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The place of Green IT within organisations: Devoteam Green IT Survey

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Abstract— Today, it is a strategic function, becoming green it reduces the impact on the environment. In the face of obstacles and in spite of the extreme speed of technological development, we need to think of the progress. This article revisits the place of the green computing within organizations, the role of the Green IT, provides a definition and the perimeters of the Green IT, through a study carried out by the Group Devoteam.

Keywords— Green IT, informatique verte, développement durable.

1. Introduction :

Les technologies de l'information et de la communication (TIC) représentent aujourd'hui 2% des émissions de gaz à effet de serre dans le monde, soit autant que l'industrie aéronautique mondiale. En Suisse, l'énergie consommée pour internet est supérieure à celle que produit la centrale nucléaire de Mühleberg, soit environ 7,8% de la consommation d'électricité globale. A l'échelle d'une entreprise, le coût énergétique représente jusqu'à 40% du budget informatique global. Les déchets produits par le secteur atteindront 75

millions de tonnes en 2014, dont 70% resteront enfouis dans des décharges. Parmi les matières premières utilisées se trouve quantité de métaux précieux, de terres rares et de minerais dont les gisements connus seront épuisés d'ici 2 à 30 ans. Malgré son importance, cette problématique est méconnue. Pourtant le Green IT « informatique verte » est une solution pour permettre aux entreprises de réduire leur impact environnemental et social dans le domaine des TIC.

Après une définition du Green IT, nous allons présenter les périmètres du Green IT. En suite nous illustrons les périmètres du Green IT par une enquête effectuée par le Groupe Devoteam, et enfin une conclusion.

2. Définition Green IT

Le green IT ou green computing, a pour objectif de réduire l'empreinte carbone générée par les Systèmes d'Information des entreprises tout en leur permettant de réaliser des économies.

Plus précisément, le green-IT, selon la définition du Journal officiel de la République Française du 12

juillet 2009, les éco-techniques de l'information et de la communication, en abrégé éco-TIC, sont des techniques de l'information et de la communication dont la conception ou l'emploi permettent de réduire les effets négatifs de l'activité humaine sur l'environnement.

Actuellement nous parlons de **green IT 2.0** ou encore de **l'IT for green** Selon certaines définitions, le green IT traditionnel ou green IT 1.0 consiste à abaisser les émissions de Gaz à Effet de Serre en réduisant l'empreinte carbone des Systèmes d'Information ou de l'informatique en général. C'est en substance ce qui est expliqué plus haut dans les axes du green IT.

Dans cette approche, le green IT 2.0 ou "IT for green" consiste à réduire les GES de l'ensemble de l'organisation par l'emploi des nouvelles technologies informatiques comme la téléconférence ou la télé-présence et à revoir les processus métiers dans le même but. C'est ce que nous proposons dans ce que nous nommons les attitudes écoresponsables.

Pour nous, il n'y a pas de débat : le green IT est un projet global et l'un ne peut pas aller sans l'autre. Grâce au green audit, c'est de façon simple et progressive qu'une entreprise ou une organisation passera du green IT 1.0 au green IT 2.0 car ceci s'inscrit dans une démarche plus large qui est celle du développement durable.

3. Les périmètres du Green IT :

Frédéric Bordage fondateur du GreenIT.fr définit trois périmètres au « Green IT ». Ces trois périmètres correspondent aux différents impacts des TIC sur l'activité d'une entreprise.

Le premier périmètre, ou Green IT 1.0, ou Green for IT, est défini comme « *une démarche d'amélioration continue qui vise à réduire l'empreinte écologique, économique et sociale des TIC* ». Ce périmètre induit donc une nécessaire prise de conscience de l'impact environnemental des TIC. On peut prendre comme point de départ le chiffre des 2% du cabinet Gartner : les TIC ayant un impact environnemental certain (qui ne se limite pas aux émissions de GES), il est nécessaire d'agir sur cet impact, en réduisant l'empreinte écologique du système d'information de l'entreprise par exemple. Un exemple concret pourrait être le choix par une entreprise d'acquérir un parc informatique peu gourmand en énergie.

