quality to improve the economic decision-making.

From the theoretical part, we are inscribed in the stream of institutional sociology that explains why certain practices tend to spread. This phenomenon is considered as convergence process, and named isomorphic change. In this context, the adoption of new practices is not considered as a choice to meet given technical and economic conditions. DiMaggio and Powell (1983) proposed three particular sources of institutional pressures to interpret them (normative, coercive and mimetic), although they can be nested and act simultaneously.

As for the qualitative dimension of accounting information, the FAS conceptual framework precisely defines its attributes and requirements. In this research, this framework leads us to qualify the question of the quality of accounting information through two criteria. The first one, the relevance that is expressed from the information that can make the difference in decision making by allowing to establish, in time, forecasts or to confirm past evaluations. The second one, reliability that is appreciated by error-free data, neutral and exhaustive leading to a faithful representation of the situation.

The reminder of this work is as follow: (section I) present the results of previous work then, (section II), the design and the implemented methodology, (section III) we estimate on a sample of twenty companies the quality of the accounting information based on the defined attributes

II. STATE OF ART

Before analysing the studies which define the qualitative requirements of the accounting information (§ 1.2), we focus on the problematic of the convergence of the accounting system in the neo-institutional theoretical framework (§ 1.1).

A. The theoretical and conceptual framework of research: convergence to norms, isomorphism and accounting information quality

Like many developing countries that wish to integrate into the world economy, Algeria is not immune to the pressures that characterize this quest under the prism of financial capitalism. Moreover, the adoption of the international accounting framework is one of the indispensable conditions of this insertion and is assimilated to a phenomenon that occurs under the influence of isomorphic forces (Dimaggio and Powell, 1983). Dimaggio and Powell (1983) explained that when one type of organization is required as model, rational actors who initiate changes in their organizations tend to make them isomorphic.

Convergence with international standards is induced in Algeria by the recommendations of economic aid agencies (World Bank and the International Monetary Fund), they aim to ensure the economic integration (Kilibi and Kossentini, 2014, Moussa, 2009). In this waiting game, this condition justifies the essence of a coercive isomorphism. The decisions on economic openness and corporate privatization interpret a mimetic isomorphism. It has also been verified that the sustained rates of economic growth are one of the major determinants to adopt IFRS (Al-Akra, Jahangir and Marashdeh, 2009, Larson, 1993, Zeghalet Mhedhbi, 2006, Zehria and Chouaib, 2013) and manifests itself as normative isomorphism.

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The adoption of an accounting framework that converges with international standards is influenced by several factors, including the fact that they are recognized by the world's most developed economies. This recognition means that they are already socially validated and are used as an undeniable argument to justify convergence to IASIFRS.

The position of international standards and the pressures of international institutions make the avoidance of Appling the IFRS difficult, almost impossible,. The legitimacy of IFRS is strengthened as countries adopt this framework. The adoption of IAS/IFRS has become a requirement, an obligation and it became no longer a choice. IAS/IFRS have emerged as the best way to do accounting and complying with them (IAS/IFRS) would be the guarantee of reliable and relevant information.

B. *Qualitative requirements for financial accounting information*

Since the convergence to IFRS, the question of the quality of the accounting model itself no longer arises. Li and Shroff (2010); Van Beest, Braam and Boelens (2009); Jacob and Madu, (2009); Chen et al (2010); Madawaki (2012); Ames (2013); Barth (2008); Shebaane, Ben Othman (2014); Saidu and Dauda (2014); Zeghal and Mhedhbi (2006); Iatridis (2008); Taiwo and Adejare (2014); Lestariet Takada (2014); Salameh (2013); Indrawati (2015); Saadi (2014) recognized that IAS/IFRS are considered as a high quality level of financial and accounting language that facilitates communication among economic agents from different horizons. However, the notions of quality and usefulness of accounting and financial information are still theoretical and remain difficult to be measured. Siegel (1982); Penman (2003); Botosan, (2004); Morais and Curto (2008); Dechow, Ge and Schrand (2010); Pounder (2013); Christensen et al (2015); Barth et al (2008); Mironiuc and Carp (2014); Ames (2013) explained that accounting quality is a fundamental attribute of accounting information. However, it poses the problem of its measurement due to the absence of consensus around its definition.

Being compliant with IFRS, the FAC addresses the quality of financial accounting information by relating it to its usefulness for decision-making (relevance) and its unbiased representation of the company's economic underpinnings (Reliability and faithfulness). Relevance is defined by the international accounting system board (IASB) as the ability to modify judgments and decisions. The influence of the decisions is exerted either by the prediction, the confirmation or both at the same time. The predictive value and the confirmatory value are interrelated. The FAC considers relevance as “the quality of information when it can influence users' economic decisions by helping them to evaluate past, present, or future events, or confirm or correct their past assessments.” The FAS does not specify any particular user. Although, the relevance is appreciable according to the user for whom the information is produced. According to the IASB, the stock market investor is the privileged recipient of financial statements and accounting information.

Academic researches (Ball and Brown (1968), Francis and Schipper (1999), Berthelot (2000), Belkaoui (1984), Perera and Thrikawala (2010), Escaffre (2012), Christensen et al (2015), Elbakry et al. (2017), Saadi (2014), Salameh (2013), Ames (2013), Carp and Mironiuca (2015), Chebaane and Ben Othman (2014), Kargin (2013)(the same observation) explored the relevance of financial reporting. by attaching it to the consideration of the financial accounting information by the investor in the stock market when the shares’ prices are already evaluated. The relevance of financial accounting information is appreciated according to two perspectives: the reaction of stock market’s investors (retention, purchase or sale securities) and the reaction of stock market shares (increase in stock prices, stagnation or decline). The first perspective is called informational or event, the second one is called valuation perspective or price study.

Thus, relevance is read through the interactions between stock market investors and financial accounting information.

In the Algerian context, the only stock market is the Algiers Stock Exchange market. The value of market capitalization is less than 0.1% of GDP (IMF Report No. 14/161, (2014)). Since its creation in 1997, only five companies have been listed in Algiers stock market. Transactions there are concentrated on a single class of instruments of capital. The capital open to the public does not exceed on average 32% the company’s capital. The only product in Algiers stock market is Treasury Bonds that is issued by the public authorities to finance budget deficits. The derivatives market and the securitization transaction are inexistent. The transaction volume and the number of shares traded are also low. The official bulletin number 23/2018 shows the following information:

TABLE I
MARKET ACTIVITY

Market	Transacted volume	Transacted value	Number of transactions
Main Market	2 000	1 850 000	5
Bond market	-	-	-
treasury bonds market	500	462 080 000	1

Source: Official bulletin of the rating n ° 23/2018, Algiers Stock Exchange

It can be said that the financial market is almost absent. It plays an extremely peripheral role in financing the economy. Algeria is called "insider economy" and its financing system is «Bank-orientated financial system". It is an economy where almost of the corporate finance is dominated by the bank system, where the total amount of credits granted to enterprises was 48,733 million dinars (IMF Report No. 14/161, (2014)).

The arguments put forward refute the hypothesis of an efficient stock market and lead us to exclude the study of the relevance of accounting information for the Algerian case. The methods and statistical models (Easton and Harris model (1991), or the Ohlson model (1995)) validated by the literature and the various researches are then inoperative in the context of absence of a financial market.

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Thus, we focus on the reliability attribute. For the IASB, it is defined in terms of representation of the faithful image of relevant events. The IASB explains that the faithful image is obtained when the information is complete, neutral and error-free, something that is rarely achievable. But the requirements of the IASB try to ensure that these qualities are sought as much as possible.

The SCF uses the concept of reliability to refer to the faithful image. Reliability is defined as the "quality of information when it is free from significant errors and biases, and users can trust it to present a true picture of what it is supposed to present or what 'we could reasonably expect to see her represent". The fair image of the financial statements is, in the sense of the SCF, what "reflects the knowledge that leaders have of the reality and the relative importance of recorded events". SCF also explains that the faithful image is "the objective that, by their nature and their qualities and in compliance with accounting rules, satisfy the financial statements of the entity that are able to give relevant information on the situation the financial performance and the change in the entity's financial position".

The production of quality information requires the conjugation of several attributes that we illustrate in the following diagram:

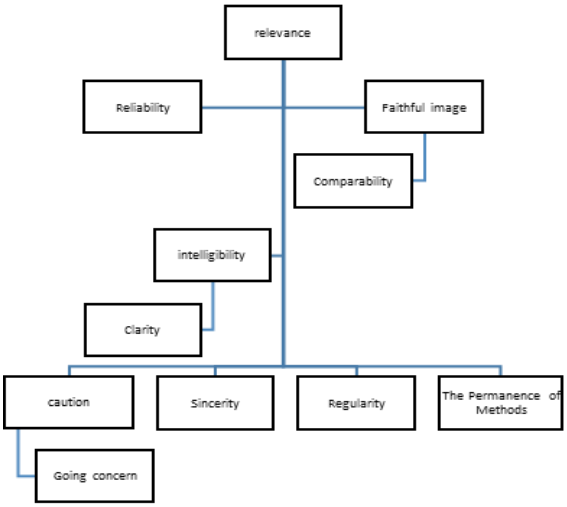

Fig. 1 Hierarchy of the characteristics of the accounting information under the SCF.

In our opinion reliability is nothing other than faithfulness. The requirement of unbiased, error-free representation on financial accounting information is justified by asset security and fair valuation. The availability of accurate information that reliably informs about the state of the company is essential. The decisions that sanction the life and survival of the company are based on its financial health. The latter takes shape in the accounting figures. The effectiveness of the decision-making process is based on the accuracy of the financial accounting information used to motivate judgment and decision-making. Good corporate governance focuses on the availability of verifiable information, representing the true image of the company. The usefulness of financial accounting information lies first and foremost in its faithfulness and reliability. The financial accounting information must be drawn up with particular care so that it can reflect as realistically as possible the events it is supposed to translate. Thus, it gives the user a certain assurance and confidence that will allow him to motivate his judgment and justify his decisions.

The reliability or the faithfulness of the financial accounting information is appreciated by two methods:

The first by means of an auditing process, which aims to verify the compliance of the information produced with the requirements laid down by law and the conceptual framework of accounting. It provides a reasoned opinion on the reliability of the information provided. This traditionally adopted methodology consists in drawing up a list of items associated with a weighting system. Thus, the accounting information produced is evaluated and makes it possible to assess and record its quality. This protocol was used by Michaïlesco (1999); Gray, Roberts and Gordon, (1991); Van Beest, Braam and Boelens (2009); the work of the French Accounting Quality Observatory (2002) and the American Institute of Certified Public Accountants (1994).

The second is realized by the study of earnings management. This method of assessing the quality of accounting figures consists of the use of regressions and statistical models. The objective is to detect if there are significant differences between the accounting result and the cash flows. This approach makes it possible to know if the accounting result is managed upwards, downwards or if it is subject to a smoothing.

III. DESIGN OF RESEARCH AND METHODOLOGY

Our work is inspired from the audit process and aims to determine whether the process of preparing accounting information in the companies of the sample corresponds to the requirements set by the SCF. We use the questionnaire as a tool for diagnosis, data collection and observation. Our questionnaire is inspired by the evaluation methodology developed by the French Accounting Quality Observatory published in (2002) under the title "How to perform the quality diagnosis of an accounting service?". It assesses the conditions of production of financial accounting information and aims to identify anomalies that lead to the distortion of the quality of the latter.

Our object of reference is a reality preconceived by the legislator. This reference is provided for by the regulations in Law No 07 of 25/11/2007 on the Financial Accounting System and Executive Decree No 08-156 of 26/05/2008 implementing the provisions of the Financial Accounting Act.

The data collection and observation method we use is aimed at researching and discovering real accounting practices. This reality has its own essence and exists independently of the researcher. Our position of externality allows us to guide research in an independent subject / object relationship. In the end, it is about questioning facts and comparing them with the preconceived hard reality.

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Our working hypothesis is that bookkeeping and the preparation of financial accounting information are made according to the recommendations of the laws and regulations in force and that it is reflected through the accounting department in its organization, its methods and processes.

The quality of the accounting information depends on the quality of the process and the body that produces it at all levels and at each stage. The evaluation of the quality produced is part of the examination of several criteria. The methodology of this measure is based on an evaluation of the information and the organizational device. This test is built on the idea that an attribute can be translated into a set of items and that it can be measured by a three-point scale ranging from satisfactory, medium to insufficient.

We used indicators that consist of a list of items grouped into six questionnaires (A to F), classified into twenty-six item categories and 90 questions.

The six questionnaires deal with:

1) The quality of the body that produces the accounting information: Questionnaire A "Control of the operation of the accounting department" (A1 to A23).

2) The quality of the process of preparing the accounting information: the questionnaires: B, C and D: B "The mastery of accounting methods (B1 to B21)"; C: "Mastery of accounting processes" (C1 to C14); D "Computer skills" (D1 to D10).

3) Exploitation of the accounting information produced for analysis, forecasting: Questionnaire E "Description of the services rendered by the accounting function (E1 to E13); F: Contribution of the function to financial performance (F1 to F10).

The twenty-six categories of items included in the questionnaire are recommendations of the SCF regarding:

- Bookkeeping, accounting principles, accounting organization (Law No. 07 of 25/11/2007 on the financial accounting system).
- Keeping of accounts by means of computer systems, (Executive decree n 09-110 of April 07, 2009 fixing the methods of keeping the accounts by means of computer systems).
- The valuation and accounting rules, the content and presentation of the financial statements as well as the nomenclature and operating rules of the accounts. (Order of 26 July 2008).

A. The period of investigation

The investigation has been conducted in APRIL, MAY and JUNE 2015.

B. The sample

Our survey covered a sample of thirty (30) unlisted companies. We administered the questionnaire at the corporate headquarters level and we retained twenty (20) usable questionnaires from companies operating in the following sectors:

TABLE II
INDUSTRIAL ENTERPRISES: IE

Field of activity	Number	Nature of capital	Legal status	
			LLC*	JSC **
Food	3	private	2	1
Medical	1	private	0	1
Energy and Hydrocarbon	3	public	0	3
Railway realization	1	public	0	1
foundry	1	public	0	1
Elevator manufacturing	1	private	0	1
TOTAL			10	

*limited liability company.
**joint-stock corporation.

TABLE III
COMMERCIAL ENTERPRISES: CE

Field of activity	Number	Nature of capital	Legal status	
			LLC	JSC
Telecommunication	1	private	0	1
Hotel	4	private	0	4
Transport	2	Public	0	2
Medical products	1	private	1	0
Automobile	1	private	1	0
Building	1	private	1	0
TOTAL			10	

Questionnaires were processed by Excel. The results are presented in the form of synthetic tables.

C. Step 1: Determining the number of nonconformities

For each completed questionnaire, we noted the number of non-compliances. The total per company is shown in summary table A. This table makes it possible to determine the proportion of non-compliance, therefore unreliability, of the financial accounting information produced by the companies in the sample.

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TABLEAU IV
TABLE OF SUMMARY OF NON-COMPLIANCE A

Code	Nature of capital	Total of non-compliance	Impact of non-compliance on reliability
I E 01	Private	45	0,5
I E 02	Private	44	0,49
I E 03	private (multination al)	8	0,09
I E 04	Private	37	0,41
I E 05	Public	32	0,36
I E 06	Public	10	0,11
I E 07	Public	39	0,43
I E 08	Public	36	0,40
I E 09	Public	13	0,14
I E 10	Private	37	0,41
C E 01	Private	13	0,14
C E 02	Private (multination al)	7	0,08
C E 03	Private	36	0,40
C E 04	Private	9	0,10
C E 05	Private	47	0,52
C E 06	Public	47	0,52
C E 07	Public	63	0,70
C E 08	Private	33	0,37
CE 09	Private	19	0,21
C E 10	Private	40	0,44
∑ impacts		615	

D. Step 2: Determining Ratings

Given the percentage of anomalies (% non-compliance) noted on each questionnaire, a partial rating should be made for each sub-item. (The results are presented in a comprehensive manner in summary table B).

The notation has three levels:

• Satisfactory if the percentage of anomalies <0.5

This is an acceptable situation. There is a good control of the process. The anomalies identified do not call into question the accounting quality which remains globally reliable.

• Medium if the percentage of anomalies is close to 0.5

There are anomalies that reveal a dysfunction of the accounting process. Even if the organizational devices are in place, they are not sufficient to provide a satisfactory level of reliability.

• Insufficient if the percentage of anomalies> 0.5

Nonconformities are common and have a serious impact on accounting quality. The processes are out of control and there is no organization in the process of self-monitoring devices to secure information and guarantee its quality.

TABLE V
SUMMARY TABLE OF PARTIAL RATINGS B

Items / Ratings	Satisfactory	Medium	Insufficient
General Organization	10	6	4
Internal control	10	0	10
Performance Tracking Tools	7	7	6
Formation and information	6	4	10
Accounting manual	11	6	3
Upstream procedures	19	0	1
Inventory	19	0	1
Valuation of provisions	7	2	11
Imputation in exceptional income	13	1	6
archiving	13	7	0
Control techniques	20	0	0
Audit	14	0	6
Fixed assets process	13	7	0
Purchase process / suppliers	11	7	2
Stock process	14	6	0
Production process	12	3	5
Sales / customer process	9	5	6
Financing process	10	6	4
Process of staff costs	11	6	3
Integration	18	2	0
Adequacy of computer tool	10	0	10
procedures / Documentation	17	1	2
Tax base optimization	10	0	10
Bank interface	8	2	10
Regulatory security	12	2	6
refunds	18	0	2
Communication	10	0	10

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TABLE VI
ANALYSIS BY NATURE OF CAPITAL
(PUBLIC ENTERPRISES)

Code	Total of non-compliance	Impact of non-compliance on reliability
I E 05	32	0,36
I E 06	10	0,11
I E 07	39	0,43
I E 08	36	0,40
I E 09	13	0,14
C E 06	47	0,52
C E 07	63	0,70
The average	34,29	0,38

TABLE VII
ANALYSIS BY NATURE OF CAPITAL
(PRIVATE COMPANIES)

Code	Total of non-compliance	Impact of non-compliance on reliability
I E 01	45	0,5
I E 02	44	0,49
I E 03	8	0,09
I E 04	37	0,41
I E 10	37	0,41
C E 01	13	0,14
C E 02	7	0,08
C E 03	36	0,40
C E 04	9	0,10
C E 05	47	0,52
C E 08	33	0,37
C E 09	19	0,21
C E 10	40	0,44
The average	28,85	0,32

E. RESULTS AND DISCUSSION

The analysis of the results obtained by the study the sample allowed us to link the quality of the accounting information produced (measured by the questionnaire) with potential determinants put forward by the literature.

The lowest values of non-compliance are found in private (multinational) companies, with only 8 and 7 nonconformities (Table IV). The maximum value of non-compliance is found in the public companies: 63 points of non-compliance out of a total of 90 questions. Also, the highest average impact of non-conformities on reliability is reported in SOEs: 0.38. This means that, on average, the accounting information produced by the public companies in the sample is 38% unreliable. This result has also been demonstrated by Fan and Wong (2002); Wang and Liu (2003); Liu and Tu (2003), Wang et al. (2007); Zhu and Li (2008), Song (2015). This research explains that state ownership and accounting quality are negatively correlated.

The initial sample consisted of 30 randomly selected companies. The return rate was 66.66%. This abstention to answer was motivated by a quasi-unanimous answer. According to a finance director, "the questions touch at the confidential dimensions of the company".

The main economic agents external to the company who are interested in accounting, provide the demand for accounting information and ensure the quality of the latter are: the State (for the sake of tax collection and the country's economic orientation) and banks (if the company has taken out a loan).

These two economic agents have privileged access to information. This situation reduces firms' incentives to produce quality information and does not promote the publication of reliable information to the general public (Michaïlesco, 1999; Ball et al, 2003; Morais and Curto, 2008; Biddle and Hilary, 2006; Soderstrom; and Sun, 2007, Nobes and Parker, 2008, Christensen et al, 2015).

Algeria is considered as "a low tax alignment country" this does not promote the production of transparent, quality information that reflects the economic reality of the company. Van Tendeloo (2007) explains that the reliability of accounting information is very low in low tax alignment countries for unlisted companies.

Since we administered the questionnaires directly, we talked to the people who have completed them. The 30 accounting professionals who received the questionnaires mostly testified the lack of understanding of the FAC and the deep rooting of the NAP practices. This phenomenon is widely spread in countries with codified law. Familiarity with an accounting system based on professional judgment takes time. This is explained by Latridis and Rouvolis (2010). The rooting of practices and logic NAP explains the phenomenon of resistance to change. The FAC was imposed coercively on Algerian companies. This new alternative agreement has given rise to different reactions among the preparers of the accounts (Amblard 2000, Demaria and Dufour 2007, Demaria 2008).

The lack of training was also mentioned by the professional accountants questioned. For the training and information item, 14 of the 20 companies have medium and insufficient ratings.

Taking into account the results of this investigation, we concluded that our initial hypothesis is invalidated. Overall, the accounting information produced by the sample is on average 30% non-compliant. This non-conformity testifies to the non-respect of the recommendations of the normative reference system. We also support this issue by the threshold of significance of the anomalies tolerated in the audit missions which can not exceed 10%. However, we are reporting here 3 times the tolerated rate.

As a result, the quality of the accounting information produced by companies is not guaranteed by the implementation of a high quality accounting framework. This

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result has been confirmed in situations of mandatory adoption of international accounting standards (Ball et al, 2003, Burgstahler, Hail and Leuz, 2006, Christensen, 2015, Nayeri, Ghayoumi and Bidari, 2012, Soderstrom and Sun, 2007, Michaïlesco , 1999, Procházka, 2017). This research explains that if companies do not have real incentives and benefits to using international standards, they do not apply them.

The adoption of a uniform set of standards has had the effect of highlighting the other factors that affect the production of accounting information. These vary between companies and between countries. The application of IFRS alone does not guarantee the improvement of the reliability and faithfulness of the accounting information. Academic contributions sharply demonstrate that the issue of accounting quality is not simply the mechanical application of the requirements of standard setters, but to a large extent the product of the judgments and incentives of those who make the accounts.

The production of quality financial accounting information is not decreed, it is built. This design goes first to those who make the accounts. The information conveyed by a preparer of accounts (which is the pivot of the information system) is an act of knowledge sharing. It is actually the perception and appreciation of this actor of the world that surround him. This perception is dependent on acquired knowledge, but also an intellectual construction specific to him. In addition, he interprets the data of the outside world, presents and draws up information, according to the dimension he will give to the event that has occurred.

Accounting is governed by formal conventions (the accounting model) and informal conventions (the incentives of individuals in situations of uncertainty). The nature of financing, the dominant book values, the relationship between accounting and taxation condition the quality of the accounting information produced.

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«The impact of human factors on the trade-off behaviour between common transport and the private car- the case study of Algiers.»

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Abstract— **The study aims to investigate the policies that would lead to a behaviour change for a sustainable mobility, and how the aspects of ergonomics and human factors can affect the trade-off behaviour between the available means of transport in Algiers .The study was based on tow research methods, a qualitative followed by aquantitative research.The Qualitative research has explored the current plan of transport in the agglomeration of Algiers and has investigated the trend of car ownership from2003to 2016 highlighting its socio-economic impacts. The key finding in this study has been the divergence in the behaviour ofcommuters, the study has therefore concluded that although significantchanges occurred in their travel behaviour with the implementation of newmeans of transport such as the tramway and the metro rather than the bluebuses (public ones), there is still important factors to be considered, and policiesto be developed; which would provide the basic requirements and comfort parameters of passengers without neglecting the environmental, social and economic aspects of sustainable transport services.**

Keywords— **urban transport, travel behaviour, mode choice, human factors, sustainable transport.**

I. INTRODUCTION

Transport is a vital faction in the sector of services; from one hand, it contributes to the motivation of urban life in all its aspects, and from the other hand, it can be a crucial factor of sustainable development for modern societies. It also ensures the mobility of people and freights to the areas of activity and services.

Human mobility is as important as the mobility of freights and perhaps even more important, because the process of production and distribution of goods would not happen without human's intervention. Add to that, its direct relation to the safety and the welfare of individuals.

Each individual Uses one or more means of transport available in his daily trips of outing, shopping and home-work or home-study trips …etc, and certainly a trade-off behaviour would occur at the moment of a travel decision; However many factors including human factors may affect this decision, and lead to a choice that might be either in the favour to sustainable development or not.

In other words, in this context, the stakes in terms of sustainable development are daunting; because, faced with this desire to develop an electro-mobility based on public transport (through the tramway projects in particular) there are challenges in terms of using cars running on abundant and cheap fossil fuels. In these particular economic aspects favouring the use of personal cars instead of common transport in Algeria, there are other factors that would strengthen this trend.

So what are these factors and what are their impacts on the trade-off behaviour between common transport and the private car in the agglomeration of Algiers?

In order to better explain the different aspects of our problematic and the constraints discussed above, we have treated the following hypothesis:

- Personal factors have a statistically significant relationship with the behaviour of trade-off between the private car and common transportation.
- Algerian commuters are not ready to give up the use of personal cars in their urban trips in favour of common transport;

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II. METHODOLOGY:

The study was based on tow research methods, a qualitative followed by aquantitative research.

The Qualitative research has explored the current plan of transport in the agglomeration of Algiers and has investigated the trend of car ownership from 2003 to 2011 highlighting its socio-economic impacts .

However a questionnaire survey was spread over a thousand of people (including people with disabilities) who benefit from transport services focusing on private car users versus users of bus aiming to examine their travel behaviour and probe the principle factorsthat affect their preferences and attitudes toward different means of transportincluding the private car .

Different tools including Microsoft-Excel, the statistical package SPSS, and stat-Excel were employed in the analysis of the questionnaire data .

III. THEORETICAL BACKGROUND:

The literature study deals with theories of how people choose their mode of travel and focus on the differences between psychological and economic theory, and qualitative and quantitative methods. It concludes with a review of methods based on utility maximization.

4.1. The Theory of Reasoned Action:

According to the theory of reasoned action, the intention of a person is a function of two basic determinants; personal and social.

"The personal factor is the individual's positive or negative evaluation of performing the behaviour; this factor is termed attitude toward the behaviour" (Ajzen, 1985; Ajzen&Fishbein, 1980). In other words the personal factor represents the way the individual perceives the behaviour and not the surrounding environment i.e. objects, people or institutions…,

"The second determinant is the person's perception of the social pressures put on him to perform the behaviour in question. And this factor is termed *subjective norm*". (Ajzen, 1985; Ajzen&Fishbein, 1980).

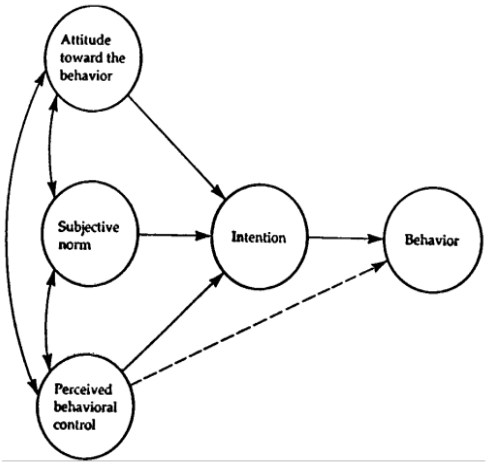
4.2. The Theory of Planned Behaviour:

After the theory of reasoned action, (Ajzen, 1985) developed the so called Theory of planned Behaviour that includes the variable of perceived behavioural control. This theory, the Theory of Planned Behaviour (TPB), assumes that the choice is also dependent on the individual's perception of his or her ability to execute certain behaviours (Ajzen, 1985). TPB has made it possible to explain the choice of travel mode (Forward 1998a, Forward 1998b).