Le second périmètre, ou Green IT 2.0, ou IT for Green, est défini par Frédéric Bordage comme « *une démarche d'amélioration continue qui vise à réduire l'empreinte économique, écologique et sociale d'un produit ou d'un service, grâce aux TIC.* » Ici, on ne cherche pas à diminuer l'impact écologique des TIC mais à utiliser les TIC pour réduire l'empreinte d'autres secteurs. Cela peut se faire par deux moyens :

- Par une éco-innovation de rupture, c'est-à-dire le fait de s'appuyer sur les TIC pour

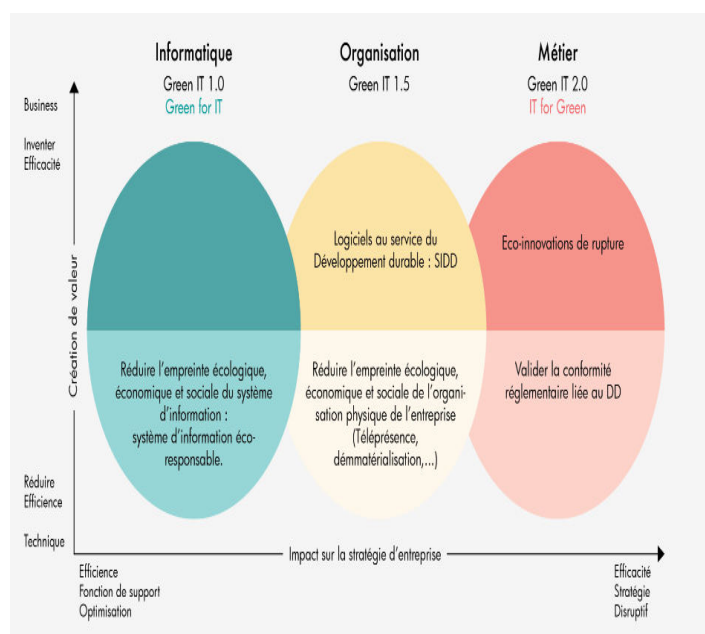
changer un modèle économique et/ou comportemental. L'économie collaborative est un exemple de Green IT 2.0, ou IT for Green, puisqu'on utilise les TIC pour passer d'une économie de produit à une économie de service, par le covoiturage ou le *cloud computing* par exemple.

- Par la « gestion par exception », qui consiste à mesurer finalement un processus grâce à des capteurs électroniques puis à analyser les données pour prendre des décisions. Le *smart grid*, c'est-à-dire la gestion intelligente de la consommation énergétique, est un exemple de démarche IT for Green.

être directement négatif pour l'environnement, en ce que les TIC consomment de l'énergie, sont constituées de ressources épuisables et produisent des déchets matériels dangereux pour l'environnement. Mais cet impact peut être réduit notamment grâce à l'écoconception et une utilisation rationnée des TIC. L'impact des TIC peut également être positif, en ce que les TIC peuvent être mises au service d'une organisation pour en améliorer la performance Développement Durable, ou à l'échelle d'un secteur en modifiant le modèle économique, de production et de consommation vers des modèles plus soutenables pour l'environnement.

4. Le green IT ou IT for green (Enquête de Devoteam) :

Devoteam est une société internationale de conseil, de services du numérique, créée en 1995 spécialisée dans le conseil en IT, sécurité, cloud computing et big data. Elle est cotée en bourse au depuis 1999. Le groupe travaille avec tous les secteurs de l'économie privée (industrie et services) et publique (services publics). Devoteam a réalisé un chiffre d'affaires de 443 M€ en 2014 et compte actuellement 4500 collaborateurs dans 24 pays d'Europe, d'Afrique du Nord et du Moyen-Orient. Parmi les enquêtes faites par ce groupe il y a une étude qui s'intitule : *Devoteam Green IT Survey Which technologies for sustainable development?* Cette enquête présente la place du Green IT dans les organisations et nous offre un baromètre de la



Les trois périmètres du green IT

Ces différents périmètres montrent la complexité de l'impact écologique des TIC. Cet impact peut

prise de conscience des acteurs. Selon cette étude nous pourrions résumer les deux périmètres du *Green IT* comme suit: ***Green for IT: how to reduce the impact of IT on the environment, or IT for Green: how IT can contribute to sustainable development.***

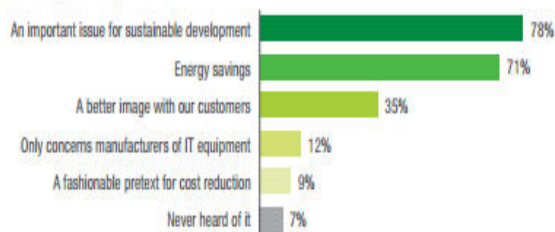
Le Green IT est la réduction de l'impact du numérique sur l'environnement, tandis que le IT for Green est la contribution du numérique au développement durable. Mais il faut voir que les différents acteurs de notre controverse n'abordent pas tous conjointement ces deux périmètres. Les démarches engagées par les acteurs rendent compte de leur positionnement par rapport à cette distinction cruciale entre Green IT et IT for Green.

4.1. Positionnement des acteurs

Le rapport Devoteam sur la place du Green IT dans les organisations a été mené auprès de 250 organisations dans le monde. Ce rapport montre que le Green IT est considéré de plus en plus sérieusement par les entreprises, qui sont chaque année plus nombreuses à engager des politiques Green IT. Mais sous ce chiffre, il est important de distinguer quelles démarches sont engagées (Green IT ou IT for Green) et pour quels motifs.

Green IT: a subject taken more and more seriously

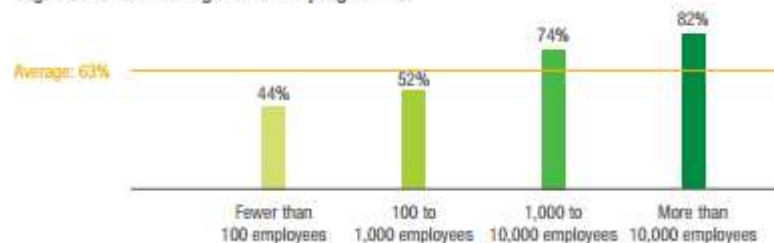
Green IT, as perceived by the respondents



La perception des répondants sur la green IT

Toujours d'après ce rapport, 71% des entreprises engagent une démarche Green IT avant tout pour réaliser des économies d'énergie. L'argument financier est donc le premier levier d'implication des entreprises.