According to TPB, the person acts rationally and his/her decisions are considered consciously and the intention behind certain behaviour depends on the following factors:

- The attitude toward the behaviour;
- The social norm ;
- The perceived behavioural control.

Fig.1 The Theory of Planned Behaviour



Source: Icek ajzen: *The Theory of Planned Behavior. Organizational behavior and human decision processes,* Ed.50, pp 179-211 University of Massachusetts at Amherst (1991) P 182.

The demonstrated in Figure1, TBP shows that it is possible to change a person's behaviour by influencing his attitudes, the subjective norm and his perceived behavioural control. If we want more people to travel by public transport, we can influence their attitudes, for example by offering free test trips, which may give them personal experience. The subjective norm can be influenced by good examples such as celebrities and politicians showing them using train and public transport in their daily trips. However Perceived behavioural control which is a function of control convictions, arises partly out of one's own experiences and partly indirectly, as a consequence of information given by other people for example how difficult someone believes it is to travel by train. (Lindström Olsson, 2003).

4.3. The (TPB) with "habit" variable

Concerning means of transport, "the variable **habit** represents a very important factor in the explanation of the commuting behaviours. By extending the variant of TPB Forward (1998b) added the factor habit to the model" (Lindström Olsson, 2003)

Findings of different studies made in four different cities confirmed that perceived control and habit have a high degree of explanation for travel mode choice and a strong linkages between intention and behaviour. The results show that the discussed

variables help to explain the travel mode choice by between 42 and 69% of the intention to walk, cycle and drive short distances.

4.4. The Theory of Utility Maximization:

A random utility maximizing random choice function assigns probabilities to outcomes as if the decision maker randomly "chooses" a strict utility function and then picks from each option set the maximal element

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Let us consider that an individual, at a particular point in the day is to choose an activity to perform and corresponding time expenditure or duration, ***tj***. We can assume that a rational individual will maximize her utility in choosing the activity type to schedule and the total time expenditure on it. In expending time for the chosen activity, however, the individual faces a time budget limitation. This time budget limitation is not constant throughout the day. The day begins with a 24-h time budget limitation which is gradually reduced with the number of activities performed over the course of the day in different locations. The remaining time budget at any point of scheduling an activity is the left over time after all previously performed activities have been completed. While executing an activity, i.e., defining the duration of a specific activity, the individual trades off between time expenditure to the chosen activity and travel time required to reach the activity location versus total time left over for all other activities to be completed in the balance of the day. As we do not know for certain the causes and factors that influence the individual's trade-offs in choosing alternative activity types and time expenditures out of a limited time budget, it is reasonable to consider the assumption that the utility associated with activity type and time expenditure includes random elements.

Hence, the utility maximizing approach to model activity type choice and time expenditure choice is really a Random Utility Maximizing (RUM) approach. Addressing the facts that the time budget decreases as the day progresses and that the scheduling of any particular activity type is affected by what activities the individual already completed in a given day means that the method captures some (though not all) of the behavioural dynamics of the activity scheduling process. In the context of such a situation the choice of a given activity type at any point in time influences expenditures of the limited amount of time from the left over time budget, and vice versa.

4.5. The Random Regret-Minimization model of travel choice

The Random Regret-Minimization model is rooted in Regret Theory and provides several useful features for travel demand analysis. Firstly, it allows for the possibility that choices between travel alternatives may be driven by the avoidance of negative emotions, rather than the maximization of some form of payoff. Secondly, it acknowledges that traveller decision-making in the context of multi-attribute alternatives may not be fully compensatory (Caspar G. Chorus, et al, 2008).

Caspar G. represents in the estimable Random Regret-Minimization model of travel choice as an alternative to mainstream Random Utility-Maximization models. Asserting that when making travel choices, people tend to anticipate and avoid the possibility that a non-chosen alternative performs better than the chosen one. This avoidance of anticipated regret, rather than the maximization of utility, is assumed to be specifically relevant in traveller behaviour.

The theory shows how regret-minimization may lead to different choice outcomes in both riskless and risky choice situations: in short, regret-minimization favours alternatives that perform reasonably well on each attribute, whereas utility-maximization favours those that perform particularly well on the most important attribute(Caspar G. Chorus, et al, 2008)..

IV. THE EMPIRICAL STUDY:

The Improvement of the living standards the recent years has had a direct impact on the growth of motorization rate. As shown in the figure below, the increase in car ownership was rather light and progressive over the period 1990-2000. However in 2001, the rate showed a significant increase. It has almost doubled over the period 2001-2008. This net increase is due to the development and economic growth observed over the past decade. In this favourable context, car dealerships have blossomed and sales have been boosted by the car loan. Algerians were quickly equipped cars. Note that the process of buying on credit has been frozen in 2009 and the introduction of a new tax on the purchase of new cars imported. These new arrangements have been made for several reasons:

- It has been noticed that many families could not pay the bills;

- From a political point of view, it is more interesting to encourage mortgage as car loans;

- There was still a good tax base for a new tax that may contribute to the fund to support public transport;

- Algeria was importing cars, perhaps should think of forms of incentives towards the manufacturers to invest locally;

- And finally, the transmission began to no longer absorb the surplus of vehicles and congestion problems became increasingly important.

A. Data analyses:

In terms of mode choice and the trade-off between public transport and private car, we headed a survey in the city of Algiers.

The survey was conducted in the period of December 2011 and January 2012. It is important to mention that the survey was administered two months after the inauguration of the metro line (9.5 km) and seven months after the opening of the first tramway line (7.5 km), so the results has been certainly influenced by the commissioning of these modern means of transportation; however experience was still recent and did not allow to highlight structural changes and/or new habits. That said, the first results of the survey still confirm a general trend of certain hypotheses that we have issued.

We have selected 1009 questionnaires from 1100. The rest has been rejected for reliability reasons.

B. The factors that influence the trade-off behaviour between the car and the common transport in the city of Algiers:

we have selected eight factors to study the characteristics of the sample and these factors are:- the sex, the age, the Educational level, the Income, the function or profession the marital status the residence location and health (the disability status for the handicapped), and according to the theory of planned behaviour these are very important human factors that may influence the trade-off behaviour between the car and the common transport, according to the theory cited in the study of Q. Ajzen 1985 and forward 1996.

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1. Sex :

The distribution of the sex factor in the sample of the study is presented in the following table

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Table 01 The distribution of the sex categories of the sample

		N	%
Sex	Men	536	53,1
	women	473	46,9
	Total	1009	100,0

It is seen from the table 01 above that the sex of the sample interviewed is distributed almost close, where the male category occupies 53.1% which is the mean of this category, while the female category is estimated to 46.9% .

This distribution converged between the two categories of male and female sample reflects the reality of the community especially the active and working one, the percentage of female participation in various aspects of life in the community knows a remarkable growing rate, especially in the field of education, health, and various fields of business…

1. Age:

For the age different categories results were as follow:

Table 02 the distribution of The age categories of the sample

		N	%
Age	Less than 20 years	102	10,1
	20 to 40 years	783	77,6
	40 to 60 years	105	10,4
	More than 60 years	19	1,9
	total	1009	100,0

The table 02 demonstrates that the distribution of age factor was concentrated in the second category (20 to 40 years old), mainly due to several key reasons, in particular that this age group represents the active and working population, which makes dynamic and perpetual mobility, and this is the main reason that made them the largest proportion of respondents during the interviews.

2. Educationallevel:

Table 03: the distribution of the educational level of the sample

		N	%
Educational level	Didn't enter school	33	3,3
	Secondary or less	230	22,8
	University	702	69,6
	Other	44	4,4
	Total	1009	100,0

The results included in this table highlights that the educational level of the sample is mainly concentrated in the Level of University by 69.6%, then the secondary or less level of education or by 22.8%, while the rest of the sample (the category of " Didn't enter school ", and the category of "other"), are presented by 3.3% and 4.4%, respectively of the whole sample; and this shows how important the young population's mobility, since the most active category are university students whom are generally aged between 20 and 40 years old.

3. Function

Table: 04 the distribution of the functional categories of the sample

		N	%
Function factor	Unemployed	88	8,7
	Student	477	47,3
	Employed	394	39,0
	Retired	25	2,5
	Other	25	2,5
	Total	1009	100,0

The results highlighted in the table above that the category of students is the mode category of the set data with a ratio of 47.3 %, followed by the category of workers, or employees by 39 % then the unemployed by 8.7 %, while the remaining two categories (Retired and Other) have the value 2.5% for each category.

These results are due to the fact that students and employees are the most needed categories to a dynamic mobility all along the day. However the retired and other categories have a limited mobility area and regarding to their needs to transportation the move less than any other categories.

4. Income:

The income factor which have been divided into four categories is presented in the following table

Table 05 the distribution of Income categories

		N	%
Income categories	Less than 15.000	597	59,4
	From 15.000 to 30.000	217	21,6
	From 30.000 to 45.000	126	12,5
	More than 45.000	65	6,5
	∑	1005	100,0
	Missed data	4	
Total		1009	

It's clear from Table 05 above that the category of people with an income less than 15,000 DA is the category acquired the largest proportion of the sample with a rate of 59.4 %, followed by the category of income ranged between 15000 DA and 30,000 DA by 21.6%.

The category of an income less than 15,000 DA are generally the category of students or workers from the working-class. These classes are characterized by their active and frequent movement in urban areas, while the second category which an estimated income between 15000 and 30000 DA may be the category of employees who consider urban mobility an essential activity in their daily lives and that their movements are relatively limited compared with the first category because of the nature of their movements which are more organized, especially in the peak times.

5. Marital Status

The factor of marital status is divided into four categories in which the category of (Father /Mother) was separated from the category of (Married), to study the effect of children in the mobility of their parents:

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Table 06 the distribution of Marital Status factor

		N	%
Marital Status	Single	724	71,8
	Married	138	13,7
	Father/Mother	108	10,7
	Other	39	3,9
	Total	1009	100,0

According to Table 06,the mode category was Single (ie, the most frequent) with a rate of 71.8%, followed by the married oneswithout children) 13.7 % and then the parents' category with 10.7 %.

Therefore, the low percentage of mobile couples who have children compared to married couples without children or single individuals explains the influence of the household responsibility which limits their movements in general.

6. Residence location:

According to the geographical division of the city of Algiers and in following the requirements of the study we have divided the area of the survey into three sections and the table 7 the results as follow: -

Table: 07 the distribution of the Residence location of the sample

		N	%
Residence location	City centre	511	51,5
	Outskirts	350	35,2
	Outside the city	132	13,3
	∑	993	100,0
	Missed data	16	
Total		1009	

According to the table 07, more than 50 % of the respondents live in the city centre and about 35 % of them in the outskirts of the city, while those who live outside the city has been accounted for 13.3%; it is important to mention that most of our sample live in the city centre because we considered the hyper centre within the centre.

7. The disability status (for the handicapped people)

We have intentionally targeted the category of handicapped people in the points of the survey distribution, to study the effect of their disability on their use of different means of transportation and the results are presented in the following table

Table 08 The distribution of the disability status of the handicapped sample

		N	%
The disability status	Motor impairment	53	39,0
	Visual impairment	34	25,0
	Other	49	36,0
	Total	136	100,0

In Table 08 the number of respondents who suffer from a disability were 13.5 % of the total 1009 respondents, and regarding to the type of their disability we consider the following: motor impairment by 39 %, and the category of those who suffer from Visual impairment were 25% however the rest of the various disabilities or health problems were 36% combined.

Through these results we can see that the number of motor impairment are most frequent, and this shows that despite the nature of their disability, they are using urban transport more than those who suffer from visual impairment, the later ones find it more difficult and in most cases they move only in the presence of companions.

C. Factors that influence the trade-off behaviour when it comes to choose between the private car and the common means of transport.

To know which of the personal factors influence the trade-off behaviour when it comes to choose between the private car and the common transport, we have first studied the opinion of commuters towards their preferred means of transport

Table 09 the opinion of commuters towards their preferred means of transport

Mean	1,82
Mode	Private car
standard deviation	,388

It is clear from the table 09 that the means of transport the most preferred in urban mobility is the private car, and it was the mode (the most frequent response

And the figure.... displays this fact obviously, where the personal car as the preferred means took 81.5%, and 18.5% representing those who choose collective urban transport as their preferred mode of transport in the urban areas.

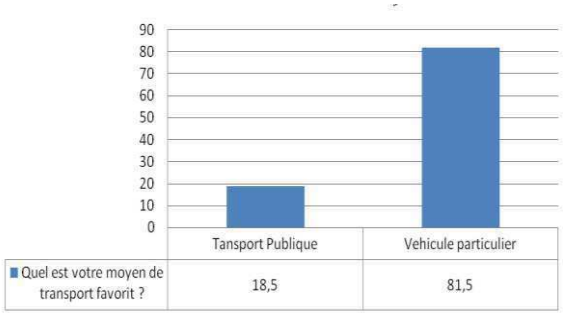

Fig. 02 The opinion of commuters towards their preferred means of transport

5.3.1. The test of Pearson correlation coefficients between the human factors and the preferred means of transport:

After calculating the correlation coefficients of Pearson between the subjective factors of the sample and their preferred means of transport, to test the presence of a relation between these factors; where coefficients that have a level of significance at the level of less than (0.05) were characterized by the sign (*) besides the correlation coefficient, and correlation coefficients with a level less than (0.01) were characterized by the doubled sign (**) however correlation coefficients that have no statistical significant were left without signs.

We can see from the table 10 that the correlation coefficients of both the sex and the age that have 0.106 and -0.101 respectively are statically significant at a level less than 0.01 as it is shown in the bilateral Sig with the value 0.001 of both factors.

The same thing with the indicator of Education and the marital status which have 0.021 and 0.031 respectively; and they are statistically significant at a level less than 0.05 since the correlation coefficient of education is 0.073 and the correlation coefficient of

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the marital status is 0.068; which means that these factors have a powerful influence on the trade-off behaviour

In the other hand the correlation coefficient of the function (profession), the Income, the residence location and the disability status (for the handicapped) all are more than the level of significance (0.05), and for this reason we assume that these factors' coefficients have not a strong correlation with the coefficient of the preferred means of transport, in other words, the cited factors do not influence the trade-off behaviour when it comes to choose between the private car and the common transport.

Table 10 : The test of Pearson correlation coefficients between the human factors and the preferred means of transport

		DSPVCTI //	Sex	Age	Level of Education	Function	Income	Marital situation	Residence location	Disability status
DSPVCTI//	P C	1	,106**	-,101**	,073*	-,005	,013	-,068*	-,049	-,029
	L.S.		,001	,001	,021	,869	,678	,031	,126	,741
Sex	P C	,106**	1	-,099**	,052	-,182**	-,217**	-,040	-,044	-,228**
	L.S.	,001		,002	,102	,000	,000	,204	,168	,007
Age	P C	-,101**	-,099**	1	,052	,455**	,417**	,310**	,117**	,039
	L.S.	,001	,002		,097	,000	,000	,000	,000	,655
Level of Education	P C	,073*	,052	,052	1	,073*	,010	-,078*	,059	,119
	L.S.	,021	,102	,097		,021	,750	,013	,064	,167
Function	P C	-,005	-,182**	,455**	,073*	1	,610**	,289**	,056	,155
	L.S.	,869	,000	,000	,021		,000	,000	,077	,072
Income Marital situation	P C	,013	-,217**	,417**	,010	,610**	1	,356**	,001	-,033
	L.S.	-,068*	-,040	,310**	-,078*	,289**	,356**	1	,069*	,119
Residence location	P C	,031	,204	,000	,013	,000	,000		,030	,169
	L.S.	-,049	-,044	,117**	,059	,056	,001	,069*	1	,108
Disability status	P C	,126	,168	,000	,064	,077	,972	,030		,216
	L.S.	-,029	-,228**	,039	,119	,155	-,033	,119	,108	1
	P C	,741	,007	,655	,167	,072	,701	,169	,216	
	L.S.	1	,106**	-,101**	,073*	-,005	,013	-,068*	-,049	-,029

** correlation is significant at the level =< 0.01 (bilatéral).
* correlation is significant at the level =< 0.05 (bilatéral).
DSPVCTI = The Decision to shift from car use to common transport use after its improvement
P C = Pearson correlation
L.S. = Level of significance

D. The factors that influence the decision to shift from the use of personal vehicle to common transport:

After highlighting the main factors that affect the preference of commuters now we should find out the readiness of these commuters to move from using their preferred means which is the personal car to using the common transport as the main mode in their daily trips in urban areas

Table 11:The responses of our interviewed sample about whether they are ready to shift from the use of personal vehicle to common transport if the later one becomes more convenient.

		DSPVCTI //	Sex	Age	Level of Education	Function	Income	Marital situation	Residence location	Disability status
DSPVCTI//	P C	1	,020	-,020	-,065*	-,026	-,072*	,098**	,022	-,118
	L.S.		,545	,551	,047	,422	,029	,003	,510	,199
Sex	P C	,020	1	-,099**	,052	-,182**	-,217**	-,040	-,044	-,228**
	L.S.	,545		,002	,102	,000	,000	,204	,168	,007
Age	P C	-,020	-,099**	1	,052	,455**	,417**	,310**	,117**	,039
	L.S.	,551	,002		,097	,000	,000	,000	,000	,655
Level of Education	P C	-,065*	,052	,052	1	,073*	,010	-,078*	,059	,119
	L.S.	,047	,102	,097		,021	,750	,013	,064	,167
Function	P C	-,026	-,182**	,455**	,073*	1	,610**	,289**	,056	,155
	L.S.	,422	,000	,000	,021		,000	,000	,077	,072
Income Marital situation	P C	-,072*	-,217**	,417**	,010	,610**	1	,356**	,001	-,033
	L.S.	,029	,000	,000	,750	,000		,000	,972	,701
Residence location	P C	,098**	-,040	,310**	-,078*	,289**	,356**	1	,069*	,119
	L.S.	,003	,204	,000	,013	,000	,000		,030	,169
Disability status	P C	,022	-,044	,117**	,059	,056	,001	,069*	1	,108
	L.S.	,510	,168	,000	,064	,077	,972	,030		,216
	P C	-,118	-,228**	,039	,119	,155	-,033	,119	,108	1
	L.S.	,199	,007	,655	,167	,072	,701	,169	,216	

** correlation is significant at the level =< 0.01 (bilatéral).
* correlation is significant at the level =< 0.05 (bilatéral).
DSPVCTI = The Decision to shift from car use to common transport use after its improvement
P C = Pearson correlation
L.S. = Level of significance

1. The readiness of the sample to shift from the use of personal vehicle to common transport if the later one becomes more convenient.

Table12The readiness of the sample to shift from the use of personal vehicle to common transport

Mean	1,37
Mode	Yes
standard deviation	,482

The results table show that the mean is 1.37 which is near to the value 1 and this means that the majority of respondents answered "Yes" for the question that says "are you ready to shift from the use of personal vehicle to common transport in your urban mobility if the later one becomes more convenient.?" and the mode of the sample was also represented by "yes", and we can say that the items of our sample are stable since the value of the standard deviation is about 0.48

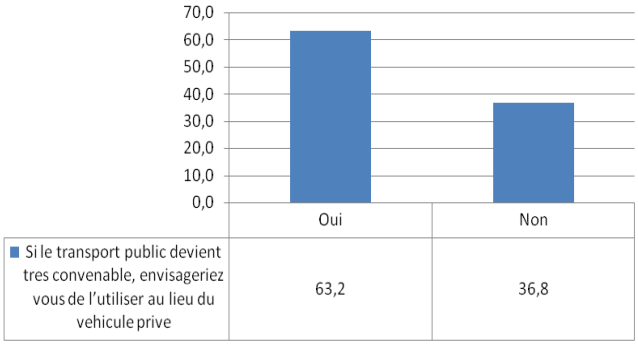

Fig. 03 The readiness of the sample to shift from the use of personal vehicle to common transport:

It is clear that the majority of commuters interviewed in our study are with the shift from the use of the private car to the common transport if this one becomes more convenient and 63.2 of the sample say "yes"

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2. *The test of Pearson correlation coefficients to the human factors the decision to shift from the use of personal vehicle to common transport if the later one becomes more convenient.*

From the results presented in the matrix of coefficients in table 11 we can see that the level of bilateral significance of Education, the Income and the marital status equals respectively: 0.047 , 0.029 and 0.003 with correlation coefficients -0.065*, -0.072* and 0.098** and all these coefficients' values are less than 0.05, which means that they all have a strong correlation with the intention to shift from the use of use their personal vehicle to the use of common transport if the last one is improved. So we can say that the Educational level, the Income and the marital status are human factors that influence strongly the decision of shifting from the use the personal vehicle to the use of common transport in urban commuting.

The other factors are not statistically significant and their correlation coefficients are more than the level of significance (0.05) which means that they are factors that do not influence the decision to shift from the use of personal vehicle to common transport in urban commuting even if the last means of transport are improved.

V. DISCUSSIONS:

The key finding in this study has confirmed the real importance of human factors when it comes to their effect on the trade-off behaviour between the use of the personal car and the common transport, and according to the tests applied on the results studied before we can consider the following:

- From the study we can conclude that Personal characteristics have a statistically significant relationship with the trade-off behaviour, and more precisely: the sex, the age, the educational level and the marital status are statically significant factors and they have a powerful influence on the trade-off behaviour.
- The majority of commuters interviewed in our study are with the shift from the use of the private car to the common transport if this one becomes more convenient and 63.2 of the sample say "yes".
- The Educational level, the Income and the marital status are human factors that influence strongly the decision of shifting from the use the personal vehicle to the use of common transport in urban commuting. the other factors are not statistically significant which means that they are factors that may not influence strongly the decision to shift from the use of personal vehicle to common transport in urban commuting even if the last means of transport are improved.

it is important to mention that human factors influencing the human behaviour, are not limited to the personal characteristics of individuals, but the later ones have an important influence especially on the behaviour of commuting and mode choice behaviour since people travel whether individually of in groups, according to their financial and marital conditions.

Finally, decision makers should take in consideration the study of personal characteristics as human factors affecting the commuting behaviour, which leads to a better understanding to mode choice behaviour and the trade-off behaviour, and this would certainly make policies and decisions more effective to develop transportation plans leading to a more sustainable mobility in urban areas.

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Multilayer perceptron (MLP) and radial basis function network for the prediction of the Tunisian small and medium enterprises' (SME) bankruptcy.

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Abstract

The objective of this work is to compare the development of neural statistical multilayer perception models and the radial basis function network for the prediction of the Tunisian small and medium enterprises' (SME) bankruptcy. The superiority of a multilayer perceptron (MLP) is easily detected. Our sample consists of 130 Tunisian companies and 18 financial ratios calculated for the 2005/2012 period. The forecasting results obtained from the neuronal model (MLP) are compared to the ones derived from the Linear Discriminant Analysis (LDA). The obtained results confirm the superiority of the neuronal technique in terms of predictability.

Keywords: corporate bankruptcy, forecasting, multilayer Perceptron, radial basis function, discriminant analysis.

1. Introduction

Corporate bankruptcy is a phenomenon that purifies the market of inefficient and unproductive firms. However, this reality is expensive for all the stakeholders such that the creditors may remain unpaid, employees may lose their jobs and owners will be at risk of losing their funds….. Therefore, acting before the outbreak of a problem certainly helps you avoid the risk of bankruptcy and save your costs. For this reason, forecasting is a major focus of the academic research studies which deal with bankruptcy not only theoretically but also practically.

Bankruptcy prediction, which consists in estimating the business default risk on the basis of the accounting data, has long been the major concern o researchers since the early 20th century, mainly with the work of Rosendale (1908), Fitz Patrick (1932).It consists in using statistical tools to detect the emergence of financial signals indicating a future failure. There is a variety of models that can be used to predict bankruptcy. Generally, the common objective of these models is to assign any business to either group (a group of bankrupt companies and another of healthy ones) using accounting ratios. Although the methodology used in these models and the analysis variables have not much changed, the evolution of the statistical analysis tools made this topic always relevant. In fact, the historical development of the prediction models may be divided into two major periods: the time of the traditional models

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and that of the artificial intelligence ones. Moreover, traditional studies about bankruptcy prediction can be classified into two groups according to the existence or absence of hypotheses about the distribution of the variables. If the distribution law of the variables is known in advance, one therefore can speak about parametric statistical methods, whereas in the opposite case, one can speak about non parametric statistical methods.

First of all, the parametric statistical classification methods are intended to establish a functional relationship the form of which is given a priori between an endogenous variable and the exogenous variables the distribution law of which is assumed to be known. The parametric prediction models can be grouped into three families. At first, the authors used a single variable to explain the business failure, hence, one can speak about a univariate statistical analysis (Fitz Patrick (1932), Winakor and Smith (1935), Merwin (19 42), Beaver (1966)). Then, since the variables multiply with the hypothesis and follow the normal distribution, one can therefore speak about a multi-varied discriminant analysis (Altman (1968)). Finally, the hypothesis of multi-varied normality of the variables is rejected in favor of the hypothesis which states that the explanatory variables have different distributions, hence the birth of the logistic regression methods (Probit/Logit) (Ohlson (1980)).

Actually, when the financial ratios do not follow a multi-normal distribution and the errors follow neither the normal nor the logistic distribution, predicting bankruptcy using parametric models is impossible, hence the resort to non-parametric models, which requires no hypotheses about the distribution of the variables. Then nonparametric techniques can be classified into two categories: models based on recursive partitioning technique (Frydman et al (1985), Bardos (1989)) and models based on the kernel estimator technique (Calia and Ganugi (1997)).

The second stage of history began with the algorithms of artificial intelligence which were developed thanks to the many constraints of traditional statistical methods. The method of artificial neural networks is one os the most famous techniques in this research field. This nonparametric technique has its origins in the artificial intelligence, specifically, in the sector on machine learning (Remade. C 2004). The techniques of artificial intelligence have produced significant results about bankruptcy forecasting without requiring any statistical restriction. The several studies that focused on the comparison between these new techniques and the traditional ones confirmed their superiority regarding the forecasting quality (Mamoghli and Jallouli (2006)). Moreover, the artificial intelligence techniques have the advantage of being adapted to any raised problem, including corporate bankruptcy prediction.

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Taking the Tunisian context, where corporate bankruptcy has been on the rise, we suggest applying the multilayer perceptron model as well as the radial basis model for the prediction of corporate bankruptcy for a sample of 130 companies. For this purpose, the second section of our contribution will be devoted to the presentation of MLP and RBF models: the network architecture, the transfer function and the learning algorithm. The third section is confined to the application of these models to the bankruptcy prediction of the Tunisian companies. This section concludes with a comparative study between the performance of the multilayer perceptron model and that of the discriminant analysis.