Organisations initiating a Green IT programme

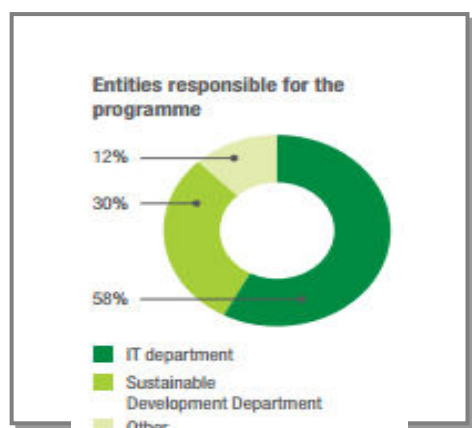


Organisations initiant un programme de Green IT

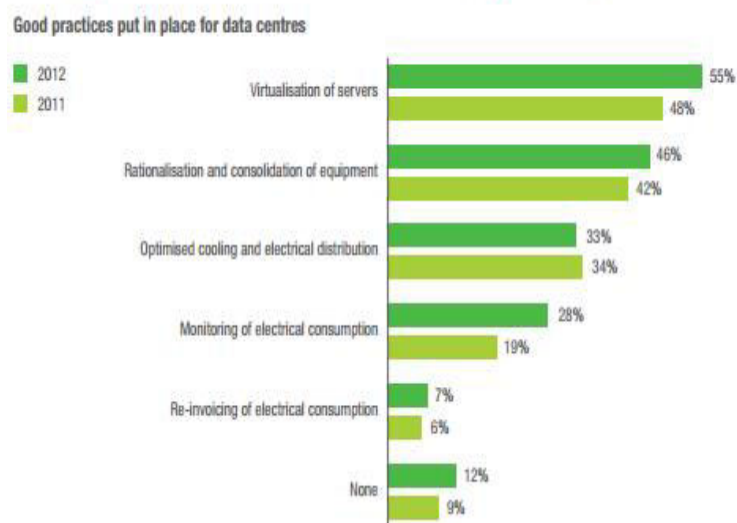
Ainsi, ce sont majoritairement les grands groupes qui engagent ce type de démarche, car ce sont les acteurs qui ont le plus de bénéfices à tirer d'une meilleure efficacité énergétique ou d'une meilleure gestion de leur parc informatique. En comparaison, les PME sont très peu nombreuses à engager ce genre de démarches, qui peuvent être coûteuses et chronophages.

4.2. Le choix des démarches va se faire selon différents paramètres

Le premier paramètre est la nature du service qui prend en charge le Green IT. Dans 60% des cas, les initiatives Green IT sont portées par les DSI (Directions des Systèmes d'Information). Dans ces cas-là, l'attention est surtout portée aux effets directs des TIC sur l'environnement, et ce sont donc principalement des démarches Green IT qui sont initiées, dont les principales sont la virtualisation des data center, puis la rationalisation et la consolidation des équipements, qui assurent un fort retour sur investissement financier, et enfin l'optimisation du refroidissement et de la distribution électrique ou le monitoring de la consommation. La principale préoccupation à l'origine de ces actions est donc l'économie d'énergie, et donc une préoccupation d'ordre économique. Or ce sont souvent les services généraux qui gèrent les factures électriques, notamment des data centers des organisations.



A step forward towards better energy management



Bonnes pratiques mises en place par les datacenters

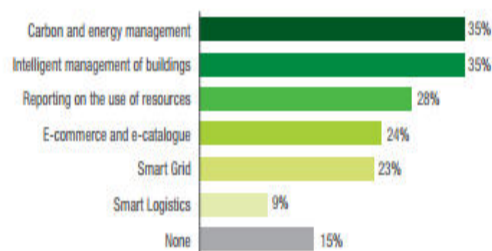
Devoteam indique qu'il est pourtant « capital d'intégrer le coût de l'énergie au prix des services informatiques afin de faire de leur réduction un objectif partagé au sein de l'entreprise. » En effet, l'optimisation de la consommation électrique est rendue complexe par la difficulté que ce n'est pas le même service qui paie cette facture et qui mène les projets pour la réduire. Dans d'autres entreprises, les initiatives Green IT viennent du service Développement Durable. Ce fut le cas chez Orange, comme en témoigne Denis Guibard, ancien Directeur du Développement Durable chez Orange. Mais l'enjeu de communication est alors très fort, car d'après Denis Guibard, le département Développement Durable se veut être un «acteur de transformation, un empêchement de faire le business comme d'habitude : il doit donc arriver à

démontrer qu'il est dans l'intérêt de l'entreprise d'agir différemment.»

Le second paramètre à prendre en compte est la nature même de l'organisation. Selon l'activité de l'entreprise, l'accent sera mis sur le Green IT ou sur l'IT for Green. Dans le cas d'Orange, de par la nature même des activités de l'entreprise, à savoir les télécommunications, le département Développement Durable a été créé pour réduire l'empreinte écologique d'Orange et donc des réseaux de télécommunications. La démarche était donc naturellement une démarche Green IT pour rendre plus écologiques les TIC de l'entreprise.

Environmental reporting and the smart building are the main applications of technology in sustainable development

Solutions adopted by companies



Solutions déployés par les entreprises

Le rapport Devoteam indique ainsi que les démarches IT for Green des groupes interrogés se concentrent principalement autour du reporting environnemental et du smart building. Ces démarches semblent plus limitées que les démarches Green IT, volet plus largement considéré par les entreprises. La contribution des nouvelles technologies au développement d'une

activité durable et responsable est pourtant potentiellement bien plus impactante : le rapport « Green IT – France 2020 » par le Boston Consulting Group indique en effet que l'utilisation des TIC pour les autres secteurs pourraient permettre des réductions d'émissions de GES équivalentes à 7% des émissions totales de la France à horizon 2020. Malgré ce potentiel de gain supérieur aux impacts de l'informatique elle-même, on voit que les entreprises se focalisent majoritairement sur des démarches Green IT, probablement du fait d'un enjeu communicationnel fort.

En effet, il est plus facile d'expliquer au public qu'une entreprise a réduit l'impact de ses activités en économisant de l'énergie ou en s'alimentant grâce aux énergies renouvelables que d'expliquer comment la mise en place de logiciels de gestion du carbone, de l'énergie et des ressources a permis de limiter l'impact environnemental. Ainsi en 2014, la société SAP s'est engagée à alimenter 100% de ses *data centers* en énergies renouvelables. Mais l'éditeur a finalement opté pour l'achat de crédits carbone compensant les émissions de ses *data centers* plutôt qu'un réel investissement dans les énergies renouvelables. Cette action témoigne d'un enjeu de communication : l'entreprise souhaite valoriser son image auprès du public, mais son action Green est finalement indirecte et uniquement financière. D'autres facteurs vont orienter l'action d'une organisation vers le Green IT ou l'IT for Green, qui peuvent être externes (contraintes

réglementaires, nouvelles lois ou concurrence) et internes (volonté du top management, maturité de l'entreprise et du secteur).

5. Conclusion

Pour conclure, les démarches en faveur d'une réduction de l'impact écologique des TIC peuvent se distinguer en deux axes : le Green IT, ou la diminution de l'impact des outils numériques, et le IT for Green, ou l'utilisation du numérique pour réduire l'impact d'autres activités. Si les enjeux économiques et financiers sont souvent les premiers moteurs de l'action, on s'aperçoit que l'enjeu d'image est aussi important pour les organisations. En effet, celles-ci semblent privilégier des démarches Green IT et donc réduire l'impact de leurs systèmes d'information, alors que les chiffres montrent que le potentiel des TIC à réduire l'impact des autres activités dépasse largement leur propre impact (2% des émissions de GES contre 7%, à l'échelle mondiale).

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Early Internationalization Behaviour Dynamics: What Role Does the Entrepreneur's Personal Resources Play? (Case of Tunisia)

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Abstract— This paper aims to understand the dynamics of the internationalization behaviour of young firms by focusing on the role of the entrepreneur's personal resources. To achieve this objective and based on a relevant literature review on international entrepreneurship, a set of hypotheses has been developed and tested in the context of young Tunisian manufacturing SMEs involved in export activities. The results revealed that the entrepreneur's personal resources in terms of international vision, prior international experiences, social networks, international competencies and academic training, have a positive influence both on the international startup and on the speed of internationalization of young companies. In addition, the results showed that the speed of international expansion is linked with the internationalization behavior at the start-up so that proactive internationalization is associated with a rapid cadence of internationalization, and reactive internationalization is associated with a slow cadence of internationalization.

Keywords— International entrepreneurship, Dynamic behaviour, international start-up, Speed of internationalization, Young companies.

I. INTRODUCTION

As a new observable phenomenon, rapid and early Internationalization enterprises have aroused the interest of academics and practitioners since the beginning of the 90s ([43]). Indeed, the emergence of this increasing and significant proportion of companies that, very early in their existence, are rapidly developing internationally has been synonymous with the emergence of International Entrepreneurship ([41], [43], [48]-[49]) as a new academic field of study which positions as the intersecting area of business strategy, international management and entrepreneurship.