2. Models of artificial neural networks: MLP and EBF

An artificial neural network (ARN) is a non parametric calculation tool inspired by the neural biological system made up of simple mathematical operators called “formal neurons”. In fact, the formal neuron is a non-linear algebraic and *set* up function of the real variables. The development of the technique of the artificial neurons comes from an imitation of some mechanisms of the human brain. A neural network is a set of interconnected units, which have a large learning and processing information capacity. In fact, it is, a mathematical algorithm that can perfectly handle the knowledge related to the relationship between the input and output values so as to correctly classify the situations. The neural network models are quite diversified, which makes the criteria of the model classification multifold. These classification criteria include: the network architecture, the (supervised or unsupervised) learning algorithm, the combination function.... In the models of the neural networks, each neuron of the hidden and output layers receives neuron values beforehand through these synaptic connections and thus produces its own value by using its combination function. Based on this function, one can single out two types of networks: MLP networks (multilayer perceptron) and radial basis function networks (RBF).

2.1. The MLP model

The multilayer perceptron model (MLP) is a static structure of the neural network which does not present feedback loops but the learning of which is supervised.

2.1.1. Network architecture

The multilayer perceptron is a network composed of 3 types of successive layers. Firstly, an input layer which brings together incoming signals where each neuron is used as an input. Secondly, there is a set of hidden and positioned layers to participate in the transfer. It is worth noting at this level that each hidden layer neuron is connected at the entry to each neuron of the previous layer and at the exit to

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each neuron of the ollowing layer. The MLP is a network of "feed-forward" type where one layer can use the outputs of the previous layers (acyclic). In general, the MLP can have any number of layers and neurons per layer. The neurons are interconnected by weighted connections. In fact, the role of these connections is to use their weight to program an application of the entrance space to the exit space using a non-linear transformation.

2.1.2. The transfer function

The MLP network achieves a scalar product between its input vector 'X' and the 'W' weight vector, adds a 'b' bias and uses an activation function 'F' to determine its output. Hence, the neuron 'i' receiving information from neurons in the previous layer, performs the following operation:

$n_i = F(S_i)$ et $S_i = \sum_{i=1}^{n} w_{ij} n_j$

with :

n_i : is the neuron state

n_j : is the state of neuron j which preceded i

w_{ij} : the synaptic weights

F : the transfer function

Different transfer functions, such as the linear function, the standard sigmoid function and mainly the hyperbolic tangent function, can be used in this type of network,

2.1.1. **Learning**

The learning principle in the MLP models is to know the contribution of each weight in the global network error. Actually, there are several methods to perform learning among which we can mention the conjugate gradient algorithm, the methods of the second order and the spread of the retro gradient algorithm which is most used in the academic research studies.In fact, the gradient of the propagation algorithm measures the error between the desired outputs and the observed outputs that result from the spread forward entries and retro propagates this error through the network layers by moving from the outputs towards the inputs. Hence, the weight isadjusted for the neurons one by one starting with the output layer.It is worth noting that at the MLP level, the rise of the number of hidden layers only adds the progress of the learning algorithm that requires more iterations to converge to a result. For this reason, the number of hidden layers in an MLP does not usually exceed two. The learning algorithm ends and then the network converges when the weights are not changed or their modification is very low.

2.2. The radial basis function model (RBF)

The radial basis neural networks (RBF) are a special class of multi-layer neural networks (F. Yang and M. Paindavoine 2005). This is a

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powerful Feed-forward architecture with a supervised learning algorithm. RBF networks are mostly used to solve problems in large spaces.

2.2.1. Network architecture

The RBF network consists of three layers; a linear activation function input layer that transmits the entries without modification, a single hidden layer containing RBF neurons which are usually Gaussian functions, and a layer of output neurons that are typically activated by a linear activation function. Each layer is completely connected to the next one but there is no connection between the neurons of a same layer. Similar to the MLP, the RBF model can be used in the prediction, the classification....

2.2.2. The transfer function: radial basis function

The radial basis functions emerged at the end of the 1980s as new forms of neural networks. Various types of functions can be used as basic functions. However, the Gaussian function remains the most used. Hence, the general form of this function is as follows:

$H(y) = \text{Exp}(- |y - c|^2 \ / \ 2\delta^2)$

with :

C : is the center of the Gaussian function

δ: the dispersion

2.2.3. Learning

The learning process of the radial basis functions starts with the calculation of the Gaussian centers using different techniques, such as the K-means method or simply the calculation of the average arithmetic mean of the input vectors. Instead of achieving a weighted sum of these inputs, this type of network compares the inputs to the computed Gaussian centers. Each Xi input is therefore associated with a Ci value. The comparison of these two quantities is usually made using the Euclidean distance. In other words, the neuron starts calculating the following size:

$d = \|X - C\| = \sqrt{\sum_{i=1}^{n} (Xi - Ci)^2}$

Then, the neuron transforms the value achieved by a non-linear activation function of the Gaussian-type:

$H(d) = \text{Exp}(- d^2 \ / \ 2\delta^2) = Z$

With δ is the standard deviation of the activation function. An empirical rule is to compute δ using the following function:

$$\delta = \left(\frac{dn}{\sqrt{2M}}\right)$$

With:

d_n = the maximum distance between the n center and the other centers;

M = the total number of centers of the hidden layer

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Finally, the network output reads as follows:

$S = f\left(\sum_{i=1}^{n} W_j Z_j + b_j\right)$

With:

f : a linear function;

WJ: the synaptic weight between the neurons in the hidden layer and the output layer;

Zj: the output of the hidden layer

bj: the network bias.

2.3. Theoretical comparison between both MLP and RBF models

An MLP and RBF are two models of artificial neural networks which are very similar. Due to this similarity, it can be said that the RBF is a special case of an MLP for a hidden layer. The similar points between these two models are multiple. First, the output function, in most cases, is a simple linear function (except for a few specific problems, it may be another function) which returns a weighted sum of the values calculated through the neurons of the hidden layer. Then, the connections between the layers have the same meaning where each neuron is fully connected to the next layer neurons. Finally, the learning algorithm used for both models is supervised.Despite these broad similarities between the RBF and MLP model, some remarkable differences should be mentioned. First, the number of hidden layers is unique for an RBF for any problem to study but can be multiple for an MLP. Second, an RBF model uses only the radial basis function whereas an MLP may use any other function as an activation function.

3. Implementation of the MLP and RBF models to the failure prediction of the Tunisian companies

In what follows, we apply multilayer perceptron neuron networks and the radial basis functions networks to predict the failure of the Tunisian SMEs. For the MLP model, we will test the different architectures to finally choose the best and compare it to an RBF model. Finally, we carry out a comparison of the performance relative to the best-performing model (MLP or RBF) with that of the discriminant analysis.

3.1. The working methodology

3.1.1. The database and the variables

In this study, we prepared prepare our own database which includes 130 small and medium healthy Tunisian companies 65 of which are failing and 65 are healthy. During the construction of the sample, we met some homogeneity criteria. First, this is about the non-financial companies where only firms belonging to the industrial and commercial sectors are retained, which ensures the sector homogeneity.

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Then, the firms that make up our sample are small and medium-sized (SMEs), which brings back us to speak of the size uniformity. To define an SME, and according to the availability of data, we have chosen the size criterion according to some earlier studies, Kapuria and Faulkner (2008). Actually, an SME is a company the capital of which does not exceed 1 million Tunisian dinars. Finally, the homogeneity of groups of companies is met through the use of the paired sampling technique which consists in associating a healthy company with each defaulting one having the same size and sector of activity.

The sample of healthy enterprises is composed of companies that have no financial problems. However, for the construction of the sub-sample of the failing companies, and due to the multiplicity of definitions of the notion of failure, we have chosen to consider failing any company that enters into legal proceedings. The financial statements (balance sheets and income statements) of these companies are collected from the services of the Central Bank, the INS and control offices. The collected financial statements are about the 3 years preceding the failure year for the period between 2005 and 2012. In this way, we obtained a database over three- year period about 130 companies.

To analyze the financial situation of the firms in our sample, we set up a range of 32 financial ratios. The descriptive analysis of these ratios as well as the calculation of the correlation matrix enabled us to eliminate ratios that are correlated in absolute value greater than 0.7. Finally, we got 18 correlated ratios classified into 4 categories: liquidity ratios, management ratios, profitability ratios, and structure ratios (appendix 1). These ratios will serve as inputs for our Neuron network models.

3.1.2. Data configuration

The explanatory variables (financial ratios) data are unprocessed gross values having different size. To standardize the measurement scales, these data are converted into standardized values. Indeed, the Xi values of each ratio are standardized compared to their average and their standard deviation using the following relationship:

$$X_i' = \frac{Xi - \mu i}{\delta i}$$

With

XI' = the standardized value relative to R_i ratio

Xi = the gross value relative to R_i ratio

μi = the average value relative to R_i ratio

δi = the standard deviation relative to R_i ratio

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3.2. Results and discussions

3.2.1. Development of the MLP model

In what follows, we will apply the MLP multilayer networks. This choice can be explained by the ability of this model to meet the specificities of the prediction problem. Rizwan et al. (2014) think that this network can achieve very significant results and has a high prediction accuracy. An MLP model consists of a collection of neurons forming n-layer. The first layer is the vector of the input data whereas the last one contains the output vector and in between a number of hidden layers are positioned. The number of hidden layers determines the degree of network complexity. To identify the optimal network architecture to be used, we first chose the backpropagation algorithm of the gradient as the algorithm learning due to its frequency use in the prediction field (Mamoghli and Adele (2006), WU et al..)(2007), Bose et Pal (2006), Yim et Mitchell (2005), Tang et Chi (2005), West et al. (2005), Min et Lee (2005), Shin et al. (2005), Lee (2004), Kim et Han (2003), Agarwal et al. (2001), Atia (2001), Tan et Dihardjo (2001…) . Then, for the transfer function at the level of the hidden layers, we have chosen the hyperbolic tangent function which is considered to be ideal for the MLP since it gives better results due to its symmetry:

Hyperbolic tangent function= $\frac{Exp\ (x)-Exp(-x)}{Exp(x)+\ Exp\ (-x)}$

Finally, the average of the squared error is used as a performance function:

$$MSE\ = ½\ \sum_{i=1}^{n}\ \ (\ Vd_i - Vc_i\ )^2$$

With :

n : the number of observations

Vd_i : the output appreciated value

Vc_i : the output calculated value

However, we have chosen to test two functions of activation for the output layer, such as the identity function and the hyperbolic tangent function. Regarding the hidden layers and given that several authors (Altman et al. 1994, Desmet 1996) claimed that a neural network requires no more than two hidden layers, we have chosen to practice the learning base on a network with a single hidden layer and then on a network with two hidden layers. Regarding the number of neurons at the level of the hidden layers, there is no exact rule that limits it. However, Yao et al. (1999) proposed an iterative method which consists in gradually increasing the number of hidden neurons of a unit until (n 1) is reached, where n is the number of neurons in the previous layer. The 20 SPSS software is our computer tool for the implementation of this work. This software includes a 'Neuron network' command which helped us model the neural networks, and a subcommand «Perceptron multistarte» for the modelling of the multilayer perceptrons.

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3.2.2. Results of the MLP model

To determine the best network architecture, we varied the number of the hidden layers as well as the activation function for the output layer. For this reason, we randomly divided our database into two parts; 70% for the learning sample and 30% for the test sample. The following table summarizes the different tested architectures

Table1: The tested architectures

	Architecture : A1	Architecture : A2	Architecture : A3	Architecture : A4
Nombre des CC*	1	1	2	2
Transfer Fonction for CC	Hyperbolic tangent	Hyperbolic tangent	Hyperbolic tangent	Hyperbolic tangent
Transfer Fonction for CS**	Hyperbolic tangent	Identity	Hyperbolic tangent	Identity

*CC : hidden layer **CS : output layer

The results of analysis of these 4 architectures using the SPSS are summarized in the following table:

Table2: Results of the test of an MLP architectures

	A1	A2	A3	A4
MSE	22,12	24,85	37,48	22,83
TBC**	93,8 %	88,3 %	79,7 %	90,4 %

**TBC : Rate of a good ranking

From these results, we conclude that the A1 architecture, which is a single hidden layer with the hyperbolic tangent function as an activation function for the hidden layer neurons and the output layer, is the best because it gives the highest TBC (93.8%), and the level of the lowest error (22.12). For this reason, in our case of failure prediction of the Tunisian companies using a multilayer perceptron model, the most efficient network is a three-layer network which uses the algorithm of back-propagation of the gradient as a learning algorithm, the hyperbolic tangent as an activation function for the output hidden layers, and the average quadratic error function as a performance function. This network configuration is [18-8-2], that is, 18 neurons in the input layer that represent our 18 financial ratios, 8 neurons in the hidden layer which establish the internal calculation of the network, 2 neurons of the output layer that represent the situation of the company either defaulting or healthy.

3.2.3. Development of the radial base model

The RBF neuron network consists of an input layer containing 18 neurons that represent our data entry, a hidden layer, and an output layer containing two neurons indicating the status of the failing or healthy company. The input variables consist of 18 independent and normalized vectors between -1 and 1 using the following relationship:

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Standardized X = [2* ($\frac{X - min}{max - min}$)] - 1

These 18 input vectors represent 18 calculated financial ratios. For the development of the RBF network, we begin by calculating the Gaussian center of each C_1… C_{18} vector, using the mean arithmetic method as well as the Euclidean distance between the 18 vectors and their centers. Then, the Euclidean distance is transformed using a Gaussian function at the level of the hidden layer. The outputs of the neurons of the hidden layer will by the identity function. The development of an RBF model using the SPSS 20software helped us reach the architecture [18-6-2]. The results of this model are presented in the following table:

Table be weighted using the Wi weights, then added to the bias of the output layer, and finally transformed 3: Results of the RBF model

	RBF Model
Error	52,48
TBC	73,6 %

3.2.4. Comparison between MLP and RBF

The comparison between the results of the developed MLP and RBF models shows that the MLP represents the best performance. Moreover, it gives the highest good ranking rate (93.8% 73.6%). On the other hand, its learning phase is the fastest and converges for a reduced number of iterations compared to the RBF network. Several previous studies reached similar results that confirm the superiority of the MLP model compared to the RBF models. Thesestudiesinclude: Simani et al (2000), Mansouri et al (2008), Mrabti et al (2009) et Badaoui et al (2014).

3.2.5. Comparison between MLP and ADL

To improve the prediction quality, the linear discriminant analysis function is to globally assess the financial situation of the company described by a range of conjunction ratios. In fact, it is to determine a discriminant function for each company and decide a Z-score * to carry out the ranking. Actually, the classification rule is:

$$Z = \beta + \alpha_1 x_1 + \ldots.. + \alpha_n x_n$$

If Zi ≥ Z * then, the company is said to be healthy

ifZi Z * then, the company is considered to be faulting

The application of the method of the linear discriminant analysis (LDA) to our database first gives us the equality test results of the average groups that give information about the most discriminating variables. Therefore, these variables must take significant and high values in Fisher's test.

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Table4: Equality test of the average groups

	Lambda de Wilks	F	ddl1	ddl2	Significance
R3	,976	4,841	1	196	,029
R10	,866	30,357	1	196	,000
R13	,949	10,539	1	196	,001
R16	,864	30,830	1	196	,000
R17	,947	10,983	1	196	,001
R21	,949	10,543	1	196	,001
R22	,899	21,952	1	196	,000
R24	,960	8,123	1	196	,005
R28	,899	22,055	1	196	,000

This table shows the relevance of the R16 ratios (coverage rate of the staff expenses), R10 (debt ratio), R22 (economic profitability ratio) and R28 (ratio of debt in the medium and long term). In fact, the debt ratio is a key factor in the explanation of failure. It affects the company's situation and helps discriminate between both groups of failing and healthy companies. In this context, Lelogeais (2003) thinks that usually failing companies suffer from a high level of short-term debt and low financial autonomy. In addition, the high cost of staff can worsen the financial situation of the company. Finally, the economic profitability ratio is generally a key element in measuring the company's economic performance and a generally significant indicator of its beneficiary capacity.

Our discriminant equation is as follows:

$$Z = 0{,}694 + (-0{,}749)\ R10 + 8{,}501\ R16 + 0{,}338\ R22 + (-3{,}220)\ R28$$

The classification result gives us a rate of correct classification equal to 82.3%.

The comparison of the multi-layer perceptron model and the discriminant analysis model shows the performance of the former fro on the basis the latter. In fact, the rate of the companies' good ranking rate provided by the MLP model is higher than that of the ADL model

Table5: The rate of good ranking of both models

TBC	
MLP	ADL
93,8 %	82,3 %

Consequently, based on the accurate ranking, the performance MLP is considered as a tool for predicting the model of business failure. It should be noted that this result is confirmed by several previous studies, such as Odom et Sharda (1990), Zhang et al, (1999), John et al (2000), Mamoghli et Jalouli (2006), Abdou et al, (2008)… .However, the superiority of the MLP model is not absolute since, according to some other authors, such as Boujelbene and Khmakhem (2007), these two models are complementary. Indeed, the internal links on a MLP have no economic meaning whereas the weights of the ratios in an ADL model are transparent and easy to interpret. Thus, complementarity lies in the ability of the LDA to

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select the most relevant variables and the use of an RNA template with these variables to calculate the lowest error rate.

3. Conclusion

Artificial neural networks are powerful tools of business failure prediction.Supervised learning, such as the MLP and RBF networks, showed a strong prediction ability. By comparing the results of these two models in this study, it can be concluded that the MLP model gives a higher TBC than that of the RBF. In fact, its learning phase is the fastest, besides, it converges for a limited number of iterations as the RBF model.Compared with the models of the artificial intelligence (NAS), the traditional methods, such as the ADL, remain applicable and provide convincing results. A comparison between an MLP and an ADL model helps us assess the superiority of the former based on the assessment of the ability of each model to correctly classify the surveyed companies. However, combining the error minimizing criterion and the ability of selection possibility of the most relevant variables, we could assess the complementarity both theMLP and ADL models.Finally, several other RNA types deserve to be considered to improve the quality of failure prediction. This is the model of non-supervised learning, such as the Kohonen map.

Appendix 1 : The used financial ratios

Code	Ratio
R1	*Currentassets/currentliabilities*
R3	*Cash and cash equivalent /current liabilities.*
R4	Permanent *capital / non-currentassets*
R8	Shareholders' equity/permanent capital
R10	*Total assets / total liabilities*
R12	*Net financial expenses / operating income*
R13	*Turnover / Total Assets*
R15	*Depreciationexpense/fixedassets*
R16	*Staff costs/added value*
R17	Customer and associated account* 365) / sales
R20	*Financial expenses / added value*
R21	*Net income /* net shareholders' equity
R22	*Operating income / total assets*

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R24	*Net fixedassets / total assets*
R25	*Total claims / total assets*
R28	*Medium and long term debt/ total assets*
R29	*Short term debt /total assets*
R32	*Log (total balance sheet.)*

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Integrate subcontracting into Supply chain configuration and diffusion of new Product

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***Abstract*— Outsourcing is one of the most replicated forms of collaboration today, as it represents a strategy for the organization internally to focus on the mainly process and create a network of external suppliers for the secondary activities**

This paper introduces a mathematical model supply chain configuration of a new product. Which integrates the outsourcing constraint in both product life cycle phases, production and diffusion. Knowing that is uncommon, the studies that consider the outsourcing constraint in the product life cycle configuration .The proposed model is applied in practical case to with several scenarios to identify the optimal plan which define the correct quantities to be produced or distributed with company resources and those to be outsourced to maximize the company's net revenue.

***Keywords*— Supply chain configuration, new product diffusion, outsourcing**

I. INTRODUCTION

Outsourcing can be beneficial, but it is necessary to choose in which process the Supply Chain will be integrated. Despite the fact that there is a lack of models in the literature that considers the presence of outsourcing, we will be based on two main works to achieve our new model.

The Supply Chain Configuration is about preparing the decisions including selection of suppliers, production process, transportation modes and facilities to place the appropriate levels of safety stocks.

The aim of this paper is to define a model when and how much quantity must be outsourced during the production and delivery process. Our model can be considered as a decision support tool which provides a modeling framework, to design a supply chain, adaptive to the changing customer demand during new product lifetime's.

II. RELATED LITERATURE

Y According to Haito and Keith [1], the company must configure its supply chain and make decisions before starting production. They provide a decision-making framework for the supply chain configuration and manufacturing by MTO (Make To Order). Their model is based on a combination of two MINLP programming (Mixed Integer Non Linear Programming) and « Contraint Programmation (CP) ». The purpose of work has shown that their model optimizes the total costs of the chain in connection with planning decisions. It takes into account various cost elements, including the cost of goods sold, the cost of security stock and the total cost of execution.

Lu,[2] investigated the problem of companies that manufacture multiple products in multiple periods of stochastic demands. In general, manufacturers have two alternative modes of production: one is to outsource the parts to external suppliers, then to assemble them, the other is to manufacture parts internally and then assemble them.

In 2013, Stritto and Falsini,[3] developed the supply chain model for the release of the new Product, while integrating warehouse location strategies, dynamics demand, and the product dissemination process. The problem is formulated as a stochastic program solved using a hierarchical heuristic solution approach, which is constituted by a Tabou procedure.

Kumar and Swaminathan[4] presented a distribution model of new NPD products . This model used to express the effect and interactions of

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supply constraints on fluctuations in customer demand for the release of the new product. They took into account supply constraints that neglected by the model Bass [5].

To prove their concept and model, Kumar and Swaminathan [4] have studied the case in which the firm can choose any level of production, even if the production capacity and convex growth. They show that setting production capacity before starting production gives optimal and relevant results.

After extensive study of the NDP model, Graves and Willems [6], found that this model focuses on the interactions between manufacturing and marketing / sales decisions in a firm assuming a fixed cost for each production unit. . Note that the NPD model does not consider other functions of the company's supply chain such as markets, supply, assembly and distribution. For this reason, they created their SCC model to optimize the supply chain configuration for new product release.

In this model, the company selects the options for each function (components, parts, or processes) in the supply chain to minimize the total cost of the entire supply chain system.

SCC also allows coordination between actors in the chain

by optimally determining their inbound and outbound service times, as well as inventory positioning in the supply chain.

Amini and Li [7], have been convinced that both the NPD and SCC approaches are extremely linked. For this reason, they presented their model named "Integred / Hybrid Supply Chain Configuration Model". The latter defined as the choice of a feasible production plan, and the configuration of the corresponding supply chain throughout the life of the product.

Since the variation in the requested trajectory was not addressed and addressed by the SCC model, they proposed a hybrid optimization model that takes into account the impact of customer demand dynamics when disseminating new products.

The development of an integrated optimization model that takes into account the configuration of the supply chain and the dissemination of products as a solution to optimize net profit during the product life cycle [7]. The authors emphasized the value of local production in increasing the benefits of society without considering other options or procedures that are capable of doing so. As a result, our work is moving in this direction from our mathematical model which deals with the integration of subcontracting constraints into production as well as distribution.

In order to concretize their model Amini and Li [7] proposed to test it on a practical case "construction of the pipelines". On our part, we will look at the same context of this application to obtain numerical values that will be comparable to those of Amini and Li. The application of our model to determine whether the use of outsourcing is interesting for company to express the concepts of reliability when integrating outsourcing within the configuration of a Supply Chain. Based on the results obtained, a comparative study will be conducted between our model and the integrated hybrid model of Amini and Li [7] in order to negotiate the consistency of the results, in order to deduce a good decision.

III. DESCRIPTION PROBLEM

The following table lists the different parameters used to solve this model. The application of the model developed allows testing several scenarios presented below.

.

Parameter	Level
π	1.1
h	0.001
w	0.005
m	3000
p	0.03
q	0.4
K	100
T	30

- The hybrid-integrated model solved by the solver GAMS DICOPT. The objective function presented as follows:

Total revenue - product life cycle

$$= \sum_{t=0}^{T} \overline{c}_N \left[\pi y_t - r_t - w l_t - h I_t \right]$$

The table below presents the obtained results:

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	Min	***Max***

Case 1 : $\alpha = 1$, $\beta = 1$	Solution1 : Max Z (1, 1)= 111,82DT
Case 2 : $\alpha = 1$, $\beta = 0$	Solution 2 : Max Z (1, 0)= 97,65 DT
Case 3 : $\alpha = 0$, $\beta = 0$	Solution 3 : Max Z (0, 0)=109,48 DT
Case 4 : $\alpha = 0$, $\beta = 1$	Solution 4 : Max Z (0,1)=86.58 DT
Case 5 : $0 < (\alpha, \beta) < 1$	Solution 5 : Max Z (0,0.45)= 87.77 DT

hybrid integrated model	38.82	**123.65**

SCC Costs = Cost of Pipeline Stock + Cost of Pipeline

	Hybrid integrated model	**Proposed Model**
Selling price	374.61	372.70
Production capacity per period	Local 100	Local + outsourced 66 local ; 34 outsourced
Production rate	100%	66% local ; 34% outsourced
Unit delivery cost	Locale (Pas de livraison dans ce modèle)	Local + outsourced 35D

Security Stock

$$= \sum_{i=1}^{N} h(\overline{C_i} - \frac{C_i}{2}) \, P_i \mu_i \quad + \quad \sum_{i=1}^{N} h \, \overline{C}_i \sigma_i \sqrt{s_i^{in} + p_i - S_i^{out}}$$

With:

	Min	***Max***
hybrid integrated model	0.42	**15.54**

Also Amini and Li [7] have tried to calculate the net profit using the general or basic formula (net = selling price - cost) and they found the following results:

Maximize total profit Net = selling price – cost

= 374,72 - 287,89

= 86,72

According to their integrated model the net profit will be equal to:

Maximize Total Profit Net = Total Revenue - Product Lifecycle - Costs SCC

= 123.65 – 15.54 = 108.11

So, we notice that the hybrid integrated model gives more effective results than the base model with a 25% increase.

Following the approach of our model, the Amini model presented in the following situation (local production and local delivery):

IV. RESULTS AND DISCUSSION

In this part, we will focus on applying our parameters and our collected data to the same context of this "pipeline construction" application in order to arrive at numerical values and results that will be comparable to the Amini and Li model. The following table presents a comparative study between the integrated hybrid model of Amini and Li [7] and our model.

TABLE 1: RESULTS PER CASES

TABLE 2: RECAPITULATIVE TABLE

Our approach will be applied while varying the quantities of products manufactured and delivered either internally (own means of the company), externally (subcontracting) or internally and externally. Since the model of Amini and Li [7] deals only with the configuration of the supply chain without giving importance to the subcontracting. We tried to calculate the results by subcontracting part of the pipeline production, we outsourced the process of casting the mold and the

Cas1 : $\alpha = 1$, $\beta = 1$	Solution1 : Max Z (1, 1) = 108.11

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formwork. Regarding delivery, we have tried to calculate the results and conclude the effect of the outsourcing of delivery in this pipeline sector.