For years, work on the internationalization of companies has been significantly influenced by the "Process Model of Internationalization (PMI)" [29]. Reference [29] has developed an internationalization model that emphasizes the importance of progressiveness in firms' international expansion. This incremental development is mainly aimed at reducing or controlling the uncertainty specific to foreign markets. Indeed, for small and medium-sized companies with limited resources, progressive internationalization privileges

prudence and risk minimization in the selection and access to foreign markets. As a result, internationalization follows a step-by-step process that begins with the entry of SMEs into foreign markets with a short psychological distance. This gradual expansion is regarded as the key to the successful internationalization of SMEs ([29]-[30]).

However, during the 1990s, the business environment has changed, notably with an improvement in the flow of information from foreign markets, a reduction in transport and communication costs and a more widely disseminated experience of firms' internationalization ([2]). This evolution of environmental conditions in the world has led to the emergence of a significant number of young companies that are internationalizing around the world as from their inception, with the ability to develop more quickly abroad. All these changes in the international environment of firms have rendered the basic assumptions of the step-by-step models invalid and created the need to formalize an alternative model of internationalization.

Therefore, other more recent theoretical approaches to the internationalization of SMEs have defended the existence of non-progressive internationalization. In particular, it is the "International New Venture (INV)" model of [49] that emphasizes a more rapid internationalization process undertaken by young companies.

The confrontation between the "PMI" approach and the "INV" approach leads us to consider that several choices of internationalization coexist within SMEs. More specifically, it emerges from this confrontation that SMEs have the opportunity to develop internationally by favoring either a gradual approach or an accelerated, non-progressive and early approach. To better understand these two approaches and their determinants, it is necessary to introduce factors that are related to the temporality of the internationalization of SMEs. As recommended by [33], incorporating time as a major conceptual dimension is essential to understanding entrepreneurial internationalization. Placed in the context of the confrontation between the "PMI" model and the "INV" approach, age and the speed of internationalization appear to be the most differentiating factors.

In view of the above developments, the main objective of this paper is to identify the reasons that can lead SMEs to a rapid internationalization mode as described in the INV model and not to a step-by-step approach, as assumed in the PMI. More specifically, our research focuses on the internal determinants that influence the dynamics of the internationalization behavior of young companies. To respond to this, it is strongly suggested that the dynamics of internationalization behavior is considerably influenced by the resource and skills-based approach. Indeed, resources and skills of entrepreneur play a central role both in the upstream and downstream stages of the internationalization decision. Upstream, they act as internal antecedents of the company, acting either as motivating factors or as factors hindering the decision to internationalize. Downstream of the decision to internationalize, these resources and skills can also operate as barriers or stimuli, this time influencing the speed of internationalization.

For research purposes, this work is based on the definition of internationalization cited by [13]. Indeed, internationalization is the process by which firms both increase their awareness of the direct and indirect influence of international transactions on their future, and establish and conduct transactions with other countries. This definition conceptualizes internationalization as a dynamic and evolving process. It also offers a holistic interpretation of the concept of internationalization by including different forms of foreign relations. In this context, internationalization has two main forms: on the one hand, an inward form consisting essentially of importations and different cooperation strategies with foreign firms on the local market, and on the other hand, an outward form bringing the company outside its local market through various ways: exportations, investments, subsidiaries, etc., etc. In this work, we use the outward form of internationalization, more particularly the export form.

The remainder of this article is organized as follows: In Section II, we examine the literature to develop a set of hypotheses that focus on the role of the entrepreneur's personal resources in the dynamics of the internationalization behaviour of young firms. Section III describes the research methodology by describing data collection and operationalization of variables. Section IV presents the results of the empirical analyses. In Section V, we conclude our work with a discussion of the findings and a presentation of some limitations and future research perspectives.

II. LITERATURE REVIEW AND HYPOTHESES

By rushing into the international arena, these new international companies, that did not have abundant resources, have not developed in stages and are challenging traditional theories of the internationalization process. This challenge was strongly reflected in the proposal of [49] in terms of "INV" theory in response to "Process Model of Internationalization (PMI)" advanced by [29].