Our objective function is as follows:

$$Max\ Z(\alpha,\beta)(r,c)=\left[\sum_{t=0}^{T}\pi_t y_t-\sum_{t=0}^{T}\overline{C_N}\left(\alpha r_{t\,\mathrm{loc}}+(1-\alpha)r_{t\,\mathrm{sout}}\right)\right]$$
$$-\left[\sum_{i=1}^{N}h(\overline{C_i}\ \frac{C_i}{2})\,\mathrm{P}_i\mu_i+\sum_{i=1}^{N}h\ \overline{C}_i k\sigma_i\sqrt{s_i^{in}+p_i-S_i^{out}}\right]$$
$$-\left[\beta C_{livloc}+(1-\beta)C_{livsout}\right]$$

After all calculations, the table below presents the results obtained when applying our model on the "pipeline construction" case study.

- Case 1: Presents the case where is to say that the production and the delivery are carried out locally by the own means of the society. This case leads to a net profit Max Z (1, 1) = 111.82DT. Comparing this result with the Amini model (Max Z (1, 1) = 108.11), we see an increase of 4%, hence our objective function gives a more profitable result than that of the hybrid model.
- Case 2: The production process is applied within the parent company such as, while the delivery process is delegated to a service provider from where. This combination resulted in Max Z (1, 0) = 97.65 DT. This solution does not present the best solution compared to the previous case and the case of Amini but it is more effective than the general case which is equal to 86.72.

Case 3: Presents a complete outsourcing of production and delivery processes. The profit Max Z (0, 0) = 109.48 DT, which is as even more efficient as 108.11 found by the hybrid model.

Case 4: In this case, we have. This combination results in Max Z (0, 1) = 86.58 DT.

Case 5: Presents a random variation of the two variables and between 0 and 1, in order to identify the best combination between production and local and outsourced delivery.

V. Conclusions

From where we find that the application of our model gives a more efficient and cost-effective solution than the integrated hybrid model of Amini even if the increase is 4% compared to the hybrid integrated model.

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Heuristic for the Mixed Team Orienteering problem with capacity constraints

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***Abstract*— this paper proposes a new routing problem named as Mixed Capacitated Team Orienteering Problem. This problem presents the case of Multi-Vehicle with capacity constraint. More precisely, it aims to find an optimal subset that maximizes the total collected profits from the nodes and arcs under the capacity constraint for each vehicle. We propose the mathematical model and the local search heuristic for the Mixed Capacitated Team Orienteering Problem with improvement algorithms.**

***Keywords*— Team Orienteering Problem, heuristic of local search, improvement algorithms.**

I. INTRODUCTION

During the last decade many problems have been modelled as VRP where the objective is to minimize the cost of each tour. Our problem presents an extension of VRP with profit treating the capacity constraint. This problem named Mixed Capacitated Team Orienteering Problem (MCTOP), it aim to finding the subset of visited nodes and arcs that maximize the total collected profit under capacity constraint for each vehicle.

II. LITERATURE REVIEW

Butt and Cavalier [1] were the first who introduced the TOP problem as the Multiple Tour Collection Maximum Problem. Then Chao et al. [2] defined the TOP problem. Several heuristics are developed to solve this problem among them a tabu search heuristic developed by Tang and Miller-Hooks [3] and a metaheuristics by Archetti et al. [4]. In 2006, Boussier et al. [5] presented an exact algorithm. The TOP is treated with an additional constraint which is the capacity constraint whence the Capacitated Team Orienteering Problem (CTOP) where a subset of the potential customers has to be selected in such a way that the constraint of capacity Q of each vehicle is satisfied. In addition, the duration of the route of each vehicle does not exceed a time limit T_{max}. The CTOP introduced by Archetti et al. [6], they solved this problem by metaheuristics.

In this paper, two additional constraints have been added to the basic problem TOP: firstly, the profit in arc where the MTOP and secondly the capacity constraint so the MCTOP.

III. DESCRIPTION PROBLEM

The Mixed Capacitated Team Orienteering Problem (MCTOP) is the extension of the MTOP for the case of multiple vehicles under capacity constraint. The MCTOP aims to maximize the total collected profit for all tour under constraint of capacity for each vehicle. Each tour tour starting in *de* and ending at the final deposit d_s, with a profit associated to the nodes and arcs.

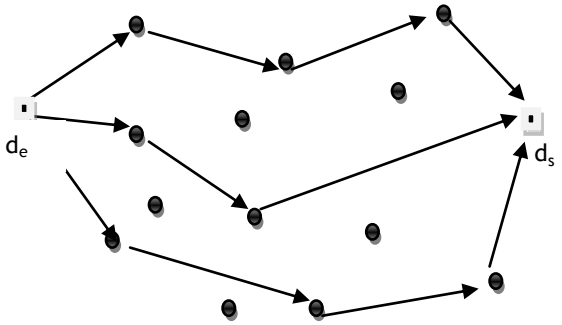

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Fig1. Illustration of the MCTOP

We consider a complete directed graph *G (V, A)*, where *V* the set of vertex *V= 1,.,.n* and *A* is the set of arcs such that:

$A = \{(i, j) \setminus i \in C \cup \{d_e\}, j \in C \cup \{d_s\}, i \neq j\}$.

c_{ij}: cost each arc *(i, j)*

t_{ij}: travel time between *i* and *j*

s_{ij}: the service time between nodes *i* and *j*.

p_{ij} : the profit in profitable arc *(i, j)* $\in E$

d_{ij}: the demand in arc *(i ,j)*

We consider a nonnegative profit p_i associated with each vertex visited only once and the profit will be collected by one vehicle when the demand d_i is satisfied. Also, we noted the service time in the node *i* in the tour by s_i and the position of vertex *i* in the tour *k* by u_{ik}.

Two decision variables are used, the first y_{ik} equal 1 if the vertex *i* is included in the tour *k* and 0 if not. The second x_{ij} equal 1if the arc *(i, j)* is included in the tour *k*, 0 otherwise.

The mathematical model of the MCTOP is presented as follows:

$$Max \quad \left(\sum_{k=1}^{K}\sum_{i=2}^{N-1} P_i . y_{ik} + \sum_{i=1}^{N-1}\sum_{j=2}^{N} P_{ij} . x_{ijk}\right) \tag{1}$$

subject to

$$\sum_{k=1}^{K}\sum_{j=2}^{N} x_{d_e jk} = \sum_{k=1}^{K}\sum_{j=1}^{N-1} x_{jd_s k} = K \tag{2}$$

$$\sum_{k=1}^{K} y_{jk} \leq 1 \quad ; \forall j=2,...,N-1 \tag{3}$$

$$\sum_{i=1}^{N-1} x_{ijk} = \sum_{z=2}^{N} x_{jzk} = y_{ik} \qquad ; \forall j=2,...,N-1, \forall k=1,...,K \tag{4}$$

$$\sum_{i=1}^{N-1}\sum_{j=2}^{N} t_{ij} . x_{ijk} \leq T_{\max} \qquad ; \forall k=1,...,K \tag{5}$$

$$\sum_{i=1}^{N-1} d_{ik} + \sum_{j=2}^{N} d_{ijk} \leq Q_k \qquad ; \forall k=1,...,K \tag{6}$$

$$2 \leq u_{ik} \leq N \qquad ; i = 2,...,N \ ; k=1,...,K \tag{7}$$

$$u_{ik} - u_{jk} + 1 \leq (N-1)(1 - x_{ijk}) \qquad ; i, j = 2,...,N ; i \neq j \ ; \ k=1,...,K \tag{8}$$

$$x_{ijk} \in \{0,1\} \qquad ; i, j = 1,...,N \ ; k=1,...,K \tag{9}$$

$$y_{ik} \in \{0,1\} \qquad ; i = 1,...,N \ ; k=1,...,K \tag{10}$$

The objective function (1) is to maximize the total collected profit on the nodes and arcs for all tour. Each tour starts by the deposit d_e and finished in deposit d_s which are guaranteed by the constraints (2). The constraints (3) and (4) ensure respectively that each node is to visit only once and the connectivity for each tour. Constraints (5) you cannot exceed the limited time T_{max}. Constraints (6) ensure that the quantities delivered by each vehicle do not exceed its capacity. Constraints (7) and (8) are necessary for the elimination of sub-tours with u_{ik} the position of vertex *i* in the tour *k*. Finally, (9) and (10) are the binary constraints.

IV. Local Search for the MCTOP

This method consists of two main steps: the initialisation solution then improvement such as relocating a customer to a new position in a route or by removing edges from the solution and replacing them with new edges.

A. *Algorithm of Decent*

The initial algorithm consists of the descent whose steps are presented below.

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Algorithm of descent

Input: set of node

Output : solution s*

[1] Initialize start and end point: 0 and N-1
[2] Initialize the tour time T_tour, T_tour = 0.
[3] Initialize the objective function F, F = 0.
[4] for i = 0 untill N-1
N0 ← d_e
N-1← d_s
[5] Draw randomly two nodes N1 and N2
[6] Assessment
if F(N1)> F(N2)
choosing N1
i++

[7] return solution s*

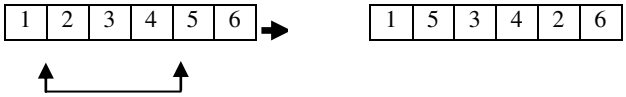
This algorithm allows obtaining the first solution which will then be improved.

B. *Improvement algorithms*

Three algorithms are used for improvement the initial solution:

- Inversion : n-1 possible movements

- Permutation : n. (n-1)/2 possible movements



- Displacement : n. (n-2) +1 possible movements

V. EXPERIMENTATIONS AND RESULTS

Our model is applied to a case of commercial Tunisian society. We increase the number of customers visited up to 100, using a fleet of vehicles where k = 3.

Table (1) summarizes the different results for all the tests, obtained by applying the method of descent with the algorithms of improvement.

TABLE I
BEST SOLUTION OBTAINED BY THE THREE ALGORITHMS

N umber of customers	**K**	**F(x)**		
		Inversion	**Permutation**	**Displacement**
10	1	875.45	956.59	890.12
	2	498.11	534.38	490.41
	3	-		
20	1	4111,93	3987.35	3872.07
	2	1389,22	1567.61	1432.11
	3	645.16	729.98	589.43
30	1	7694,04	7856.53	6821.97
	2	6410.03	5341	5776.34
	3	2014.11	2395.44	2412.87
50	1	9649.72	9329.67	8287.99
	2	6013.20	5893.87	5763.12
	3	4741,52	4906.34	4987.31
100	1	10189.45	11231.83	10654.19
	2	6567,23	6721.80	5890.43
	3	4715,17	4772.67	3950.45

The improvement algorithms could increase the solutions compared to the ones found in the initial heuristic of Descent.

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The permutation procedure marked superiority for the majority of cases. This improvement has also led to an increase in the time of the tour, but still less than T_{max}.

IV. CONCLUSIONS

In this work, we introduced the first model of the Mixed Capacitated Team Orienteering Problem (MCTOP), according to our knowledge, it's an extension of the MOP to multiple vehicles which the objective is to maximize total collected profit in nodes and arcs under constraint of capacity for each vehicle. Since the MCTOP is an NP-hard problem, we presented the first heuristic to tackle it. The Local search heuristic is developed for solving the MCTOP using the algorithm of Descent. Next, three algorithms of improvement are used for the initially obtained solution.

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I have taken efforts in this paper. However, it would not have been possible without the kind support and help of the company "SVI". I am highly indebted to "SVI" for providing necessary information regarding the implementation of model.

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Approach of Principal component analysis for the modal choice problem

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***Abstract*— this paper presents the problem of modal choice. We observe the growth of road transport in parallel with the decline of rail transport, which loses its share of the market. To determine the reasons and the criteria of modal choose a questionnaire is conducted to study companies' perceptions towards land transport modes. These responses are analyzed by SPSS using the principal component analysis method to determine the modal choice criteria and obstacles related to road and rail transport in Tunisia.**

***Keywords*— road transport, rail transport, modal choice, Principal Component Analysis**

I. INTRODUCTION

Freight transport has become an essential activity where the stakes are extremely sensitive and varied. These stakes mainly concern the economic and industrial organization of the country, globalization, the environment, the logistic organization of the companies and they also touch the criteria of the modes of transport and their technical and economic capacities. Major changes have affected land transport, there is a decline in rail traffic to compared the road. The new organization production "just-in-time" has favoured the dominance of the road mode, which is able to adapt to the new demands in terms of speed, door-to-door delivery, flexibility and responsiveness. It should be noted that the growth of road transport causes the decline of rail transport in parallel, which loses its market share. It is the consequence of a rigid response to the needs of industrialists, a delivery station to station, in addition that it is unable to react in case of unexpected demand. It's not competent to manage demand fluctuations.

The choice between modes raises a problem that is limited to two principal questions: what is the basic criterion for choosing a mode of transport and how to distribute freight traffic between competing modes? To answer these questions, we study the existent by using the questionnaire method then the treatment with SPSS and analysed the results by the principal component analysis method.

II. LITERATURE REVIEW

Evers [1] explained shippers' perceptions by the price-quality ratio of different modes. The result shows that the chargers have a bad perception towards combined rail-road, but it is preferable using the rail.

Bontekoning et al [2] analysed the relationship between road congestion and the decision of shippers to use alternative modes. The results of this study showed that most loaders that have favorable conditions for non-road mode use other alternatives.

Tsamboulas and Kapros [3] have shown that when shippers refer to the cost criterion for choosing the mode of transport, they therefore prefer combined transport.

Houée et al. [4] presented the modal choice by combining the revealed and declared preferences data. They reached the following conclusions: an increase in cost or road transport time for companies that use their own means of transport led to a remedy on behalf of account of others and rarely to rail transport.

Bontekoning et al. [5] analyzed the relationship between road congestion and shippers' decision to use alternative modes to the road. The results of this study showed that most loaders that have favorable conditions for using non-road mode choose other alternatives without using combined transport.

Savy [6] stated that the choice between land transport depends on such elements, it is necessary to take into account the nature of the products, the size of the lot to be transported and its conditioning, the distance to be covered and the travel time.

III. PRESENTATION OF THE APPROACH PRINCIPAL COMPONENT ANALYSIS :PCA

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In order to determine the choice of the companies towards the modes of transport, we used the method of Principal Component Analysis PCA.

This method consists in transforming correlated variables into new variables uncorrelated from each other. These new variables are called principal components, or main axes. It reduces the number of variables and makes the information less redundant.

The first step is to distribute a questionnaire to 150 companies containing various questions which are interested in the modes of transport, the types of products transported, the conditions of transport ...

The second step is processed the data collected by SPSS software and make the Principal Component Analysis.

Finally we interpret the results using the correlation matrix and diagrams.

A. Organizational Chart of the approach PCA

About our methodology for solving the problem, we chose the use of a questionnaire referred to enterprises and then a principal component analysis by SPSS 20. This analysis identifies the relationship between the variables used in the questionnaire to clarify the situation of transport road and rail in Tunisia. The figure (1) illustrates the processus.

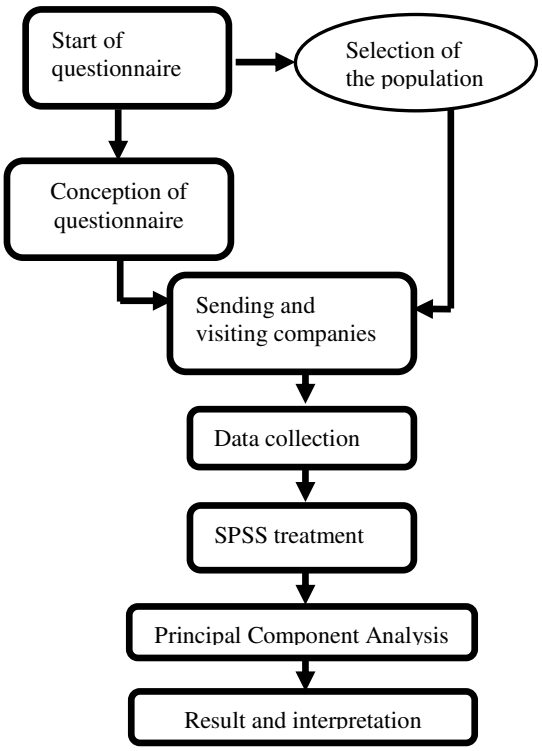

Fig .1 Organizational Chart of the approach PCA

B. Data collection

In order to collect data, we distributed a questionnaire to 150 Companies using land transport for the distribution of their products.

The questionnaire method seems the most sensitive because the answers must be accurate and clear. This method was chosen because it provides insights into the actual practices of enterprises towards the transportation operation.

In this work, we have taken into account in the choice of companies, those who have the opportunity to use the road mode, rail transport or both modes.

The distribution depending on sectors activity, the companies surveyed are subdivided in two sectors of activity as follows:

58% industrials companies,
42% commercials companies

IV. Results and Discussion

In this section we present the results obtained by applied the PCA method.

A. Repartition of used modes

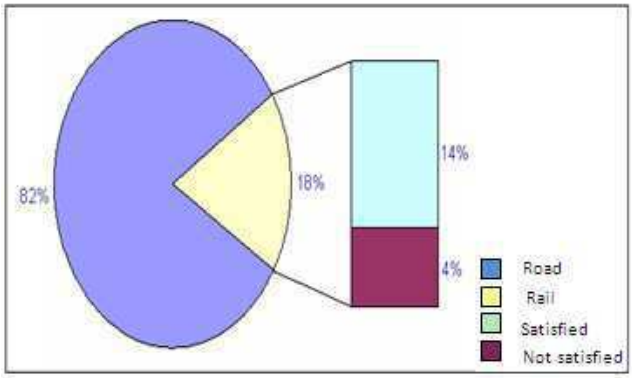

Fig .2 Distribution of the modes used

The rate 82% of the companies transport these products by the road mode it's due to the use of their own fleet of vehicles, they are satisfied by only one mode of transportation and ignore the more interesting options that could be offered by other modes. This group of companies that exclusively use the road has no idea about the conditions of rail transport. The majority of companies that have access to rail mode is satisfied by the conditions offered by this mode.

B. The modal choice criteria and their importance

The table presented below contains the most interesting modal choice criteria (Cost of tansport, quality of services…). We tested the importance of these criteria for the companies surveyed, the result is as follows:

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TABLE I
THE CRITERIA OF THE MODAL CHOICES ACCORDING TO THEIR IMPORTANCE

The criteria of choice	Low importance	Normal	Important	Very important
Cost	-	-	12%	88%
Quality of service	-	5%	30%	65%
security	-	4%	48%	48%
Flexibility	2%	24%	48%	26%
Time of transport	-	10%	12%	78%
Nature of goods	9%	11%	50%	30%
Respect of deadlines	-	10%	14%	76%
Respect the environment	16%	74%	10%	-
Availability	-	-	30%	70%
Better transport conditions	2%	8%	26%	64%

We conclude that companies attach great importance to the cost and time of transport these two criteria are the main determinants in modal choice. Since the cost of transportation is part of the total cost of goods, companies seek to minimize it in order to realize their profit on the one hand and to meet the expectations of their customers in other hand.

C. Correlation Matrix

The following correlation matrix is obtained from the ACP.

ANNEXE I
CORRELATION MATRIX

In order to be able to extract a component corresponding to a linear function of the initial variables, these variables must necessarily be inter-correlated. The matrix has a number of interesting size coefficients (-.34, .75, etc.).

There is a linear independence between the cost of transport and the security of the transfer of products, both between the nature of goods and the cost of transport.

D. *EIGENVALUES*

The table below shows the eigenvalues of the different components.

TABLE III
DISTRIBUTION OF EIGENVALUES AND PERCENTAGES OF VARIANCE ASSOCIATED WITH EACH OF THE PRINCIPAL COMPONENTS

Components	Initial eigenvalues		
	Total	% of variance	% Cumulative
1	3,510	35,098	35, 098
2	1,810	18,104	53,202
3	1,234	12,342	65,543
4	,894	8,941	74,484
5	,720	7,201	81,686
6	,574	5,740	87,426
7	,422	4,221	91,647
8	,375	3,751	95,398
9	,282	2,825	98,223
10	,178	1,777	100,000

The ACP method is to maximize the variance explained by the first component. It can be seen that the eigenvalue of the first component is 3.510 which corresponds to 35.098% of the total variance of 10 components. The second component explains an additional portion of variance, independent of the first, and corresponding to a lower proportion than the previous one. Examination of table (III) shows that the C2 component explains 1.810 units of variance (out of 10), which corresponds to 18.104% of the total variance. We can therefore say that after extracting two main components we reach 53.202% of the total variance. With the third component providing 1,234 we obtained 65,544% of the total variance. Thus, we can be satisfied by 3 components given the purpose of the PCA which allows reducing the data of 10 variables with 3 components which gives 65.544% of the initial variance.

E. THE MATRIX AND DIAGRAM OF THE COMPONENTS AFTER ROTATION

The table (IV) presents the results of matrix after rotation, which simplifies the structure of the solution by maximizing the variance of the components.

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TABLE III
MATRIX AFTER ROTATION

	Components		
	1	**2**	**3**
Transport availability	,828	,203	-,005
Better transport conditions	,823	,240	,020
Respect the environment	,621	,186	-,369
Respect of deadlines	,129	,186	-,275
Quality of service	,070	,725	,218
Nature of goods	,357	,689	,059
Security	,422	,506	,309
Cost	-,210	,098	,865
Time of transport	,603	-,112	,626
Flexibility	,085	,543	,570

The study of the matrix after rotation shows that the first component is defined by the importance of the availability of transport, better conditions and less important to respect the environment. The second component is defined in terms of respect for orders, quality of service and nature of goods transported. Concerning the third component, it is defined by the cost of transport, the time and in less important to the flexibility.

V. OBSTACLES OBTAINED BY USING THE ROAD AND THE RAIL TRANSPORT

In this section, we presented the obstacles obtained by using the road and the rail transport.

A. OBSTACLES OBTAINED BY USING THE ROAD TRANSPORT

The main road transport obstacles are presented in the figure below, we noted:

- P1: road infrastructure problem
- P2: congestion
- P3: insecurity
- P4: loss or destruction of goods
- P5: limited capacity
- P6:others problems

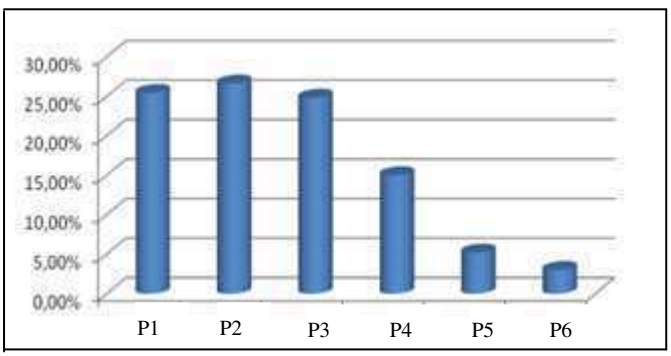

Fig .2 Problems obtained using de road transport

The surveyed companies affirm that there are three essential obstacles: traffic congestion, bad infrastructure and the risk of road accidents. Regarding the capacity of the vehicles it doesn't an obstacle since the 34% of the companies surveyed do not exceed 5 tons, so they can be transported by road.

B. THE OBSTACLES OBTAINED BY USING *THE* RAIL *TRANSPORT*

For companies that have a significant activity and use rail for the transfer of their products, they encounter difficulties in terms of travel frequency. Moreover 26% of companies make more than 10 trips daily to various cities of Tunisia, this relatively large number of travel can be carried out by road transport. The rigidity of the rail is another problem since it transports from station to station. The products transported must wait at the terminal until they are loaded into the truck, which causes the increase of transport costs.
Although the wagons used by SNCFT are varied, they remain non-adaptable for all types of products, for example liquids products. The latter need to be transmitted in cistern wagons which are generally reserved for the transport of fuels to the detriment of other types of liquids it's probably to be perishable because of the absence of a special cistern.

VI. CONCLUSIONS

This work presented the problem of modal choice. We observe the growth of road transport in parallel with the decline of rail transport. This mode has increase very quickly to the detriment of the rail mode. This is the result of a rigid response to the needs of companies.

A questionnaire is conducted to determine companies' perceptions of land transport modes. These responses are analyzed by SPSS using the principal component analysis method to determine the modal choice criteria and obstacles related to road and rail transport in Tunisia. The companies claim that the rail offer is limited and it's conditioned by the types of products transported, the frequencies of travel and the distances traveled.

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I have taken efforts in this paper. However, it would not have been possible without the kind support and help of the companies that have agreed to answer my questionnaire. I would like to extend my sincere thanks to SNCFT for data concerning rail transport.

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ANNEXE

ANNEXE I
CORRELATION MATRIX

		Cost	Quality of service	time of transport	Security	Flexibility	Nature of goods	Respect of deadlines	Respect the environment	Availability	Better transport conditions
Correlation	Cost	1,000	,191	,355	,090	,481	,051	-,096	-,342	-,096	-,114
	Quality of service	,191	1,000	,063	,397	,362	,439	,296	-,020	,296	,331
	time of transport	,355	,063	1,000	,357	,295	,224	-,024	,162	,344	,380
	Security	,090	,397	,357	1,000	,429	,519	,202	,223	,355	,367
	Flexibility	,481	,362	,295	,429	1,000	,290	,282	,124	,184	,160
	Nature of goods	,051	,439	,224	,519	,290	1,000	,421	,290	,302	,458
	Respect of deadlines	-,096	,296	-,024	,202	,282	,421	1,000	,332	,271	,236
	Respect the environment	-,342	-,020	,162	,223	,124	,290	,332	1,000	,430	,347
	Availability	-,096	,296	,344	,355	,184	,302	,271	,430	1,000	,755
	Better transport conditions	-,114	,331	,380	,367	,160	,458	,236	,347	,755	1,000

a. Determinant = ,023

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Simulation based optimization models to allocate personnel and reduce the expected waiting time in an outpatient medical service

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Abstract— ***Outpatient services are one of the most congested hospital divisions because they combine consultation, care and follow-up activities. In such system, as in the external orthopaedic surgery department of the Habib Bourguiba in Sfax, patients have to wait for too long and this for several stages of the process such as registration, consultation and payment.***

A major problem in this case is the adequacy between the current and the required number of personnel. Indeed, allocating a number of personnel more than the need may lead to reduce the waiting time of patients but the related cost may increase and vice versa. Furthermore, the staffing level i.e. number of personnel, depends on the number of patients arriving at each day as well as the task requested to serve each one. In fact, in such system, the arrival of patient is random and the most of operation are unpredictable. Thus, it will be difficult to define the appropriate number of personnel to allocate for this type of system.

In this paper, we present a mathematical model and a simulation optimization method to define the number of personnel to allocate in the external orthopaedic surgery department of patients in Habib Bourguiba Hospital of Sfax. The proposed method permits to take into account the stochastic behavior of the system induced by random times and unexpected operations.

The objective of this study is to minimize the average waiting time of patients with the minimum cost of services. The result of this problem can be used to improve the ambulatory care clinic with better quality care.

Keywords: ***surgery consultation service, Simulation, Optimization, patient flow, average waiting time.***

I. INTRODUCTION

Patient waiting time for healthcare services is identified by the World Health Organization (WHO) as one of the key measurements of a responsive health system. In this work, we are interested in the problem of long waiting time in the outpatient services. As a case study we have chosen the outpatient service of the orthopaedic surgery of the Habib-Bourguiba hospital of Sfax.

A major problem in this case is the adequacy between the current and the required number of personnel. Indeed, allocating a number of personnel more than the need may lead to reduce the waiting time of patients but the related cost may increase and vice versa. Furthermore, the staffing level i.e. number of personnel, depends on the number of patients arriving at each day as well as the task requested to serve each one. In fact, in such system, the arrival of patient is random and the most of tasks are unpredictable. Thus, it will be difficult to define the appropriate number of personnel to allocate for this type of system. We

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present a mathematical model and a simulation optimization method to define the number of personnel to allocate in the external orthopaedic surgery department of Habib Bourguiba Hospital in Sfax. The proposed method permits to take into account the stochastic behavior of the system induced by random times and unexpected operations.

The remainder of the paper is organized as follows: In section (2), we present a brief review of the literature related to our subject. Section 3 states the problem definition. Section 4 depicts the architecture of the proposed methods and the design of experiments for testing and presents analysis of results. Section 5 present the conclusions and gives some future perspectives.

II. Literature Review

In public hospitals, and especially in outpatient departments, the patients flow has become intensified, the number of patients entering the system far exceeds the number of the patients treated. In fact, the problem of scheduling appointments for outpatient services has attracted the interest of many academic's researches and practitioners over the past 60 years. This interest began with the famous work of Bailey [1]. The aim of this work was to develop a planning system that satisfies the interests of consultants and patients: patients prefer to have the minimum waiting time, doctors like to spend a short period of inactivity and prefer to finish on time. Wang [2] studied the planning problem in two different ways, once as a static scheduling problem in which the number of patients expected is known, and once as a dynamic scheduling problem in which an additional number of patients are planned after a first batch of programmed patients. The author studied a single server system with exponential service time, with the objective of minimizing the weighted sum of customer flow time and system completion time.

In the literature, it has been observed that simulation has widely been used for the resolution of problems of hospital organization in the last twenty years, whether for the emergency department (El Oualidi [3]; Achour [4]; Dehas [5]; Ping-Shun Chen [6]; Glaa [7]; Tao [8]; Belaidi [9]; Jlassi [10]), operating theater (Marcon[11]; Millard [12]; Ramis [13]; Tyler [14]), surgery (Vasilakis and Kuramoto[15]), nursing units (Gascon [16]), maternity care at home (Nidhal Rezg [17]), imaging (Mebrek [18], Moussa and Belkadi, [19]), hospital logistics (Aleksy [20]), the stomatology department (Belkadi, and Tnaguy [21]) and other units.

Simulation techniques are often used to model patient's flows in different hospital departments. Indeed, this technique is useful when it is used to model the complex patients flow systems and to test the scenarios resulting from the change of certain parameters. Among the services where simulation techniques are interesting are the emergency services where the flow of patient's is subject to the many sources of uncertainties. El Oualidi [22] presented a simulation model of the patient flow in the emergency department by the Structured Analysis and Design Technique. This model has the aim of minimizing the average length of stay. Thanks to the simulation, a reorganization of the service made it possible to reduce the length of stay by 30%.

A frequently used method is the optimization-based simulation. A first model developed in 2006 by Rohleder [23] to model patient service centers using simulation techniques. In fact, this method enables to simulate discrete events in a descriptive and flexible way and accommodate the demand structure of this particular situation. The results are used to analyze the configuration of the service centers and estimate the resources needed to meet the demand within the recommended waiting time. In addition, one objective of this research was to develop a model for a new, larger service center that would improve operations and resource utilization. After reviewing various scenarios and adjusting the data to the most recent information, a representative model was used when the new service center was created but had to be readjusted due it is expected increase of demand. Hence, the importance of understanding that modeling a health system is an ongoing process and that a comprehensive dynamic model would be the best way to predict and understand real outcomes.

Jlassi [24] developed a simulation model the patient's journey within the emergency department of Habib Bourguiba hospital in Sfax, Tunisia. At the end of their study, they found a great disparity in the durations of various activities of the emergency department, in this respect they gave some explanation of these disparities, which are of human origin (medical and paramedical personnel infusing), Equipment (lack of radiology equipment) and infrastructure (emergency department too small) and then proposed scenarios for improvement.

Rohleder and Lewkonia [25] used a simulation model to reduce the patient's waiting time in an orthopedic outpatient department. For this purpose, they proposed scenarios for improvements that are based on adding new resources and reviewing appointments. Similarly, in the orthopaedic service, Chantal [26] proposed a model based on discrete event simulation. This model generated three improvement scenarios in connection with the appointment planning, the patient's trajectory and the increase in the number of orthopedic surgeons in order to reduce the time spent by patients in the clinic.

Santos [27], in a center in British Columbia in 2013, focused on the problem of modeling the pathway of patients with acute spinal cord injury. By studying three typical scenarios, they found that modeling the system highlights the indirect impact of several medical and administrative interventions, both upstream and downstream of the continuum of care. The practical results reduced the length of stay and decreased the use of rehabilitation beds.

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In 2010, Rodier [28] developed a model of patient flows in France, while taking into account several parameters such as the patient's journey, human and material resources, bed capacity. The proposed model is based on discrete event simulation method and allows defining and implementing performance indicators to facilitate decision-making from the point of view of the managers.

Ramis [29] used a Flexsim GP simulator to shorten the imaging center waiting time. In four hospitals in Chile, the researchers identified all the flows, resources, schedules and exams. After comparing seven configurations, they were able to reduce the total patient waiting time by 35% without changing the staff, but the assignment of common functions. Therefore, the productivity of a center can be increased by 54%, assuming infinite demand.

Al Araidah [30] studied outpatient consultations in a local hospital in Tehran, Iran. The researchers used a discrete event simulation model with total time and service time in the stations as data. The statistical comparison was also used to confirm the performance model proposed for the current system. The results showed that many improvement scenarios can be applied to the reduction of waiting time of up to 29% and a reduction in the total visit time by 19% without purchasing any new resources.

Ahmed and Alkhamis [31] developed simulation and optimization model to design an aid decision tool for an emergency service in a governmental hospital in Kuwait. The main contribution of this article is the increase of the patient's flow by 28% and the reduction of the average patient's waiting time by 40%.

Ping-Shun Chen [6] proposed simulation-based optimization models to analyze the patient routing mechanisms. The objective of the study is to obtain the best possible number of patients with the minimum average waiting time and to maximize income of both hospitals in Taiwan. The results can build patient's referral mechanisms between two hospitals.

In this work, our objective is not to maximize the number of patients because the outpatient clinic must satisfy all the received demand. But, we aim to respond to this demand with the minimum average waiting time and therefore minimizing the average total time spend in the service. Simulation and Optimization have been considered by several authors for this type of problem. The difference is always in the way these techniques are used. Usually simulation is used to reproduce the behavior of health care system in order to evaluate its performance and analyse the outcome of different scenarios. In this paper, we used a discrete event simulation tool to evaluate the sources of dysfunction of the actual system and to identify the most sensitive components to change and to improve. Approximate mathematical model of the system was derived using the OptQuest tool of Arena software. The later is used to give a list of feasible solution that contains the best one of them for each of objectives.

III. PROBLEM DESCRIPTION

A. DESCRIPTION OF SERVICE

In order to understand the functioning of the actual system and identify the data necessary to model the patient paths in the orthopedic outpatient clinic of Habib Bourguiba Hospital, we conducted an on-filled survey from 04/01/2016 to 05/02/2016 for an average of 200 patients per day. This survey allowed us to collect statistics on patient's arrivals and service times that helped us to determine the arrival rates of patients during different days of the week and the distribution of service times at each stage of the service. Indeed, from a structural point of view, the outpatient orthopedic surgery department has 7 functional sub-assemblies: admission, consultation of surgery (resident), consultation of medicine (assistant), plaster room, radiology and treatment room. The table below (table 1) shows the distribution of human and medical resources associated with each functional set.

TABLE I

BREAKDOWN OF RESOURCES BY OUTPATIENT DEPARTMENT OF ORTHOPAEDIC SURGERY (ABDELMONEEM [32])

Rooms	***Things to Do***	***Medical staff***
Reception	*Rgistration and payment*	*2 Input operators* *2 Payments*
Rooms for Surgery	*Surgical consultation*	*3 residents*
Medical consultation rooms	*Medical consultation*	*2 assistants*
Room service	*Care*	*A nurse*
Plaster room	*Plaster removal*	*A nurse*
Radiology	*Radio*	*A nurse*
Meeting room RDV	*Making appointment*	*A nurse*

As mentioned in section (1) patient may have to follow different paths through the same set of services. These moves may be divided into two mains pathways as summarized in the following figure (figure1). The rectangles represent the steps of the process (tasks) while the arrows represent the movements within the service.

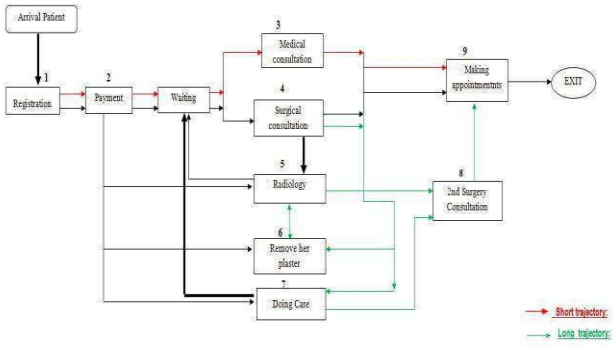

Fig. 1 The pathway of patients in the outpatient orthopaedic clinic Abdelmoneem [32]

Any patient arrives to this service must be registered. He then moves to the payment; this action notifies the nurses that the patient has arrived. After that and depending on the case, the patient is called by the nurse to:

• Be referred to the radiology department,

• Remove the plaster and be directed to the radiology department,

• Or to directly meet the orthopedist (assistant or resident).

Once the patient has switched to radiology, he deposits a white paper to the payment for that purpose. This action, warns the nurse that the patient is ready to meet the orthopedic surgeon. Following his meeting with the orthopedic surgeon, if the consultant is resident, the patient may be redirected back to the plaster room and resume the same route until he returns to his orthopedist for a second visit in the following resident (called 2nd passage). Alternatively, the patient may take an upcoming appointment (as required) and leaves the service.

B. PROBLEM FORMULATION

The notation of the model is presented as follows:

- Indices:

i: index of patients.

j: index of the number of service in the external service of orthopaedic surgery

M: Number of service

N: Number of patients.

- Parameters:

B: the upper limit of the budget available to operate the service

Q: the upper limit of waiting time in the service

L j: the lower limits of the number of service j in the service

U j: the upper limits of the number of j in the service

Decision Variables:

X_j : represents the number of service.

C_j : represents the external service cost of orthopaedic surgery

WT_i: the average service time of patient i.

- Optimization model 1: minimizing the service time

$$Z = \text{Min} \sum_{i=1}^{M} WT_i \quad (1)$$

S/C:

$$\sum_{j=1}^{N} C_j X_j \leq B \quad (2)$$

$$\sum_{i=1}^{M} WT_i \leq Q \quad (3)$$

$$L_j \leq X_j \leq U_j \quad (4)$$

The objective function (1) seeks to minimize the average service time of the patients. Constraints (2) ensure that the total cost of adding new personnel staff should not exceed the upper bound of the budget available to operate the service.

Constraints (3) determine the mean service time of patients i, which must be less than or equal to the maximum allowable service time, Q. The constraints (4) ensure that the number X_j of added new staff personnel j should not exceed the upper limit U_j.

IV. METHODOLOGY

A. SIMULATION-BASED OPTIMIZATION

Simulation is increasingly used in the design and organization studies of complex systems. The objective of using simulation-based optimization to improve performance and meet a number of objectives that are often contradictory, such as reducing cost with maximizing the use (Physical and human) resources, improving the quality of care by providing effective diagnostic systems.

To reflect these advances in simulation-based optimization, simulation software publishers have integrated experimental research and optimization research modules into their simulation packages. Examples: Auto Stat, Auto Mod, Witness optimizer and OptQuest tool of Arena Klassen and Yoogalingam [33]. The majority of researchers used the Arena OptQuest .

OptQuest is a generic optimizer that makes it possible to separate successfully the optimization solution procedure from the simulation model. The optimization procedure uses the outputs from the simulation model to evaluate the inputs of the model. The optimization procedure then uses a search algorithm, where the successively generated inputs produce varying evaluations, not all of them improving, but which over time provide a highly efficient path to the best solutions. The process continues until it reaches some termination criterion.

OptQuest uses the elements of controls, responses, constraints, and objectives in searching for optimal solutions. These elements are discussed in the following section.

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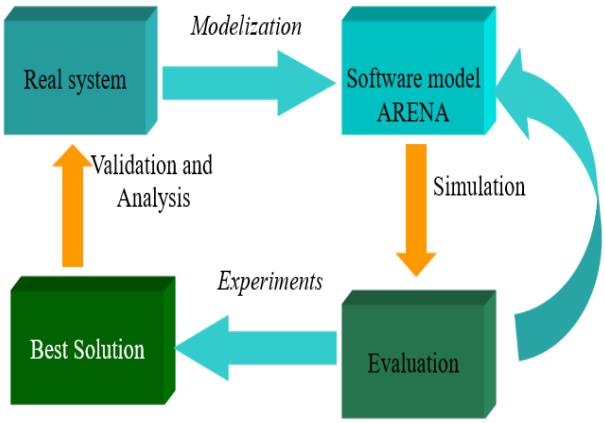

Figure 2 Framework for Simulation-based optimization

In this work, we apply the discrete event simulation (DES) using the ARENA software. This includes collecting and editing data, constructing DES models and checking them. At the same time, the optimization part of this study is carried out using the OptQuest optimizer. Relevant steps in this phase include determining system variables, defining objective functions and specifying linear constraints on system variables, and some performance measures (sometimes called objective functions). Then, a search algorithm is applied to find the optimal solution. The last step occurs at the end of each cycle of the simulation model used for objective function evaluation.

Through direct interviews with some officials in the department and with the financial director of the hospital, the most important indicators that we need to take into account in our study are:

- The cost of each new agent or added specialist
- Waiting time for a patient.

B. DISCRETE EVENT SIMULATION MODEL

Discrete event simulation is a technique used to model an observed process. On the basis of field data, it is possible to develop a basic model that reflects the observed reality. This basic model, when verified and validated, becomes an important decision-making tool because it helps visualize the changes without disrupting the activities of the observed process. In the table below we present the statistical distributions on which we are based on to model the service time at each stage of the process. This time includes the waiting time and the service time. These distributions are released using the "Input Analyzer" module of the ARENA simulation software, which is specially designed to adjust the theoretical distributions to the observed data by estimating their parameters (Table2).

TABLE II

STATISTICAL DISTRIBUTIONS USED IN SIMULATION MODEL

Task	**Statistical distribution (minutes)**
Arrival Patient	*EXPO(5)*
Registration	*UNIF(1, 5)*
Payment	*UNIF(1,5)*
Assistant	*UNIF(5,20)*
Resident	*UNIF(5,20)*
Doing care	*TRIA (5, 7,10)*
Plaster removal	*TRIA (5,10, 15)*
Radiology	*TRIA (5, 7,10)*
Making appointments	*TRIA (0.5, 1,1.5)*

The real model was used to validate our results and ensure that they represent the observed reality. The theoretical model (basic model) was used to generate improvement solutions. By running our simulation model during 100 replications of 24 hours, we obtained the different estimated times. A comparison is made, in terms of the time to be served (this variable contains the waiting time in front of each step of the process plus the service time), between what is observed and what is simulated to verify the validity of the model. The results of the comparisons are presented in the following table (Table 3).

As mentioned in table 3 differences between the times observed in the field during our data collection and the simulated ones (obtained according to the actual arrival times of the patients) are less than 6 minutes. These results confirm the validity of the simulation model.

TABLE III

COMPARISON RESULTS BETWEEN THE REAL AND THE SIMULATED MODEL

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After having detected the possible sources of the long total time passed in the service (that due to the long time spend in admission and consultation) and after confirming the validity of our simulation model, we can then suggest a set of propositions that can improve the functioning of the care process:

- Increase the number of registration officers.
- Increase the numbers of cashier agents
- Adding new medical assistant
- Adding new residents

C. RESULTS

Given the objective, design constraints and response constraints, OptQuest within ARENA was used to implement the optimization approach proposed in this study. This was done by firstly using the design variable values in the present system as an initial solution. The feasibility of this solution is determined by checking if the design constraints are satisfied, otherwise a new set of design variable values that satisfy the design constraints is searched at a given step size. After selecting appropriate values for the design variables, OptQuest must invoke Arena to run a simulation and determine whether or not the current trial solution is feasible with respect to the response constraints, otherwise a new solution that satisfies both the design and response constraints is searched. If a feasible solution is found, a new solution that yields better system performance results is sought. This process continues until all the design variable possibilities are exhausted or a predetermined time limit is reached.

	Agent	**Assistant**	**Resident**	**Nurse**
Salary	*600*	*1800*	*1200*	*900*

Task	**Average Observed Time (minutes)**	**Average simulated time (minutes)**	**Difference (in minutes)**
Registration	170.5	171.5	0.5
Payment	112.0	114	2.0
Assistant	70.0	72.85	2.85
Resident	112.0	113.69	1.69
Doing care	8.0	8.93	0.93
Plaster removal	13.0	13.03	0.03
Radiology	8.00	8.93	0.93
Making appointments	1.00	1.09	0.09

Table 4 defines the lower and upper bounds of each type of personnel in the outpatient orthopedic surgery. These values allow us to fix the upper limits in OptQuest resource's parameters.

TABLE IV

LOWER AND UPPER LIMITS OF THE NUMBER OF DIFFERENT PERSONNEL RESOURCES

Variable	**Lower bound**	**Upper bound**
Registration: X_1	*1*	*3*
Payment: X_2	*1*	*3*
Assistant: X_3	*1*	*4*
Resident: X_4	*1*	*5*
Plaster: X_5	*1*	*2*
Radiologist: X_6	*1*	*2*
Care: X_7	*1*	*2*

TABLE V

TABLE OF SALARIES (TND/MONTH)

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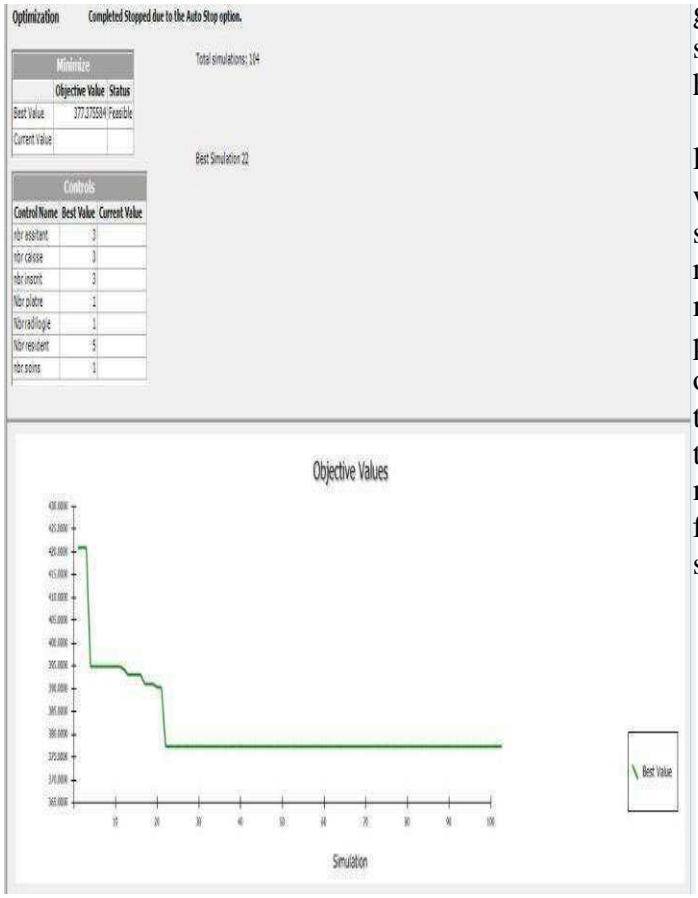

Figure 3.View the optimization results as OptQuest searches for the optimal result.

The theoretical model (basic model) was used to generate improvement solutions. By running our simulation model during 100 replications of 24 hours, we obtained the different estimated times.

In the following table (table 6) we indicate the list of feasible solution obtained for the patient's waiting time using OptQuest. The proposed solutions are too closer to each other's. They are ranging from 377.37 to 403.94 minutes. Results of model simulation and optimization showed that performance of the optimized department of the orthopaedic surgery was better overall compared to the current department. Consequently Solution 1 is the best solution, waiting time was reduced the most by 377.77min on average, the total revenue for the optimized department of the orthopaedic surgery was increased by 17700 TND/MONT.

TABLE VI

THE LIST OF FEASIBLE SOLUTION OBTAINED FOR THE PATIENT'S WAITING TIME USING OPTQUEST

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	Registration: X_1	**Payment: X_2**	**Assistant: X_3**	**Resident: X_4**	**Plaster: X_5**	**Radiologist: X_6**	**Care: X_7**	**Average waiting time**	**cost**
Based Solution	*2*	*2*	*2*	*3*	*1*	*1*	*1*	*418,31*	*12300*
Solution1	*3*	*3*	*3*	*5*	*1*	*1*	*1*	*377.37*	*17700*
Solution2	*2*	*3*	*4*	*4*	*1*	*1*	*1*	*383.5*	*17700*
Solution3	*2*	*2*	*2*	*5*	*1*	*1*	*1*	*388.34*	*14700*
Solution4	*2*	*3*	*3*	*5*	*1*	*1*	*1*	*390.23*	*17100*
Solution5	*3*	*2*	*4*	*5*	*1*	*1*	*1*	*390.33*	*18900*
Solution6	*3*	*3*	*2*	*5*	*1*	*1*	*1*	*391.08*	*15900*
Solution7	*2*	*3*	*2*	*5*	*1*	*1*	*1*	*391.54*	*15300*
Solution8	*2*	*2*	*3*	*5*	*1*	*1*	*1*	*391.91*	*16500*
Solution9	*3*	*2*	*3*	*5*	*1*	*1*	*1*	*392.14*	*17100*
Solution10	*2*	*2*	*3*	*4*	*1*	*1*	*1*	*393.08*	*15300*
Solution11	*3*	*3*	*1*	*5*	*1*	*1*	*1*	*393.09*	*14100*
Solution12	*3*	*3*	*1*	*4*	*1*	*1*	*1*	*394.31*	*12900*
Solution13	*3*	*3*	*3*	*4*	*1*	*1*	*1*	*394.67*	*16500*
Solution14	*3*	*3*	*4*	*5*	*1*	*1*	*1*	*394.9*	*19500*
Solution15	*3*	*2*	*1*	*5*	*1*	*1*	*1*	*395.06*	*13500*
Solution16	*3*	*2*	*2*	*5*	*1*	*1*	*1*	*395.21*	*15300*
Solution17	*1*	*3*	*3*	*5*	*1*	*1*	*1*	*396.75*	*16500*
Solution18	*1*	*2*	*3*	*5*	*1*	*1*	*1*	*397.71*	*15900*
Solution19	*3*	*2*	*2*	*4*	*1*	*1*	*1*	*397.95*	*14100*
Solution20	*2*	*3*	*2*	*4*	*1*	*1*	*1*	*398.11*	*14100*
Solution21	*2*	*2*	*4*	*5*	*1*	*1*	*1*	*399.69*	*18300*
Solution22	*3*	*1*	*4*	*5*	*1*	*1*	*1*	*401.92*	*18300*
Solution23	*2*	*2*	*4*	*4*	*1*	*1*	*1*	*402.9*	*17100*
Solution24	*1*	*1*	*3*	*5*	*1*	*1*	*1*	*403.57*	*15300*
Solution25	*3*	*2*	*1*	*4*	*1*	*1*	*1*	*403.94*	*12300*

V. CONCLUSIONS

This article elaborates an approach for enhancing the performance department of the orthopaedic surgery in Habib Bourguiba Sfax Hospital.

The department of the orthopaedic surgery was represented by a DES model developed with the aid of ARENA software and supplemented with the gathered and fitted experimental data. OptQuest of ARENA was used to implement the optimization for the selected design variables to improve performance of the current system.

The optimization process included defining a suitable objective function is to reduce the average patient's waiting time of service.

Results of model simulation and optimization showed that performance of the optimized department of the orthopaedic surgery was better overall compared to the current department. Consequently Solution 1 is the best solution, waiting time was reduced the most by 377.77min on average, the total revenue for the optimized department of the orthopaedic surgery was increased by 17700 TND/MONTH.

Future studies can continue this line of research by focusing on the coordination between the emergency and the orthopaedic services in order to well manage the patients flow and for a best appointment scheduling system.

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REGIONAL PLANNING AND TERRITORIAL DEVELOPMENT IN MOROCCO

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***Summary* –- Since its political independence, Morocco based its economic activity on planning. However, the adopted plans were central. And in order to face the need of territories development, the state limited its action to the regionalization of the already established plans. Since 1992, the national planning was abandoned to be replaced, starting from 2005 by sectoral strategies which coincide with a third experience of regionalization marked since 2015 by the adoption of the regional plans. Will the latter be effective in term of territorial development without a planning or a global national strategy?**

***Keywords* –- development plans - regionalization of the plan – regional planning – sectoral strategies – territorial development.**

I. INTRODUCTION

Since the Second World War and considering the need of reconstructing the economies destroyed by the war, planning had held an important place in the governmental policies in several countries. If the socialist countries had opted for an institutionally necessary imperative planning, the capitalist countries on the contrary, to remain on the path of liberalism, had elaborated an indicative planning. Similarly, in the developing countries, this planning was introduced to supplement the market mechanisms, often imperfect. (p.6, [1]).

Morocco's recourse to planning dates back to the post-colonial period in order to deal with inherited economic, social and spatial problems. However, it was not able to achieve balanced territorial development, or local development as it was called before the 1970s (p.68, [2]), in spite of the attempts to regionalize the national plans. (II)

From 2005 onwards, sectoral strategies will be adopted by supplanting national planning. They coincide with the "advanced" regionalization, put in force since 2015, which insists on the adoption of regional plans. Hence our interest in discussing their effectiveness in the absence of national planning. (III)

Our research thus follows a qualitative method using an inductive approach, starting with the description of the observed realities: the abandonment of national planning, the use of sectoral strategies and the adoption of regional development plans (RDPs). In the context of these observations, territorial development challenges us.

II. NATIONAL PLANNING AND THE REGIONALIZATION OF PLANS

A. National planning: a strategic choice since Morocco's political independence.

Historically, the economists have developed several theories about the development planning by considering it as "a continuous process involving decisions or choices about alternative possibilities in the use of available resources to achieve particular objectives over a specific period of time". (p.2, [1]). The plan is thus considered as an instrument of economic policy, prepared for a fixed period which can be short, medium or long term depending on the objectives and availability of resources. It is supposed to be a continuously readjusted reference document.

According to an operational approach, planning is a system, a particularly complex general function of orientation, management and regulation of the economic activity while having operational data. It is structured in four functions: formulation of economic strategies and policies, investment programming, the implementation of the investment program monitoring, macroeconomic monitoring to readjust, through economic policy measures, the economic and social development strategy. (Pp : 10-11, [3]). Therefore, as a method of managing the development of the national economy, planning is a working process whose result is the plan. (p. 15, [3]) It is a means considered effective in reducing uncertainty through the objectives and means that it recalls.

Ref[4], (p.154), shows that the plan was considered as the ownership of the nation. Thus, if there is a need to localize or regionalize certain actions, the regional policy is limited to a devolution procedure by choosing an executant to apply a central decision locally.

Regional policy experiments carried out since the 1929 crisis have shown that the objectives of the regional intervention remain centralized and without any real effectiveness of land-use planning policies conducted to correct spatial disparities and social inequalities. (Pp : 154-155, [4]).

It was only with the emergence of the concept of local development at the end of the 1960s and the appearance of the concept of sustainable development towards the end of the 1980s that the regional planning evolved with a slight development of decentralization depending on whether the states are federal or centralized unitary.

The recourse of Morocco to planning is essentially a political matter. The study of the socio-economic and spatial situation of the country during the adoption of such a strategical choice, after the political independence in 1956, shows that it was marked by a large-scale spatial and economic imbalances (Useful Morocco and useless Morocco). This worrying legacy has been a reality to face. Hence the application of planning.

Practically, many types of planning have been adopted in Morocco, covering several areas. On the one hand, it targets

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the different geographical scales, from the communal to the national level. On the other hand, it is applied in various fields such as (annual) finance laws, land-use planning through the adoption of national, regional and urban planning schemes (between 10 and 20 years), and economic and social development (3 or 5 years), etc.

However, it seems that such a multiple and entangled planning has not led to a balanced territorial development considering several disabilities. We will emphasize the last category, the focus of our study.

B. National development planning: centrality and simple regionalization of plans.

Planning had been identified as an effective means for the development. However, economic and social development plans were restricted to take into consideration the regional data in their programs. It was the province, the pre-eminent political-administrative territorial unit that was favored as the territorial framework for the planning implementation at the expense of the region. (p.25, [5])

Table I lists the various development plans, specifying their objectives and certain limits.

TABLE 1
RECAPITULATION OF THE DEVELOPMENT PLANS IN MOROCCO

Plan's type	Objectives	Limits
Biennial 1958-1959	The transition Plan: an Equipment Program to ensure the transition of the equipment plan 1953-1957 under the protectorate.	Technical role
Quinquennial 1960-1964	To modify the structures of the Moroccan primary and dominated economy. Its main objectives: Executive education and training; Agrarian structures reform; Industrialization; State reform.	the province's growing place
Triennial 1965-1967	-Agricultural development (modernization of the sector); -Tourism development; -Executive training; -Industrialization	-Unachieved Objectives -the province's growing place
Quinquennial 1968-1972	Same priorities. We add : the demographic policy ; the industrial development and the commercial exchanges ; the thrift and aid policy; the projects elaboration and implementation of certain reforms (administrative, fiscal...); the implementation of the process of regionalization of the plan.	-The first steps of regionalization to allow the stakeholders participation in the implementation of the plan. -Projects with a provincial character.
Quinquennial 1973-1977 or «economic and social development plan»	Accelerated economic growth (7.5% per year) and increased investment (18% per year)	Unachieved objectives due to the decline of phosphate prices in the world market.
Triennial 1978-1980	Its main orientations: The imports reduction; The improvement of the internal and external fundamental balances; pursuing a social and territorial planning policy.	Various regional studies without balancing effects.
Quinquennial 1981-1985 or «economic and social re-launch plan »	The territorial integrity defence and the relaunch of the economic activity by: Mobilizing private savings, Increasing the investment, Improving the external balance by increasing exports, Tackling unemployment, Tax reform.	Marginalized plan in favor of the Structural Adjustment Program (SAP) in 1983.
Quinquennial 1988-1992 Or « orientation » plan	The accentuated liberalization of the economy, the disengagement of the State and the privatization. The plan identifies the following priorities: encouraging small and medium-sized enterprises (SMEs); encouraging the private initiative through privatization; developing the agriculture sector; and tourism.	An attempt to strengthen the area. 1992: Its erection as a local collectivity. Regional planning is only mentioned in the perspectives of the plan.
Quinquennial 1996-2000 Or economic and social strategic development plan	The private sector promotion; The fundamental balances maintenance; The exports development; The rural world development.	It was not concretized (the alternation and the second experience of regionalization).
Quinquennial 1999-2003	The improvement of the national economy's competitiveness; The enhancement of human resources; The development of the rural world.	Return to planning in the context of free trade agreements.
Quinquennial 2005-2010	Preparing Morocco for the 2010 free trade area.	It was not concretized.

Source: our own elaboration on the basis of the PDES and our doctoral thesis [6]

Indeed, the planner's awareness of all the disparities had existed, but the advocated policies had not followed the path leading to balanced development. The entire policies had a global approach, or in the case of areas specification, they were chosen according to their inherited importance. (p.358, [6]).

The region-oriented territorial practice took place only in the 1970s. Thus, since the quinquennial plan 1968-1972, a process of the plan's regionalization called "regional development" will be implemented with emphasis on regional projects. (p.169, [6]).

In the context of a new regional development strategy, the 1988-1992 orientation plan emphasized the strengthening of regional and local planning in parallel with the royal directives in terms of the reinforcement of the territorial collectivities' economic role and the deepening of decentralization and regionalization processes (Royal Speech of 1984 and the constitutional revision of 1992 setting up the region as a local collectivity). The new regional planning vision was based on a multiannual communal equipment's programming and an integrated regional priorities programs. (p.285, [7]).

However, the planning problems were tremendous in terms of funding and governance (decentralization and deconcentration). The 26 years of implementation of the first experience of regionalization have been strongly criticized at several levels: regional division (seven regions), the region's law, its tasks and prerogatives, its human and financial

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resources and its relationships with deconcentrated and decentralized authorities, etc.

During the second regionalization experience implemented in 1997 (sixteen regions), the region's role was the planning and the regional council develops a regional plan according to the priorities of the national development plan. Certainly, new missions and attributions are noticed for the region but without accompaniment texts. (p.146, [8])

Moreover, the lack of financial and human resources, which guarantee the autonomy, represents a concern for the decentralization actors since the communal reform of 1976. (Pp : 67-76,[9])

Similarly, planning remained captive of an approach that draws an analogy between territory and authority, which considers that "the territory is the place where the State deploys its strategies and exercises its political domination". (p.22, [10]). This has led to collectivities with entangled and interfered competences and limited outcomes.

Decentralization, vital for a unitary State (p.249,[11]), does not imply disengagement but rather the transfer of various competences to local authorities by redefining and refocusing the role of the State on its main tasks such as the promotion of balanced land-use planning. (Pp: 250-251,[11]).

In this key field of planning and economic development, the region is recognized, in recent reflections, as the organizing authority and the framework for spatial planning and participatory programming of structuring actions. (Pp : 251-254, [11])

In brief, the trend towards regional planning was not pursued due to the lack of clear regional development policies. So, is it going to find a place as part of sectoral strategies?

III- THE USE OF SECTORAL STRATEGIES: WHAT GUARANTEE FOR THE REGIONAL PLANNING SUCCESS?

A. Multiple sectoral strategies without a national strategic framework

Since 2005, the Moroccan economy has been oriented towards sectoral strategies that have marked the cut with the national planning era. (p.68, [12]).

Thus, Morocco confined itself to multiple sectoral strategies of an economic and social aspects, which we have tried to regroup in Table II.

TABLEAU II
THE SECTORAL STRATEGIES IN MOROCCO

	Sectors	Title of the strategy
Economic	Tourism	-Blue Plan in 2003 -Vision 2010 ; -Vision 2020 ; -AZUR Plan.
	Agriculture	-Green Morocco Plan 2008 ; -2020 Strategies of the rural development.
	Entrepreneurship	-« Mouquawalati » Program in 2006
	Industry	Emergence Plan 2005 ; Emergence Plan 2008 ; Industrial Acceleration Plan Emergence 2009-2015.
	Renewable energies	- Renewable energy plan by 2020; - National energy strategy 2030 -Plan solaire marocain -Plan intégré de production d'électricité par énergie éolienne.
	Trade	-Plan/Programme RAWAJ 2020, plan de développement du commerce et distribution. -Maroc export plus / commerce extérieur -The national plan of the commercial exchanges development.
	Logistics	-Logistics competitiveness strategy for 2015
	Maritime fishing	-Halieutis
	Ports	-Port strategy 2030
	NICT	-Digital Morocco 2013 in 2009.
	Craft industry	-Vision 2015 of the craft industry
	Infrastructure	-Infrastructure programs and major projects
Social	Health	-Health Strategy 2017-2021
	Professional training	-Strategic vision of vocational training
	Education	-Strategic vision of the 2015-2030 reform "for a school of equity, quality and promotion". -National strategy of higher education -Multi-Year Action Plan for Higher Education and Scientific Research 2017-2021

Source: Our own elaboration (the list is, perhaps, not exhaustive)

The analysis of these different strategies highlights several observations. In fact, in terms of time, they were developed in different circumstances with different horizons. In terms of adoption procedures, they have been criticized for the marginalization of institutions (parliament and government) and their conception by mainly foreign consultancy companies (p.72,[12]).

Similarly, their objectives, considered to be far from reality, are not being achieved, particularly in terms of job creation: nine plans have envisaged the creation of 3,260,000 jobs between 2013 and 2020 while the Moroccan economy generated, according to the High Commission for Planning (HCP), only 129,000 jobs per year, on average between 2000 and 2014. (pp : 75-76,[12]).

In addition to what is mentioned, it seems that these strategies suffer from a lack of coordination of their governance and of an integrated national strategic framework as underlined in the royal speech of 30 July 2010. They conceal problems related to their elaboration, implementation, monitoring and evaluation as raised in the 2014 Report of the Economic, Social and Environmental Council, in the 2013 and 2015 Bank Almaghrib Report and in the Economic and Financial Report related to the 2015 Finance Law). (p.77, [12]).

Considering these different sectoral strategies pitfalls, will the regional planning be able to achieve the objective of balanced territorial development?

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B. The regional planning: a tool for balancing the territory

The main purpose of this tool is a balanced land-use planning. It is envisaged in a region as a means of accelerating economic development. It has been demonstrated that, in order to establish a good regional program, several dimensions must be taken into consideration by the plan: the level of the administrative scale (regional, national, rural areas...); the economic activities diversity; the existing laws and political structures; the surrounding physical environment; the interactions between social groups and the way they meet to define values and norms and to identify their critical problems. (Pp : 19-20,[13]).

Unlike the regionalization of the plan, which is limited to taking regional data into consideration when elaborating a national plan, a regional plan is considered as a" strategic document", drawn up by the region according to its own specificities, allowing the medium-term coherence of public interventions in the regional territory through the State-regional plan contracts. (P.205, [14])

Since the territory has become a strategic development actor, within the framework of "glocalization" (p.21,[10]), and since we are talking about the "Big Bang of organizations"[15] and also about the "winning regions"[16], it appears that the problem of territorial development in Morocco can only be apprehended by the realization of the integrated development of each region. The latter requires that plans should be drawn up for each regional entity according to its local resources and development prospects. It had to tackle, as a priority, intra-regional disparities through the eccentric reorientation of economic flows concentrated in poles, created according to the regional conception of the seventies.

Such a conception will be implemented through the new experience of regionalization in Morocco. This is what was proposed in the report of the consultative commission on regionalization (set up by the King in January 2010) where regional competences in terms of integrated development are listed according to the rules that specify on the one hand, areas of competence that may be shared between the State and local authorities (water, energy, transport, etc.), by applying the principle of subsidiarity, on a contractual basis and in a progressive way, by making the corresponding resources and means available to these authorities; and on the other hand, the areas of competences in different fields which are updated according to the evolution of the local authorities' resources and intervention capacities. Another rule that reinforces the decentralization process is the recognition of the pre-eminent role of the regional council in the elaboration and monitoring of regional development programs. It elaborates, in a concerted way, the development plan of the region as well as the land use regional plan, then it adopts it after the State' consultation. (p.14, [17]).

C. Regional plans without national planning!

In 2015, and following the three reports established by the Consultative Commission on Regionalization, the third "advanced" regionalization experience is launched by granting new prerogatives to the region. Thus, Article 5 of Organic Law No. 111-14 on Regions stipulates that: *"In application of the provisions of Article 143 of the Constitution, the region shall play a pre-eminent role in comparison with other territorial authorities in the preparation, implementation and monitoring of regional development programs and regional land-use planning schemes, while respecting the specific competences of other territorial authorities"*. (p. 197, [18])

Such an extension of the new regions' powers would enable them to create a new territorial development dynamic based on the RDPs because of the differences in their specificities and therefore in their strategies.

Practically, to this day, ten out of twelve regions have adopted RDPs. [19]. Thus, the two remaining regions are: Darâa-Tafilalet (Region 8) and Guelmim-Oued Noun (Region 10).

Thus, these regional plans, developed gradually, are established when the country has invested in sectoral strategies whose limits have already been identified.

This leads us to the question of the need for a national strategic vision to ensure the success of RDPs. It seems that the interaction between regional and national planning is essential as the first is established by reference to the second. In the regional planning, the presence of the State remains significant considering its national role as an arbiter and its capacity to ensure the coordination and the coherence of all the regional plans by reference to a concerted strategic vision of economic and social development. (p. 182, [20]).

V- CONCLUSION

Confronted to the territorial development issue, Morocco is, it seems, required to put in place a coherent and concerted strategic framework in order to strengthen the regional planning and guarantee the success of the RDPs. The current regions remain, despite the efforts made in the context of "advanced" regionalization, entities that suffer, in part, from the lack of sufficient financial resources and therefore autonomy.

Admittedly, the participatory approach is one of the requirements for the establishment of good territorial governance (p.128 [21]). But, it must be conducted far from the double-headed practices between decentralized and deconcentrated authorities, far from the cleavages between politics (concerted RDPs but without significant financial means) and economics (dirigiste and uncoordinated sectoral strategies but financially supported by the State).

The opportunity of the quest for a new development model (Royal Speech October 2017) should be taken to review the sectoral approach, considered until recently as "the most decisive" (p.58[22]), and establish a holistic strategic vision to achieve territorial development that requires democracy and socio-spatial equity.

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However, such an experience, still embryonic, requires an evaluation by conducting an impact study of the RDPs on territorial development in the medium and long term.

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Adoption et usage des Smartphones à Casablanca: quel impact sur le projet Casa Smart-city ?

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***Abstract*— Few years ago, Morocco started raising investment in the technologies of information and communication and heighten it to the rank of national priority. It has instituted a real project called "Digital Morocco 2013", one of its objectives is to make the Kingdom technological hub in the region, and by way of consequence, to stimulate the competitiveness of its territories. No one can, indeed, contest the observation that the economic development of territories is intimately correlated with their numeric development. This awareness of the strategic character of ICT has led the Moroccan public authorities to reconsider their policies towards a digital development of the territory, following the same trajectory as many developed countries.**

In this logic a whole reflection has been lunched around the metropolitan development of Casablanca. A very ambitious project baptized "Casablanca Smart city" is "imported" as the intelligent cities of developed countries such as Barcelona, Nice, Singapore and well of others. This project strives to transform the metropolis of Casablanca in an ecosystem called " smart city" thanks to numeric projects that will allow an optimal analyze of the informational wealth of data that is gathered and analyzed; and the restoration of harmony between the administration and the users by proposing them a suitable public service.

In spite of all these laudable efforts to make this metropolis a model in terms of numeric development, no one can ignore the major challenges that it must confront, among others, the resorption of the numeric fractures in terms of accessibility and use as well as the numeric literacy of the citizens. These last constituent the pillar of the Casablanca Smart City concept as users, consumers and producers of information and data.

These reports lead us to a questioning of the feasibility of the Casablanca Smart-City project. We will tempt to answer this question through an empiric survey of the adoption and the use of the smartphones by 1500 individuals residing in the metropolis of Casablanca. The idea is to appraise the numeric literacy of the citizens of Casablanca through how much they can use their technological tools, in this case their smartphones. Indeed, the success of the Casa Smart City project is based on the existence of a strong connected community in the city through their use of mobile ICT infrastructure such as smartphones and other mobile devices.

***Keywords*— Smartphone, smart city, smart citizen, Casablanca, adoption and use of smartphones.**

I. INTRODUCTION

The concept of the city has progressed much since its inception from the ideal town to the smart-city. Aiming to improve the citizens' life quality, public authorities are experimenting with new concepts of territorial, urban and local development. The cities then become laboratories of experimentation of new ideas and techniques of urban conversion before the labelling of the concept« urban labelling » [1]. The success of an idea makes it an exportable concept to other contexts. Experimenting with an idea about a city requires tangible and intangible investments as well as a favorable legal and political framework. This city-laboratory concept remains a luxury for some countries. Southern cities have neither the socio-economic conditions, nor the political and financial autonomy of western cities nor the time for the experimentation of new ideas. Urban sprawl is increasing, according to a UN estimate (2014), about 70% of the world's population will live in urbanized areas by 2050. Under the constraint of this massive urbanization, the cities of the South countries would then ask for turnkey models of urban development.

With this in mind, many smart cities that have proven themselves are looking to sell their concept. Smart cities ranking contests are organized all over the world in order to convey the concept. The best ranked cities in 2016 by the Juniper Research[1], namely: Singapore, Barcelona, London, San

[1] www.juniperresearch.com

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Francisco and Oslo, have built a brand image that will enable them to be well positioned on that global market. These cities are often classified according to indicators, covering technology, transport, energy, open data and the economy.

Adopting this smart city concept by countries around the Mediterranean includes both opportunities and risks. As the successful experiences of Mediterranean cities such as Barcelona, Nice, Marseille ..., cities such as Tunis, Cairo, Algiers and Casablanca have imported the concept of smart city and are trying to adopt it.

In Morocco, a reflection on the metropolitan development of Casablanca putting first the strengthening of its national and international competitiveness to make it a real technological hub has been started. A very ambitious project called "Casablanca Smart city" has begun. This project aims to transform the metropolis of Casablanca into a smart city thanks to digital projects enabling optimal analyze to the informational wealth of data collected and analyzed; with the aim of bringing the administration and users closer together by offering them an appropriate public service.

The approach of Smart City is based on the use of mobile and ubiquitous ICT infrastructure such as smartphones and other mobile devices to develop interconnected applications, services and pilot projects in order to gradually create an ecosystem of social, sustainable and collaborative innovation. Which promotes the creation of an interconnected smart city environment. Therefore, importing the Smart City project for the city of Casablanca would require a "Smart" citizen. In other words, he must show a dexterities and intellectual skills that would allow him to manipulate digital technology because he will be both producer and consumer of digital data.

However, some alarming figures show daunting obstacles to the adoption and use of technologies, especially the Internet and technological support. Major disparities characterize the metropolis in particular between rich neighborhoods and peripheral areas where the first degree digital divide is ubiquitous [2]. Moreover, the price of access to technology remains inaccessible for a large segment of the population: according to a report by the World Bank (2014) a representative household belonging to the 40% poorest Moroccan population should pay 32.11% of his income to access to mobile broadband. This same household should bear a financial burden of 29.03% of its disposable income to have access to the fixed broadband. Adding to these impediment the illiteracy which hinders a large proportion of citizens from manipulating the technology.

These findings lead us to rethink the adoption and use of smartphones and their involvement in the success of the Casa Smart City project. The contrasts observed challenge us in several ways:

1. Would Smartphones be adopted by all Casablancans?
2. What uses do they make of their Smartphone?
3. Are these uses enough to ensure the completion of the project aimed to make Casablanca a smart city?

We will attempt to answer these questions relying on an empirical study that we conducted with 1305 individuals residing in the metropolis of Casablanca in 2015. A model of qualitative econometrics will help to estimate the determinants of the adoption and use of Smartphone by Casablancans. To that end, we refer to the Davis [3] Technological Acceptance Model (TAM) and its extensions.

The first section of this article presents the conceptual framework retained through a review of the theoretical and empirical literature on the concept of smart city as well as the acceptance and adoption of new technologies. In the second section, we present the survey and the main results.

II. Review of the literature

A. Smart city: Concept and components

The Smart City concept has been around for twenty years. It was strongly linked in the beginning to the progress made by ICTs. Its diffusion has gone from the digital city to smart city ... This concept is based on the integration of ICT in the urban planning process.

Despite the abundance of names, the Smart City was associated by some authors with the concept of "smart growth" which recognizes the link between land use planning and quality of life [1]. This idea was developed by multinationals in the ICT sector such as IBM, which identified cities as potential

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customers with huge profits. In order to sell its services to the government, IBM built its project around three components: 1) a system for planning and managing the services; 2) ICT infrastructure services; and 3) Human services [4]. Amazed by the idea, public authorities have made it a real territorial marketing tool.

For city planners, the Smart City seems like a promising solution to face growing urbanization [5], climate change, scarcity of resources and competition between cities. Making a city a Smart City does not mean transforming or expanding its attributions or functions, but it aims to exploit the vast amount of data and information generated by the progress of ICT, and to use it in the goal of improving the well-being and everyday life of citizens.

Giving a single definition to this concept may limit its scope. The Smart City is the subject of multidisciplinary research such as economics, geography, urban planning, research and development in the field of hardware and software infrastructure, etc. Nevertheless, its central core remains the data [6].

The concept gives rise to two reflections. The first can be built around technologies and tools of communication that allow to collect and disseminate information that transforms the city into a "digital city", and the second privileges the involvement of the technologies user by making the city "smart". That leads us to the next question; is Smart City a set of smart platforms or it is the way of using these platforms to improve the living conditions of citizens and visitors of cities?

According to Attour and Rallet [7], a city is considered "smart" only if it has the capacity to develop itself while mitigating the negative effects of this growth on financial costs and well-being of its inhabitants. Similarly, Komninos [8] discusses the integrated use of many electronic and digital technologies by residents and visitors in order to raise the quality of life and employment in an area.

In fact, the approach of the intelligence of a city would be larger than a simple use of the new technologies. It includes diverse urban approaches such as the economy, education, democracy, infrastructure, transport, environment, security and quality of life [9].

The following figure groups together the aspects showed in a study made by Giffinger and al. in 2007 [10]. This study proposes a smart city model by identifying the following components:

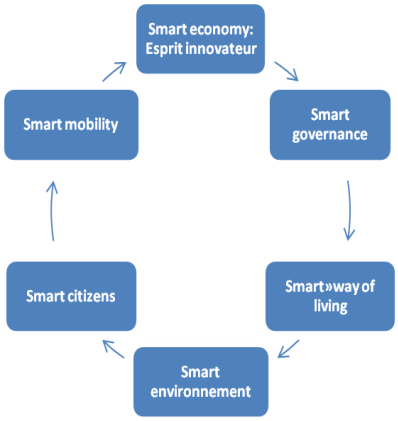

Fig. 1 Components of the intelligent city inspired by Giffinger, s.d

Smart mobility: Transport is a sector that affects both the economy, the environment and the well-being of citizens. In order for mobility to be smart, it must participate in improving logistics flows and facilitating the mobility of citizens. By developing applications that make it possible to provide and access information on road traffic, car parks, high-risk areas, transport delays ... This intelligent mobility aims to make it easy for citizens to access, quickly and in real time to information related to road traffic [11]. In this sense, technology has led to the development of alternative means of transport, which positively influences the fluidity of roads and therefore positively impact the environment.

Smart economy: aims to encourage the innovative spirit and entrepreneurship of citizens. This component cannot exist without the involvement of companies, universities, innovation and research centers, governments and citizens in order to value the data. Such a vision is largely inspired by the triple helix model of innovation systems in the urban economy. The interaction between these actors aims to create a climate of innovation in which smart initiatives of economic development emerge.

Smart governance: It is based on the digitization of public administration procedures and virtual access to official documents. The participation of citizens in decision-making and the development of city strategies through digital platforms dedicated to the exchange of ideas between the local government

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and the inhabitants of the city remains a goal for the Smart City. In short, to be qualified as smart, governance must be both participative and digital.

Smart way of living: transforming the city to improve the quality of life of its inhabitants requires, first and foremost, a health and safety education and housing system that meets the needs of citizens and then a cultural infrastructure and a social cohesion leading to the development of the inhabitants. This component remains vital for the attractiveness of the city.

Smart environment: the smart city must work to protect its environment, through good management of natural resources, pollution reduction, waste treatment, environmentally friendly housing, etc. The smart environment is based on the use of ICT to rationalize energy and water consumption in the city.

Smart citizen: It is the hard core of the concept, its participation is crucial because he is both user and producer of the smart services in the city. The smart city is created by the citizen and for the citizen. He must be able to appropriate all the uses of the smart city thanks to ICT mainly smartphones. It must have digital skills. These skills develop with learning through three levels: the instrumental skills that enable it to use technological support, the informational skills through which it can process digital information content and strategic skills that provide it with the ability to use it proactively, to contextualize in its own framework of life and to make decisions with a view to acting on its professional and personal environment , individual or collective [12]. This user of smart services must have the requisite skills to know an intellectual level enabling him to use ICTs, open-mindedness, creativity and involvement in the political life of his city.

In summary, The adoption of the concept is synonymous with the emergence of a new service based on the six components mentioned above. This service offer must make the citizen a priority. It must be built around citizens needs by placing them at the heart of urban development in a role of consumers and actors. The Smart City is a city that puts data at the service of its citizens through data projects covering all areas.

Given the complexity of the urban environment, setting up a Smart City project is more complicated than it may seem. Each of its components can be considered as a subsystem of a global system. The evaluation of the overall project requires a test of integration of the different components.

Zygiaris [13] has developed a performance measurement system that identifies the different layers of a city: 1) It begins with an elementary layer that responds to the basic components of the city; 2) Then the 'green city layer' which integrates the environmental and green component of the city; 3) The 'interconnection layer' which encourages innovation in ICT infrastructure to interconnect people, transport systems, local government and other devices; 4) The 'instrumentation layer' which, thanks to the interconnection layer, has the role of using data from the latter and making them available to the public; 5) The open integration layer, which ensures that all smart applications and services communicate with each other to produce accurate information; 6) The application layer where the city is observed and controlled in real time. The information is shared through interconnected and instantaneously instrumented operators; 7) The innovation layer allows the city to achieve territorial attractiveness based on an innovative ecosystem that allows the creation of value.

B. Casa Smart city : Context of the project

The awareness of the strategic character of ICTs in the economic development of the territories has led the Moroccan public authorities to rethink their policies towards a spatial planning based on digital, following the same trajectory as many developed countries.

The city of Casablanca has followed the smart cities movement by launching the "Casa Smart City" project. It aims to transform the metropolis of Casablanca into a smart city through projects related to urban toll management, intelligent parking, intelligent public lighting, video surveillance, waste management and treatment, decreasing the consumption of energy and water, facilitation of urban travel by focusing on the environmental component and improving the quality of life of the Casablancans.

Several initiatives have been launched with this vision, the "E-Madina" cluster was launched in 2015 with the aim of creating and developing a smart city ecosystem to bring out the city's transformation solutions using digital technologies.

In January 2016 an intelligent and optimized urban surveillance system comprising 760 CCTV cameras connected by 220 km of fiber optics was installed in Casablanca. In order to encourage smart governance, an interactive citizen

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communication application has just been launched. Entitled "MajlisKOM" which means " your council", it is intended as a platform dedicated to the management and dissemination of the activities of elected assemblies, town halls, municipalities and local authorities. The event "Smart City Expo" which is in its second edition in 2017 gather the professionals of the domain and the event "smart City Connect" aims to raise people awareness of the concept. Through these achievements, Casablanca seeks to position itself as an African leader in the area of smart city.

Despite all these achievements and laudable efforts to make this metropolis a model in terms of digital and economic development, no one can challenge the major difficulties facing the city. Casablanca remains a city of contrasts as summarized in the following table:

Strong points	Weak points
Area: 1 200 km² with 70 km of coastline	Density: 15.165 HBT/km² (exceeding 40,000 in certain borough)
Population: 4.2 million (12.6% of the Moroccan population)	10 million travel per day
10 Faculties, 7 large schools, more than 45 private higher schools	Education level: 34% have no instruction
Labour force: 46.4%	Unemployment rate from 15 to 24 years: 37.5%
Share of national GDP: 30%	23% of homes do not have access to drinking water
National VA share: 50%	The wastewater treatment rate is only 45%
Share of national investment: 48%	Human Development Index: 0.64
Share of productive units: 39%	The slums represent 15.8% of the dwellings
Industrial workforce: 60%	12% of the city's inhabitants live in a dwelling representing 0.6% of the total area

Fig. 2 Key figures of the city of Casablanca. Source: HCP-2014 census

As mentioned above, the city of Casablanca suffers from some social inequalities, 34% of the population has no education, 22.2% of the population is illiterate in urban areas, 15% of population is living in slums, etc.

Referring to the Zygiaris model [13], we must begin with the elementary 'city layer' where the basic functions of the city concept must be corrected such as : the fight against unsanitary housing, illiteracy, increasing unemployment of young people, the encouragement of entrepreneurship, the improvement of urban infrastructures as roads, car parks, public transport ..., and the setting up of a participative governance. The second step is to set up an intelligent infrastructure which allow the collection, processing and dissemination of information in a readable form by its citizen, and also a citizen intelligence offering them the opportunity to participate in the success of the project. Without these conditions, the Casa Smart City project may create additional inequities in the metropolis as well as another way of social exclusion of this population.

In summary, the success of the Smart City project is tantamount to involving the citizen in this process of change. Getting acceptance is also a challenge. The social acceptability of the project and the respect of privacy remain a social aspect that must be studied for the implementation of the concept because it remains an significant limit since the citizen are the heart of it.

C. The technology acceptance model

The initial model of technology acceptance (TAM) that was developed by Davis in 1986 [3] is an adaptation of both the theory of reasoned action [14] and the model of planned behaviour [15]. The TAM has undergone several revisions including those proposed by Davis and Venkatesh in 1996 [16], by Venkatesh in 2000 [17] and by Venkatesh and al. 2003[18].

The TAM provides a theoretical explanation to the behavior for new technologies adoption. Pointedly, it allows to define and predict the origin factors of the acceptance/rejection or of the use of new information technologies in various contexts. Davis [3] starts from two major questions. The first relates to the reasons why an individual could accept or reject information technology. The second concern the characteristics of the technological system and the effort that must be made by the potential user to accept the technology. Thus, the use of a system depends on two subjective perceptions: perceived usefulness and perceived ease of use.

Davis asserts that the attitude, belief, and intention to use a new technology, in this case, the computer, depends on two factors: perceived ease of use, and perceived usefulness. Davis defines perceived utility as "the degree to which a person believes that the use of a particular system could improve his performance" ([3], [14], [15], [16], [17], [18], [19], [20]). It is linked to the intensity of the belief, in terms of potential performance, that an individual may feel as a result of the use of a new technology.

The perceived using ease is defined as " the degree to which a person believes that using a particular system would be free of effort" ([3], [14], [15], [16], [17], [18], [19], [20]). Thus, an individual would easily accept new technology if the needed effort to use it is low.

The hypothesis made by Davis is that the adoption of an information system is determined by the intention of its use. This intention is itself influenced by the attitude of the individual towards the use of technology. The attitude ultimately depends on the two aforementioned beliefs: perceived usefulness and perceived ease of use. Similarly, external variables not included in the model, such as the user profile, training, design and system characteristics, documentation, etc., could influence the adoption of the technology ([3],[14], [15], [16], [17], [18], [21]).

TAM's strength in describing the adoption behavior of new technologies has been validated in various contexts and applications such as e-mail, voicemail, word processing, e-commerce, etc. ([22]; [23], [24], [25], [26], [27], [28], [29], [30], [31], [22] , [26]; [21], [17], [32], [33], [29], [34], [35]). In this context, a meta-analysis published by King and Hue 2006 [27], listing 88 empirical studies and involving more than 12,000 observations using TAM, reveals that the model is robust and has strong predictive power, regardless of the context in which it served. This result is corroborated by the meta-analysis of Yousafzai's and al. [34], [35], which covered 145 articles published about TAM between 1989 and 2004.

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This study also recognizes the originality of the TAM and its strength in predicting the use of computer systems. Similarly, in another meta-analysis by Legris and al [28], of 22 empirical studies that tested the model, the authors go in the same direction as their predecessor by demonstrating that the TAM is a robust theoretical model that can explain the Use of information technologies in different contexts.

The technology acceptance model (TAM) have known several improvements and extensions to enhance its explanatory power, including those contributed by Davis and Venkatesh in 1996 [16], by Venkatesh in 2000 [17], Venkatesh et al. 2003[18] summarized the main work of technological acceptance and developed a "unified theory of technology acceptance and use" (UTAUT). The latter was formed from a vast review of the literature, including eight models: (1) Rational Action Theory (RAT), (2) the Technology Acceptance Model (TAM), (3) model of motivation (MM) ([36], [37]), (4) planned behavior theory (PBT), (5) The model combining the TAM and the planned behavior theory (6) PC using model (MPCU) [38], (7) the theory of diffusion of innovation (DOI) [39] and (8) social cognitive theory (SCT) [40].

In their integrator model, UTAUT, Venkatesh et al. [18] reveal:

i) Three major determinants of technology usage intention: "expected performance" of a system to boost user productivity, perception of "expected effort" to apprehend the system, "social influence" refers to the amount which an individual perceives that his important close people think that he should use a system ";

ii) Two direct determinants of the use of technology: "facilitating conditions" defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of technology" and "the intention to adopt a behavior ". Beyond the direct determinants, the model puts forward the significant impact of four moderating variables: gender, age, previous experience and usage context, which can be either voluntary or obligatory.

The unified theory of acceptance and use of technology (UTAUT) is considered by Venkatech and al [18] as the best explanatory model of the individual use of an information technology. It would explain 70% of the "intent of use" variance and 50% of the variance for usage.

This model, like its predecessors, has experienced different extensions and empirical validations applied to different types of technologies in different contexts [41] and across different cultures ([42], [43], [44], [45], [46], [47]).

III. EMPIRICAL STUDY

Our study differs from the existing literature in that we scrutinize the individual decisions of adoption and use of Smartphones. We surveyed by questionnaire 1305 individuals located in the Greater Casablanca. The choice of this metropolis is motivated by the fact that the public authorities have launched a very ambitious project to make this city a "Smart city". As it was developed in the literature study, the pivotal pillar of a smart city is the "smart citizen" through its participation in the production of data and use of information provided by mobile terminals. Studying the adoption and use of smartphones by inhabitants of Casablanca will allow us to firstly evaluate their "Smart" level insofar as they are the main beneficiaries, and secondly to evaluate the success of the Casa smart city project.

It is important to note that the structure of the questionnaire enabled us to verify the quality and consistency of the collected answers. To ensure validity an coherence of collected information, the meaningful questions were asked several times in the questionnaire in different formulations. It should be also noted that the development of the questionnaire was based on a broad review of the theoretical and empirical literature.

The questionnaire is made-up of four blocks of qualitative information: "technological dependence of the respondent", "adoption of Smartphone", "use of Smartphone" and "socioeconomic variables of respondents". The materials collected are subjective responses in the form of qualitative information.

The first results show that 92% of respondents have access to Internet. Compared to other access ways, the connection to the Internet in a mobility situation remains by far the preferred means of our interviewees. The Smartphone is at the top of the connection brackets with a rate up to 71% against 33% for laptops and 11% only for fixed computers. The connection via tablet concerns only 6% of the respondents.

Also, 97% of respondents state that they have a mobile phone. 83% of them have Smartphones. The top five reasons for adopting the system by our respondents are "to remain constantly connected" with a rate of 62%, "to communicate with my friends" to 54%, "it helps me in my work" to 38%, "I love new technologies" to 36% and "to organize my life" with a rate of 20%. The imitation effect "do like the others" was mentioned by only 9% of the respondents. By contrast, the reasons of the non-adoption of Smartphones seem to be related to the two factors advanced in the literature by Davis namely "perceived utility" and "perceived ease of use". In fact, 54% of respondents reject the Smartphone because they do not see it as useful: a mobile phone is only used to make calls and send messages. Similarly, for 20%, the refusal of adoption would be linked to the complex characteristics of the technological system insofar as they consider that they do not have the cognitive necessary skills for the use of the Smartphones. It should be noted that the cost does not appear to be an important obstacle to the adoption because it was evoked by only 15% of the respondents.

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A. Presentation of the econometric model, the explanatory variables and the hypotheses to be tested

We propose to analyze the determinants of individual choices of the adoption and use of smartphones by the inhabitants of the Casablanca metropolis through an econometrics qualitative modeling [48]. This choice is justified by the fact that the variables are qualitative. We have privileged a Probit model in which it is estimated that the binary variable is the decision to "adopt" or "not to adopt" a Smartphone depending on the respondent's socio-economic profile. The objective of the model is to specify the probability of the adoption conditionally on the exogenous variables relating to the characteristics observed on the individuals of the sample.

1) The explanatory variables

We formulate the working hypothesis that the adoption and use of smartphones depend on the socio-economic conditions of individuals. Several empirical studies in the United States, Europe and Africa agree that access and use of ICTs is correlated with individual's socioeconomic factors, namely income, socio-occupational category, education, age, household composition, gender, place of residence, etc. ([49], [50], [51], [52], [53], [54], [55], [56]). Smartphone specific studies conducted in different contexts also highlight the significance of the individual's profile in adoption and use behavior ([49], [50], [51], [52], [53], [54], [55], [56],[57], [58], [59], [60], [61], [62], Park and al and. Lane and Manner [54] tested the impact of "big five" personality traits and socio-demographic characteristics on the possession and use of Smartphones. Also, logistic regression on a sample of 312 individuals revealed a significant impact of gender, age, education level and extroversion in the adoption of Smartphone. Alkhunauzan and Love [49], in an empirical study of a sample of 574 people living in Saudi Arabia, demonstrate that demographic factors, such as gender, age and level of education, have a significant statistical impact on trade acceptance Via the Smartphone (M-commerce). Pheeraphuttharangkoon [56] addresses the same problem on a sample of adults aged 50 and older using two databases, one from the Oxford Internet Institute and a second from the Office of National Statistics of 2009, 2010, 2011, 2012 and 2013. Probit models revealed the sway of socioeconomic data such as age, sex, marital status, education level, employment status and income within the use of Smartphones.

Like our predecessors, we used the same explanatory variables in our model, assuming the hypothesis that the adoption of smartphones depends on the socio-economic conditions of individuals. The variables we have used are: income, socio-professional category, educational level, age, neighborhood, gender, marital status, number of children.

In addition, we introduced two variables justifying the respondent's technological profile: the Internet connection and the possession of technological equipment (tablet, computer, laptop, Smart TV, mobile phone, e-reader, others). We thus constructed the variable "technological profile" which corresponds to the number of equipments possessed by the individual. We can thus predict that the propensity to have smartphones increases among technophiles (Leguel et al., 2004). Similarly, having an Internet connection at home or at work could have a significant positive impact on the likelihood of owning a smartphone. These people may feel the need to stay connected to the Internet constantly on their mobility.

B. The model results

Firstly, let's present the results of the Probit model, which appraises the probability of adopting the Smartphone according to the individuals socio-economic characteristics and their technological profile.

The results of the model are consistent with the literature and predictions previously formulated. The possibility of adopting a Smartphone increases with the fact of owning several IT equipment. This probability would be stronger if the degree of the individual technological dependence is high. Indeed, we find that the more the individual is technophile, the more likely he or she will have a Smartphone. Similarly, Internet ownership at home and / or work increases positively and significantly the chance of having a Smartphone. This can be explained by the desire to make use of the functionalities offered by a Smartphone, inter alia, being able to access the mobile Internet connection.

The socio-professional category has a very consequential impact on the probability of adopting Smartphones. We find that this probability is even stronger among students, managerial staff, liberal professions and company managers, non-managerial and manual workers, compared to retired or unemployed people. The rejection of this equipment by the latter categories can be explained by the cost factor which remains potentially high in Morocco. For retirees, non-adoption could be explained by perceived difficulty in use and perceived non-utility. Retirees may not find it useful to own a Smartphone or may be discouraged by the complexity of its use.

The level of studies significantly influences the likelihood of having a Smartphone. The model reveals that the higher the level of education is (two years of higher education), the stronger is the propensity to have a Smartphone. This implies that an important level of education allows to have

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qualifications and cognitive skills that promote adoption but also the use of the Smartphone.

Income seems having a significant positive impact. Individuals whose salary is between 5,000 MAD and 10,000 MAD are distinguishable from the others because they have a positive impact on the probability of adopting a Smartphone.

The number of dependent children significantly decreases the propensity to own a Smartphone. Individuals with more than one dependent child will be less likely to have a Smartphone. This negative relationship between the adoption of Smartphone and the number of dependent children can be explained by the potentially advanced age of people with lot of children. The latter, as explained above, may not be attracted by any new technology, in this case Smartphones, because of the complexity of manipulation they convey. and in other hand the decrease in the propensity to use technological products because of the number of dependent children.

Low aged people, especially between the ages of 18 and 35, are clearly distinguished from older people because we find that being young increases positively and significantly the probability of having a Smartphone. This result can be explained by a generational effect [2]: digital natives have lived with the digital revolution and are therefore naturally predisposed to consume information and communication technologies. Conversely, seniors can be completely overwhelmed by the digital and all the supports that it implies, because this requires skill and dexterity that this population does not have.

Moreover, the geographical location of the individual appears to be one of the decisive variables in access to technology. The model reveals that the propensity to adopt a smartphone is all the stronger as the person lives in a wealthy neighborhood relative to other neighborhoods. Conversely, living in a poor neighborhood significantly decreases the likelihood of having a Smartphone. An individual is therefore, ceteris paribus, less likely to have a smartphone when he lives in popular neighborhoods. This result may be related to the relatively high cost of access to this digital technology. We can also comment on this outcome by detaching from new technologies as these vulnerable people have other priorities and place more emphasis on meeting needs at the lower end of the pyramid of needs.

The remaining variables of gender and marital status did not show significant effects on the probability of Smartphone adoption. This result is interesting in itself, at least for the gender and marital status variables because it presages the non-existence of a difference in behavior between men and women as well as widowed, married, divorced or single Smartphone access.

In sum, our results reveal that the adoption of Smartphones by the inhabitants of the Casablanca metropolis, the future Smart City, is part of the technophile character and the socioeconomic profile of the individual. We find that the fringe of the most vulnerable population of the metropolis undergoes the fracture of first degree relative to access to the Smartphone. In fact, our estimates reveal that technophiles, young people, the most qualified, having a paid professional activity, who live in the bourgeois neighborhoods of the metropolis and who have few dependent children have a high probability adoption of their Smartphone. These are people who do not suffer from any form of inequality of whatever nature (social, digital, geographical, etc.). Conversely, it is technophobic, elderly, illiterate, or very poorly educated people who do not engage in professional activities, who live in working or middle-class neighborhoods and who have many dependent children, who have a low propensity to adopt smartphone.

1) The main uses of smartphones by the inhabitants of Casablanca

The importance of the adoption of Smartphones naturally gets us thinking deeply about their uses. Within a short timescale, the functionality of mobile phones has evolved from an interpersonal communication device to real multimedia equipment [63]. Intuitively, we could say that the near-generalization of technological equipment (resorption of the first degree fracture) could automatically be translated into its effective and efficient use. We therefore discuss the problem of inequalities related not only to the access to Smartphone equipment, but rather to the use that is made of it. This is what theoretical literature describes as a "fracture of use" or "second-degree fracture", which the causes depend on abilities, skills and cognitive abilities to appropriate any digital technology.

In this context, the survey results show that respondents have a rudimentary use of their Smartphones (Chart 1). We note that the main uses are Alarm clock, pictures, communication by free messages and clock, with rates reaching 83%, 82%, 73% and 65% respectively. The mobile Internet connection ranks fifth in the top uses with a rate of 65%. We also note, not surprisingly, the prevalence of the social media and interpersonal communications in the uses of Internet in a mobility situation. Thus, 64% of mobile users follow the news of their social networks and 50% manage their e-mail. Nevertheless, very few mobile users use their Smartphones for practical life applications such as E-banking (12%), public service applications (16%) or health applications (18%).

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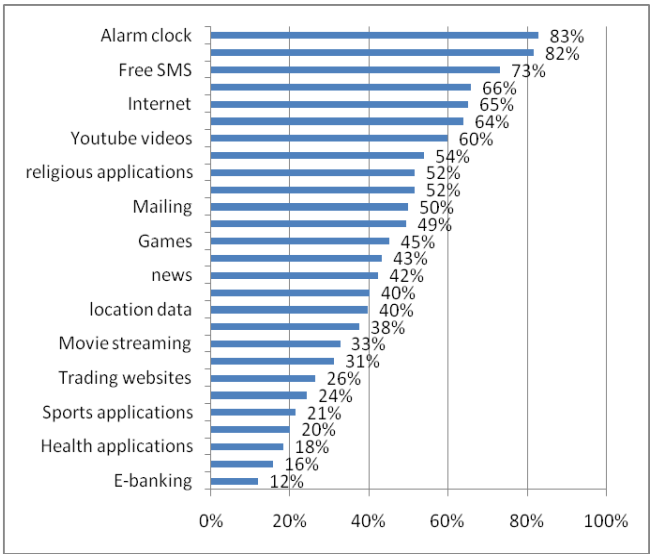

Fig. 3 Uses of smartphones

As for applications downloaded to the Smartphone (Chart 2), the re-sults corroborate our usage statistics, as once again, social networks ranked first with a rate of 83% of respondents followed with a con-siderable gap by lifestyle applications (24%), the news 12%. And fi-nally the applications for practical activities represent only 4%.

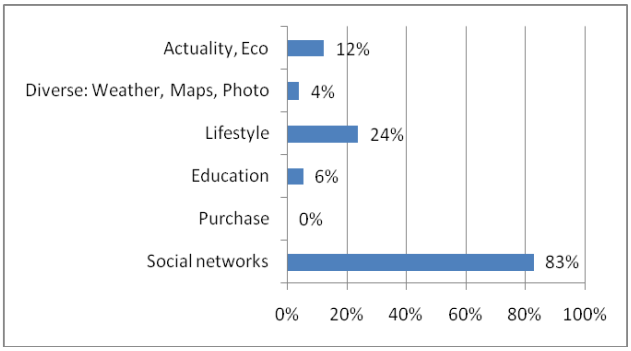

Fig. 3 Applications

We note that the uses of smartphones are dominated by the basic functions of smartphones and the social network. Other applications related to hobbies and practical activities represent only a small proportion. In order to use smart services, the citizen must have the three levels of digital skills: instrumental, structural, and strategic. In our case, the Casablancans are only at the first level linked to a basic use of digital technology, the more we interact with digital support, the more our skills are developed. This interaction requires some skills, only the educated category of the population reaches this stage.

The question of security is an obstacle to usage, this is seen through the use of banking service applications and merchant websites. Hence the need to set up an open data protection system related to the Smart City project.

The use of localization services, which stands at 40%, shows us that the Casablancans have issues in the indications and orientation in the city.

IV. Conclusion

We tried in this paper to analyse the relevance and the efficiency of the project Casablanca Smart-City through an econometric study of the adoption and the use of the Smartphone by the residents of the city of Casablanca. We then conducted a study on the main uses that adopters make of their smartphones. The underlying idea is that the main component of any intelligent city is an intelligent citizen having intellectual and cognitive faculties allowing him to generate and to treat the data from mobile terminals, in this particular case the Smartphone.

To do it, we designed and administered a questionnaire on the adoption and the use of Smartphones with 1305 individuals located in the great metropolis of Casablanca.

The estimation of the econometric model with endogenous variables adopting Smartphone according to the numerical and socioeconomic characteristics of the individuals allowed us to find interesting results.

Large gaps are found between young and old, technophile or technophobic, graduated or illiterate, working or non-working people, living in middle-class neighborhoods or poor neighborhoods, with many or few dependent children and by gender. We can see that smartphone accessibility is based on socio-economic conditions and differences in cognitive ability between individuals.

As a result, the Casablanca Smart-city project, which is supposed to improve citizens' well-being and quality of life, would benefit only those who do not suffer from any form of exclusion. On the other hand, it will accentuate the inequalities for the initially vulnerable people, because proposing a project not adapted to an individual knowing that he does not have the necessary dexterities to benefit from it, amounts to excluding it doubly.

Technology has never been neutral. It is a differentiation element between cities and between citizens. Some challenges facing the city of Casablanca can be solved by a simple technological solutions, but some others need a social innovation to support the citizen in this smart process.

The Smart City is a multidimensional concept which purpose is to provide a certain quality of life to its citizens. To build it, it must be coherent with its historical, political, social, territorial and cultural context. In case of phase shift between the sold product and the needs felt, the project remains doomed to failure.

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Assignment problem under skills and preferences constraints: A case study

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***Abstract*—In this work, we present an assignment problem of human resources, taking into account their skills and their preferences. Composite three stages (assessment of competences, modeling of assignment problem, resolution), it constitutes a system effective assignment aimed at better matching the achievements of an agent with the requirements of a task and also the satisfaction of the agents' preferences. To solve it, an exact method method was developed and tested at a central university in Tunisia.**

***Keywords*—Assignment problem, Competences, Preferences**

I. INTRODUCTION

Recognition of the important role of human resources in issues related to the conduct of different processes is justified more by a variety of research that has focused on the combined integration of skills and preferences, either to the integration of one two human characteristics (skills or preferences), allocation problems, planning or scheduling. This emancipation has engendered a change in the formulations of these problems. Moreover, a better identification of skills and a distinguished presentation of preferences constitute two conditions for more precise modeling of the constraints taking into account these resources in their workplace.

In a highly competitive environment, the company must be more flexible, responsive and innovative. Conscious of these imperatives, it grants a particular attention to the involvement of human capital as a distinctive element of performance. Indeed, the accession of human capital through the mobilization of its skills is an effective lever for achieving the objectives and improve business performance. Next to this unavoidable concern for the management of skills, business leaders find themselves placing an interest growing to meet the needs of those resources that allows for a clear improvement in the quality of their yield and therefore, induced performance.

We hope through this work to provide leaders with companies a concrete tool for decision support they would deploy to address one of the issues related to the conduct of administrative processes, such as the problem allocation of human resources while taking into account their skills and preferences.

II. LITERATURE REVIEW

In the health field, Aickelin and Dowsland [1] presented a time schedule for hospital service by assigning assignments to different nurses. To do this, the authors work to distribute evenly the unwanted vacations and to find the answer to the needs of each session in term of number of nurses to ensure a better assignment whose objective is to minimize the cost of preference which translates the usefulness of a schedule for a nurse, the lower the schedule is in terms of satisfaction of the nurse's preferences. This problem is solved by a genetic algorithm by assigning a permutation by replacing a low-grade nurse with highly qualified nurse, but not the other way around.

Thus, Mkaouar [2] presented an approach based on the combination of the advantages of the bee algorithm and the immune system for the assignment of engineers according to skills and preferences in a company in the telecommunications sector. They aimed to minimize the cost of assignment while minimizing the gap between skill levels acquired by the resources and required by the tasks and by best respecting the preferences. On the other hand differentiate between resources according to their grades, in [3][4] the authors were interested in proposing assignments based on required needs detailed in terms of competency criteria. Indeed, the study of the impact of skills and preferences on the company's performance is neglected. Thus, Wei et al. [5] presented a two-stage stochastic model for a problem of home-based assignment of health care structures. They sought to assign nurses to patients over a planning horizon while considering the skills and abilities of nurses and taking into account the randomness of the time required. The goal is to find the balance of nurses' workloads.

Peters and Zelewski [3] presented the assignment problem as a program by goals to search a best compromise between the three objectives defined in terms of skills and preferences. For that, a prior identification of some of the variables of the

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problem (degrees of importance of skills by report to each post, the skills preferences required, the preferences of candidates in relation to skills to be mobilized) by the AHP method.

Sabar [6] tackled the scheduling problem and real-time staffing. It proposed a mathematical model of the dynamic assignment problem of employees on an assembly line with the consideration of preferences, skills and inter-station employee movements. Although skills and preferences have been well defined in this work, the authors have often neglected the impact of either of these two human aspects on performance administrative. Such a lock has led us to explore the studies who have taken a separate interest in the problems appropriations and taking into account preferences.

A diversity of significant works interested mainly to resource allocation issues human resources with consideration of skills. Some consider the difference between operators as a factor having a direct impact on operational performance. Thus, as long as the under-privileged actors pass generally longer than the competent actors.

Bennour and Crestani [7] proposed an approach to quantify the impact of the individual dimensions (knowledge, know-how and know-how be) and collective (inter-business and intra-business) skills of human resources in the estimation of modulation rate of the nominal performance of different trades involved in carrying out the activities of a process. In other studies, the authors have shown that actual duration of a task can vary linearly depending on the rate of competence (Marmier [8]). Gruat et al. [9] considered the duration of a task according to productivity of the resource that will run.

Unlike the last two studies, Valls and al., [10] assumed that the execution time of a task varies by a certain percentage predefined according to the level expertise of the resource (senior, standard, junior) that is affected.

More recently, Hlaoittinun [11] and, Gonsalves and Itoh [12] proposed an approach to correct the duration of realization of a task based on a degree of similarity that allows to estimate the proximity between the required skill levels and acquired skills.

So, the execution time can be set under the form of a linear function of a corrective coefficient which can vary linearly [11] or exponentially [12] according to the degree of similarity between required and acquired levels.

III. PROPOSED APPROACH

Moreover, a better identification of skills and a distinguished presentation of preferences constitute two conditions for more precise modeling of the constraints taking into account these resources in their workplace.

We model the problem as a linear program. We applied our approach in the Central University in Tunisia for the allocation of three teachers to the four modules.

1) Identification and assessment of skills: To identify the required skills in this problem, we refer to the entity-relationship proposed by Harzallah and Vernadat [13]. The adapted topology of competence resources to the different aspects is presented in table1.

TABLE I
TYPOLOGY OF RESOURCES WITHIN THE JURISDICTION

(Harzallah and Vernadat [13])

	Category of competence		
	Regular	**Bold**	**Italic**
Resources Skills	Theoretical Knowledge (TK)	Procedural Know-How (PK - H)	Relational (R)
	Knowledge of the Existing (KE)	Empirical Know-How (EK - H)	Cognitive Capacity (CC)

According to the topology described in table 1, we determine the matrix (resources of competence * task).

TABLE 2
MATRIX (RESOURCES OF COMPETENCE * MODULE)

Cat. of competences	**Module 1 (M1)**	**Module 1 (M2)**	**Module 1 (M3)**	**Module 1 (M4)**
TK	Computer tools	Production management	Operational research	Statistics
KE	Workplace safety standards	Workplace safety standards	Workplace safety standards	Workplace safety standards
KP	Principles database management	Performance indicators	Optimization problems	Analyze of difficult problems
PK – H	Using Access, SQL	Using computer-assisted management	Using Ceplex	Using SPSS
EK – H	Creation of new work for better learning situations	Implementation of storage process	Creation of new work for better learning situations	Creation of new work for better learning situations

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R	Know how to communicate with the students	Know how to communicate with the students	Know how to communicate with the students	Know how to communicate with the students
CC	Conflict management	Conflict management	Conflict Management	Conflict Management
B	Curiosity about the student behavior	Curiosity about the student behavior	Curiosity about the student behavior	Curiosity about the student behavior

2) Mathematical model

We recall that a classic assignment problem allows to assign n individuals to m tasks (with $n > m$). For each partial assignment of individual *i* to task *j*, there is a cost. As part of this work, our goal principal is to find the best match between these two subsets with a minimum total cost, trying to minimize the gap between skills required and acquired and to satisfy the preferences of the operators.

The parameters of our model are defined as follows:

P_{ij} : Execution time of job *j* by human resource *i*

CC_{ij} : Proximity coefficient between task *j* and human resource *i*

e_i : Hourly cost of each human resource *i*

S_{ij} : Penalty cost due to dissatisfaction with human resource preference *i* for task *j*

b_{ij} : Cardinality corresponding to each linguistic variable

$CT^{\max}$: Total workload of the resource *i*

$P_{avr,j}$: Average execution time of task *j*

To model the assignment of resource *i* to task *j*, we used a binary variable x_{ij} defined as follows:

$$X_{ij} = \begin{cases} 1 \text{ If resource } i \text{ is assigned to task } j \\ 0 \text{ otherwise} \end{cases}$$

Objective function

$$\text{Min} \sum_i \sum_j e_i (2^{ref - b_{ij}} - 1) X_{ij}$$

Constraints include:

1. Each task can only be performed by a single resource

$$\sum_i X_{ij} = 1, \quad 1 \le j \le m \qquad (1)$$

2. A capacity constraint, it shows that a load of each resource does not exceed the total workload

$$\sum_i P_{ij} . X_{ij} \le CT^{\max}, \quad 1 \le i \le n \qquad (2)$$

A resource i can be assigned to a maximum of two tasks

$$\sum_i X_{ij} \le 2, \quad 1 \le i \le n \qquad (3)$$

The necessary data in this proposed model: the average execution time ($P_{avr,j}$) as well as the maximum workload ($CT^{\max}$) which corresponds to the number of hours available for each candidate, cost per working hour and preferences of each candidate. These data are summarized in the following table:

TABLE 3

THE AVERAGE EXECUTION TIME OF EACH TASK ($P_{avr,j}$), THE COST PER WORKING HOUR (e_i), THE NUMBER OF AVAILABLE HOURS AND, THE DEGREES OF PREFERENCES OF EACH CANDIDATE

	$P_{avr,j}$	**C1**	**C2**	**C3**
e_i	–	17	17	17
$CT^{\max}$	–	40	40	40
T1 (M1)	20	VH	M	L
T2(M2)	15	L	H	H
T3(M3)	20	L	M	VH
T4(M4)	20	VH	M	H

With:
"L": low preference level.
"M": average preference level.
"H": high preference level.
"VH": very high preference level.

Thus the following table shows the values of the assignment costs of the candidates for the various tasks.

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TABLE 4
COST OF ASSIGNMENT FOR EACH CANDIDATE I AND FOR EACH

TASK J

	C1	**C2**	**C3**
T1	304.81	478.38	694.28
T2	487.9	345.95	396.78
T3	648.21	393.21	365.63
T4	394.23	466.14	338.81

Using the CPLEX software, the following assignment results are obtained.

TABLE 5
OPTIMAL ALLOCATION SOLUTION

Candidates	**Task**	CC_{ij}	**Preference**
C1	T1	0.74	VH
C2	T2	O.29	H
C2	T3	0.89	M
C3	T4	0.74	H

3) Experiments result discussion

The result shows that the obtained assignment represents a good compromise between the satisfaction of the candidates' preferences and the high levels of competence

- At the competency level

All candidates are allocated to tasks with proximity coefficients greater than 0.7 only candidate C2, the latter is assigned to task T2 with a proximity coefficient less than 0.5.

It represents a deviation of 54% from the maximum proximity coefficient for carrying out this task.

This assignment can be explained by the multicriteria nature of the model which seeks to find a compromise between several objectives: minimizing the cost of assignment, minimizing the gap between required and acquired levels and satisfying preferences. The latter represents an allocation cost higher than that of the candidate C3. Minimizing the gap between required and acquired levels and satisfying preferences

- At the level of satisfaction of preferences

The tasks T1, T2 and T4 are assigned to candidates with high and very high preference levels. Only task T3 is assigned to candidate C2 having an average preference level, the latter represents an allocation cost higher than that of the candidate having the high preference level. There will be an overshoot of the maximum workload for performing this task.

- Impact of skills and preferences on the assignment cost

The following table shows the percentage of the execution cost and the penalty cost relative to the allocation cost for the optimal allocation result.

TABLE 6
PERCENTAGE OF EXECUTION COSTS AND PENALTY COST

RELATIVE TO ASSIGNMENT COSTS

		% of execution cost	**% of penalty cost**
T1	**C1**	94.4%	5.6%
T2	**C2**	85.2%	14.8%
T3	**C3**	69.7%	30.3%
T4	**C4**	85%	15%

We note that the cost of execution represents a significant percentage of the cost of allocation in relation to the cost of penalties for the different tasks. From these results, it can be concluded that the interest of respecting the candidates' preferences constitute a strategy for reducing the cost of the assignment. Thus, the impact of satisfying candidates' preferences on lowering the assignment cost is better than the impact of the best match between acquired and required competency levels.

VI. CONCLUSIONS

In this paper, we present an assignment problem integrating more realistic constraints. The generated solutions offer a good allocation of human resources according to their skills and preferences while minimizing the cost of assignment. Our approach allows an improvement in the company performance.

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A new approach for evaluation and classification of human resources according to skills and preferences

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***Abstract*—The management of human resources is one of the key points of the competitiveness of the companies. The effective use of their skills is essential to the satisfaction of the performance of the imposed targets. Thus, managers of the enterprises are given a growing interest to the satisfaction of the needs of these resources that allows an improvement of the quality of their training performance and hence an improvement of the business process performance. We seek through this article to provide the leaders of companies with a tool for decision-making in the assessment and classification of human resources according to the skills and preferences. To do this, we propose a new approach consisting of three steps. The first step is the identification and evaluation of the skills acquired by each human resource and required by each task using the 2-tuple method. Thus, the second step is about the calculation of a coefficient of proximity between the required and acquired skills using the multicriteria TOPSIS method (technical for Order by Similarity to Ideal Solution). The third step is the classification of human resources for each task using the SMART method (Simple Multi-Attribute Rating Technique).**

***Keywords*: Evaluation, Classification, Competences, Preferences, 2-tuple, TOPSIS, SMART**

I. Introduction

Developments, economic constraints and increasingly harsh global competition push companies to seek new solutions to stay efficient and maintain their position in the markets today. Indeed, search for performance requires the enterprise not only flexibility in its organization of work and better control of emerging technologies but also and above all a better consideration of human resources. Thus, several actors, industrial and scientific, agree today that the value creation and the improvement of the performance can be done without the involvement of all the actors of the company. However, several authors have stressed the importance of saving the reservoir of knowledge in the organization. According to Zarifian [1] such recognition has led to the emergence of a new model of the competence model called resource management. It is included as part of the emergence of new forms of organization and productive performance. Thus, the improvement of performance requires a good identification and estimation of the skills of human resources and a better assessment of their levels. Indeed, the best use of human resources is not in the identification of skills. Actually, it affects the need to meet the needs of the resources. Accordingly, the answer to the expectations of the resources has a positive effect on the improvement of the quality of their performance [2].

In addition, taking into account these two human characteristics (skills and preferences) is an effective way of improving the performance of business processes. The goal of the assessment and the classification of human resources is to help leaders of companies to improve performance.

II. Literature review

In literature, several methods for assessing the skill levels of human resources have been presented. The objective is common. It is the choice of the best candidate for a particular task.

Golec and Kahya [3] presented an assessment process that relies on a good identification of the deducted criteria of the strategic objectives of the organization. At the end of a discussion between the human resources expert and the manager, an assessment in the form of linguistic variables is attributed to each candidate. It reflects its level relative to all flag associated with each criterion.

After translation of the language assessments in Fuzzy numbers, the authors opt for the use of Łukasiewicz fuzzy operator to determine the level of each candidate against each criterion. Each candidate for each criterion defined levels presenting all data entry in the following inference step. Finally, after the application of the rules of inference followed by the process of defuzzing, the skill level of each employee is expressed as a numerical value.

Wi et al. [4] presented an evaluation of the skills of the employees using the keywords required by a well-specified R & D project. The proposed method starts by determining the degree of correspondence between the keywords required by the project in question and those of previous projects carried

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out by the candidates. Then, using the theory of fuzzy logic, it is possible to deduce the levels of personal knowledge (knowledge and know-how) of each employee and the degrees of familiarity among employees. Then, using the theory of fuzzy logic, it is possible to deduce the levels of personal knowledge (knowledge and know-how) of each employee and the degrees of familiarity among employees.

De Andrés et al. [5] proposed an assessment method based on the notion of "computing with words", introduced by Herrera and Martinez [6]. Evaluations of the teamwork of each candidate in linguistic form are obtained by applying the model "of 360" performance evaluation. This model allows the involvement of a set of evaluators who are in contact with the employee concerned (colleagues, employees, customers...).

As all of the obtained assessments are expressed in language values of different granularities, authors are required to unify these multi- granular linguistic information in an area of unique expression [7]. Once this is accomplished the aggregation of all of the obtained uniform assessments can be performed by the application of the model 2-tuple linguistic representation proposed by Herrera and Martinez [6]. Thus Maurice H [8] presented an evaluation approach while taking advantage of the benefits of the previous work. It is based on A good identification of the evaluation criteria surpassing cases of redundancy and ambiguity. The typology of resources of jurisdiction presented by Harzallah and Vernadatbased [9] on the analysis of different aspects considered in the studied field meets this need.

Perfect representation provided by one group of decision-makers ensuring the minimum distortion of information while targeting the objectivity. The qualitative aspect of the chosen criteria dictates the use of a linguistic approach, including the model of representation language 2-tuple to express ratings provided by policymakers. Its ability to close linguistic and digital information and escape from subjectivity by means of assessment aggregation engenders an easy manipulation of information.

III. PROPOSED APPROACH

Our approach is divided into three stages. The first step is the identification and evaluation of the skills acquired by e ach human resource and required by each task using the method 2-tuple. Thus, the second step represents the calculation of a coefficient of proximity between the acquired and required skills using the multicriteria TOPSIS method. The third step is the classification of human resources for each task using the SMART method. For the determination of the first and the second stage, we will follow the approach proposed by Maurice H, [8].

1) Identification and assessment of skills: Identification is to identify the needs of the duties in terms of the skills required by referring to the entity-relationship model proposed by outgoing and Vernadat (2002). This model offers a topology of resources of competence adapted to the different aspects. It is summarized in the following table.

TABLE I
TYPOLOGY OF RESOURCES WITHIN THE JURISDICTION (OUTGOING AND VERNADAT, 2002)

	Category of competences		
	Regular	**Bold**	**Italic**
Skills	Theoretical Knowledge (TK)	Procedural Know-How (PK - H)	Relational (R)
	Knowledge of the Existing (KE)	Empirical Know-How (EK - H)	Cognitive Capacity (CC)

Based on this topology we will fill a matrix (resources of competence * task). Thus, we applied our method for the allocation of three teachers to the four modules in the Higher School of Management of the Central University of Tunisia.

TABLE 2
MATRIX (RESOURCES OF COMPETENCE * MODULE)

Cat. Competences	**Module 1 (M1)**	**Module 1 (M2)**	**Module 1 (M3)**	**Module 1 (M4)**
TK	Computer tools	Production management	Operational research	Statistics
KE	Workplace safety standards	Workplace safety standards	Workplace safety standards	Workplace safety standards
KP	Principles of database management	Performance indicators	Optimization problems	Analyze difficult problems
PK – H	Use Access, SQL.	Use CAPM	Use Ceplex	Using SPSS
EK - H	Creation of new work for better learning situations	Implementation of storage process in workshop	Creation of new work for better learning situations	Creation of new work for better learning situations
R	Know how to communicate with students	Know how to communicate with students	Know how to communicate with students	Know how to communicate with students
CC	Conflict management	Conflict management	Conflict management	Conflict management
B	Curiosity about student behavior	Curiosity about student behavior	Curiosity about student behavior	Curiosity about student behavior

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In order to identify the tasks and the candidates, it is interesting to identify the right people to assign the most possible correct evaluations regarding the required and acquired levels. The more this person is in direct contact with the candidates or tasks, the more credible is his decision.

TABLE 3

AGGREGATE RESOURCE LEVELS OF ACQUIRED AND REQUIRED

COMPETENCIES FOR MODULE 1

Category of competences		Required	C1	C2	C3
M1	**(TK)**	(H, 0.33)	(H, 0)	(H,-0.33)	(M, 0)
	(KE)	(H, 0.33)	(H, 0)	(H,-0.33)	(M, 0)
	(KP)	(H, 0.33)	(H,-0.33)	(M, 0)	(L, 0)
	(PK-H)	(H, -0.33)	(H, 0)	(M, 0)	(H,-0.33)
	(EK-H)	(H, 0)	(M, 0)	(M, 0.33)	(M,-0.33)
	(R)	(H, 0.33)	(H,-0.33)	(M, 0)	(M,-0.33)
	(CC)	(H,-0.33)	(H, 0)	(H,-0.33)	(L, 0.33)
	(B)	(H, 0)	(H,-0.33)	(M, 0)	(M, 0.33)

TABLE 4

AGGREGATE RESOURCE LEVELS OF ACQUIRED AND REQUIRED

COMPETENCES FOR MODULE 2

Category of competences		Required	C1	C2	C3
M2	**(TK)**	(H, 0.33)	(H,-0.33)	(H,-0.33)	(M, 0)
	(KE)	(H, 0)	(H, 0)	(M, 0.33)	(M, 0.33)
	(KP)	(VH,-0.33)	(H, 0)	(M,-0.33)	(M,-0.33)
	(PK-H)	(H, 0)	(H,-0.33)	(M, 0)	(M,-0.33)
	(EK-H)	(VH, 0)	(H, 0)	(M, 0.33)	(M,-0.33)
	(R)	(H, 0)	(M, 0.33)	(M, 0.33)	(M,-0.33)
	(CC)	(H, 0.33)	(M, 0.33)	(H,-0.33)	(H,-0.33)
	(B)	(H, 0)	(H,-0.33)	(H,-0.33)	(M, 0)

TABLE 5

AGGREGATE RESOURCE LEVELS OF ACQUIRED AND REQUIRED

COMPETENCES FOR MODULE 3

Category of competences		Required	C1	C2	C3
M3	**(TK)**	(H, 0)	(H,-0.33)	(H, 0)	(M,-0.33)
	(KE)	(H, 0)	(H,-0.33)	(H, 0)	(M,-0.33)
	(KP)	(H, 0)	(M, 0.33)	(H, 0)	(M, 0.33)
	(PK-H)	(H, 0.33)	(M, 0)	(H, 0.33)	(M, 0)
	(EK-H)	(H,-0.33)	(M,-0.33)	(M, 0.33)	(M, 0)
	(R)	(H, 0.33)	(L, 0.33)	(H,-0.33)	(M,-0.33)
	(CC)	(H, 0.33)	(M,-0.33)	(H, 0.33)	(L, 0.33)
	(B)	(H,-0.33)	(M,-0.33)	(M, 0.33)	(M,-0.33)

TABLE 6

AGGREGATE RESOURCE LEVELS OF ACQUIRED AND REQUIRED

COMPETENCES FOR MODULE 4

Category of competences		Required	C1	C2	C3
M4	**(TK)**	(H,0)	(M,-0.33)	(M, 0)	(H, 0)
	(KE)	(H,-0.33)	(M,-0.33)	(H,-0.33)	(H, 0)
	(KP)	(VH,-0.33)	(M,0)	(M, 0)	(H, 0)
	(PK-H)	(H,0)	(M,-0.33)	(M, 0.33)	(H,-0.33)
	(EK-H)	(H,-0.33)	(M,-0.33)	(M, 0.33)	(M, 0.33)
	(R)	(H, 0)	(M, 0.33)	(M, 0.33)	(M, 0.33)
	(CC)	(M, 0.33)	(M,0)	(M,-0.33)	(M, 0)
	(B)	(H, 0.33)	(M,-0.33)	(H, 0.33)	(VH,-0.33)

2) Determination of the coefficient of proximity between acquired and required skills:

- Determination of anti-ideals and ideal solutions for each module

Using TOPSIS method and the results of the evaluations, the aim of this step is to determine for each resource jurisdiction the bad reviews as an anti-ideal solution and the good reviews as an ideal solution among all assessments.

The following tables represent the ideal and anti-ideal solutions for each module.

TABLE 7

IDEAL AND ANTI-IDEAL SOLUTION FOR MODULE 1

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		Ideal solution (Xj^+)	**Anti-ideal solution** (Xj^-)
M 1	*(TK)*	(H,0.33)	(M,0)
	(KE)	(H,0.33)	(M,0)
	(KP)	(H,0.33)	(L, 0)
	(PK - H)	(H,-0.33)	(M,0)
	(EK - H)	(H,0)	(M,-0.33)
	(R)	(H,0.33)	(M,-0.33)
	(CC)	(H,-0.33)	(L,0.33)
	(B)	(H,0)	(M,0.33)

TABLE 8

IDEAL AND ANTI-IDEAL SOLUTION FOR MODULE 2

		Ideal solution (Xj^+)	**Anti-ideal solution** (Xj^-)
M 2	*(TK)*	(H,0.33)	(M,0)
	(KE)	(H,0)	(M,0)
	(KP)	(VH,-0.33)	(L, 0)
	(PK - H)	(H,0)	(M,0)
	(EK - H)	(VH,0)	(M,-0.33)
	(R)	(H,0)	(M,-0.33)
	(CC)	(H,0.33)	(L,0.33)
	(B)	(H,0.33)	(M,0.33)

TABLE 9

IDEAL AND ANTI-IDEAL SOLUTION FOR MODULE 3

		Ideal solution (Xj^+)	**Anti-ideal solution** (Xj^-)
M 3	*(TK)*	(H,0)	(M,-0.33)
	(KE)	(H,0)	(M,-0.33)
	(KP)	(H,0)	(M,0.33)
	(PK - H)	(H,0.33)	(M,0)
	(EK - H)	(H,-0.33)	(M,-0.33)
	(R)	(H,0.33)	(L,0.33)
	(CC)	(H,0.33)	(L,0.33)
	(B)	(H,-0.33)	(M,-0.33)

TABLE 10

IDEAL AND ANTI-IDEAL SOLUTION FOR MODULE 4

		Ideal solution (Xj^+)	**Anti-ideal solution** (Xj^-)
M 4	*(TK)*	(H,0)	(M,-0.33)
	(KE)	(H,0)	(M,-0.33)
	(KP)	(VH,-0.33)	(M, 0)
	(PK - H)	(H,0)	(M,-0.33)
	(EK - H)	(H,-0.33)	(M,-0.33)
	(R)	(H,0)	(M,0.33)
	(CC)	(M,0.33)	(M,-0.33)
	(B)	(VH,-0.33)	(M,-0.33)

- Calculation of the distance between different levels and ideal and anti-ideal solutions

After you have determined the aggregated levels acquired and required as well as the ideal and anti-ideal solutions and the degrees of importance, it is interesting to calculate the Euclidean distances between the different levels and ideal and anti-ideals solutions using the following formulas

-Euclidean distance between the different levels and ideal solutions

$$d_{ij}^{+} = \left(\sum_{r=1}^{8} \frac{wrj[\Delta^{-1}(Ca_{ij}, \propto_{ij}) - \Delta^{-1}(xrj^{+})]^2}{\sum_{r=1}^{8} wrj} \right)^{\frac{1}{2}} \forall = \{1, 2, 3\} \text{ i and } j = \{1, 2, 3, 4\}$$

-Euclidean distance between the different levels and anti-ideal solutions

$$d_{ij}^{-} = \left(\sum_{r=1}^{8} \frac{wrj[\Delta^{-1}(Ca_{ij}, \propto_{ij}) - \Delta^{-1}(xrj^{-})]^2}{\sum_{r=1}^{8} wrj} \right)^{1/2} \forall \text{ i} = \{1, 2, 3\} \text{ and } \{1, 2, 3, 4\} = \text{A j}$$

With:

$\Delta^{-1}(Ca_{ij}, \propto_{ij})$: The aggregate level acquired by the candidate i for task j.

xrj^{+} : The ideal level of the resource for the task j r.

xrj^{-} : The level of anti - ideal for task j r resource.

wrj : The weight of importance of the resource for the task j

The following table represents the Euclidean distances of each candidate against each module

TABLE 11

DISTANCES EUCLIDEAN BETWEEN DIFFERENT LEVELS AND IDEAL AND ANTI-IDEAL SOLUTIONS

		d_{ij}^{+}	$d_{ij}^{-}(Xj^{-})$
M1	C1	0.40	1.15
	C2	0.88	0.64
	C3	1.44	0.22
M2	C1	0.61	1.05
	C2	1.17	0.50
	C3	1.55	0.11
M3	C1	1.20	0.51
	C2	0.29	1.26
	C3	1.34	0.16
M4	C1	1.33	0.74
	C2	0.85	0.78
	C3	0.39	1.14

- Determination of the coefficient of proximity between the skills acquired and required

Relying on TOPSIS technique and the results found in the preceding table, it is interesting to calculate the close coefficient according to the following formula:

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$$CC_{ij} = \frac{d_{ij}^{-}}{d_{ij}^{+} + d_{ij}^{-}} \quad ; \; i = \{1, 2, 3\} \text{ and } j = \{1, 2, 3, 4\}$$

TABLE 12
COEFFICIENT OF PROXIMITY FOR EACH I AND FOR EACH TASK j

CC_{ij}	**C1**	**C2**	**C3**
T1 (M1)	0.74	0.42	0.13
T2 (M2)	0.63	0.29	0.06
T3 (M3)	0.29	0.81	0.10
T4 (M4)	0.35	0.47	0.74

3) Classification of candidates

In the light of the information available, it is possible to get a ranking of candidates for each task and then select the best. We propose a method based on the principle of the SMART methodology where alternatives are classified according to two criteria, the proximity between the competence acquired and required, and the degree of preference for each task.

Step 1: Put the criteria according to the descending order of importance.

Several research studies have indicated that the satisfaction of the needs of the resources for the execution of the tasks leads to improve their yields, and is better than the correct match between the skills acquired and required. Accordingly, we have considered the criterion of preference is more important than the criterion of proximity in our case.

Step 2: Determine the weight of each criterion. A value of 60 is attributed to the criterion of preference and a value of 40 is attributed to the criterion of proximity.

Step 3: Normalize the coefficients of importance.

Preference (C1) = $\frac{60}{60+40}$ = 60%, close = $\frac{60}{60+40}$ = 40%

Step 4: Assessment of the actions on each attribute (uj (have)) for the Task1

The following table represents the degrees of the preferences of the resources for each task

TABLE 13
DEGREES OF PREFERENCES

	C1	**C2**	**C3**
T1 (M1)	**VH**	**M**	**L**
T2 (M2)	**L**	**H**	**H**
T3 (M3)	**VH**	**M**	**L**
T4 (M4)	**VH**	**M**	**H**

With:
'L': preferably low level.
"M": preferably average level.
'H': preferably high level.
"VH": very high level of preference.

For levels of preferences, a value of 0.2 has been given to 'low', the value 0.5 was granted medium, to 0.7 to 'high' and 0.9 to 'very high '.

Rating of candidates for the Task 1:

The following table represents the coefficients of the proximity between the skills acquired and required, degrees of preferences, as well as the values that represent the degrees of the preferences of the different candidates for the Task1

Table 14
COEFFICIENTS OF PROXIMITIES AND DEGREES OF PREFERENCES FOR THE TASK1

	Proximity	**Preference**
Candidate C1	0.74	'VH' 0.9
Candidate C2	0.42	« M » 0.5
Candidate C3	0.13	« L » 0.2

For proximity:
Max = 0.74, Min = 0.13

U1 (IC) = 10. $\frac{(0.74 - \text{Proximity})}{(0.74 - 0.13)}$ %

U1 (C1) = 100. (0.74 - 0.74) / (0.74 - 0.13) = 0%
U1 (C2) = 100. (0.74-0.42)/(0.74-0.13) = 52.4%
U1 (C3) = 100. (0.74-0.13) /(0.74-0.13) = 100%
For preference

U2 (C1) = 0 PERCENT, U2 (C2) = 57.1, U2 (C3) = 100%
Step 5: determination of the values of the actions

TABLE 15
DETERMINATION OF THE VALUES OF THE ACTIONS

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	Competence	Preference	U (Ci)
Weight	0.4	0.6	----
C1	0	0	0
C2	52.4	57.1	55.2
C3	100	100	100

Step 6: Classification of the candidates.

Based on the previous table of values of actions, you get the following classification: C3 > C2 > C1

The same approach of ranking of candidates is followed for different tasks. The following table represents the result of the ranking of candidates for different tasks.

Table 16
RANKING RESULTS

Task	Ranking
Task1 (M1)	C3 > C2 > C1
Task 2 (M2)	C1 > C3 > C2
Task3 (M3)	C3 > C2 > C1
Job4 (M4)	C2 > C1 > C3

IV. CONCLUSIONS

This work has allowed us to make contributions in several organization processes, including the assessment of skills and human resources preferences for the fulfilment of the tasks. Indeed, we have proposed a method of decision-making for the management of this process based on skills and human resources preferences. The goal is to help leaders of companies to achieve the objectives of improved performance by respecting the skills and preferences. In this context, our method includes three steps. The first step represents the estimation of the levels of competence acquired by human resources and required by the various tasks through the implementation of the language model 2-tuple. This model allows giving an objective and effective assessment and closing linguistic and digital information.
The assessment is based on a good identification of the components of competence using linguistic values without numerical values that may lead to a loss of information.

In this way, we get the linguistic levels for each component of competence, but these results do not allow determining the best human resource for each task. We used the multi-criteria TOPSIS method to determine the coefficient of proximity between the competence acquired by the human resource and competence required for each task.

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