A. International Entrepreneurship as a Dynamic Behavior

Reference [49] is pioneers in providing a specific theoretical framework for companies with rapid and early internationalization. They introduced the theory of International New Ventures (INV) which is commonly used in the literature on international entrepreneurship. The proposed definition is as follows: "*A business organization that, from inception, seeks to derive significant competitive advantage from the use of resources and the sale of outputs in multiple countries*" ([49]). It is a clear and precise definition, which underlines the strategic aspect of internationalization and shows that it is possible to be international both through the use of resources (material, human, financial, technological, etc.) and through the commercialization of products in several countries. Reference [47] proposed another definition to the INVs. They are "*firms that make observable foreign commitments (e. g., sales efforts, investments) within a conventionally accepted short period after formation*" ([47] p.92). They specify that this short period can be considered as less than 6 years by convention.

To better understand the behavioral dynamics of young international companies, we proceed to a simple confrontation with process models of internationalization (PMI), given that the two theories, PMI and INV, represent very different internationalization principles. In particular, the description of the start and speed of the development of international activities is not the same for very young and international companies and companies that are internationalizing according to the PMI model.

1) *Early international start-up*: From the inception phase, the theory of rapid and early internationalization is fundamentally different from the theory of step-by-step internationalization. The first difference found in the literature concerns the time between the company's formation and its internationalization. Although the literature review revealed disparities in the age limit below which a company can be considered as rapidly and early internationalized, most researchers in international entrepreneurship agree that INV are internationalizing much more quickly than traditional companies and often very early after their creation ([48], [49], [3], [36]- [40]). Indeed, from the INV perspective, the development of international activities is proactively achieved by seeking international opportunities for development and growth.

However, the step-by-step approach of internationalization describes an incremental process by which companies are being internationalized slowly and progressively. The fundamental assumption of this approach is that companies only start internationalization when they have obtained a solid knowledge base in their domestic market, i.e. at an advanced age. They tend to avoid uncertainty and thus delay the start of the internationalization process ([53]).

In addition, the number of countries targeted by new international companies at the start of the internationalization process differs from those that follow the step-by-step model. By definition, firms that adopt the INV model are engaged, from the beginning of their formation, in a much larger

number of countries than firms that adopt the PMI model ([49], [40]).

Another specificity of the internationalization behaviour of young companies resides in their cultural diversity when selecting the countries they penetrate. Thus, in contrast to companies following the step-by-step models, whose markets are chosen according to their psychological distance from the local market, INVs target countries that are very distant psychologically from the start-up phase. In these companies, the choice of markets is based on international opportunities and their development potential, and is not influenced by the psychological distance as assumed by the PMI model.

Therefore, while the step-by-step models recognize that psychological distance plays a very important role in the firm's internationalization process, for INV the concept of psychological distance from foreign markets loses its relevance. INV have thus a more extensive cultural and geographical diversity than firms following the step-by-step models. INV also have a combination of distinct strategies that enable them to succeed, building on intangible resources ([35]). Aware of their resource constraints, they emphasize hybrid governance structures, including alliances as a means of entry ([49]).

2) *The speed of internationalization:* The internationalization process can be described in a temporal sequence in which internationalization movements are occurring ([33]). The temporality of internationalization is defined in terms of the speed, regularity and history of firms' entry into the various foreign markets. In order to take into account this temporality of internationalization, it is therefore necessary to analyze the speed of international development over time ([33]).

In this regard, [48], in their model of the forces influencing the speed of internationalization, define the speed of internationalization through dimensions related to initial entry into the foreign market, the speed of penetration of targeted countries and the speed of engagement. They suggested that the internationalization of INVs is associated with a rapid speed of internationalization.

In the context of the confrontation between the step-by-step model and the INV approach, the speed of internationalization appears to be a differentiating factor. Compared to traditional companies whose speed of the internationalization process depends on the path dependency phenomenon, INVs do not follow a predetermined sequential progression for international expansion and development and they proceed more quickly with their international engagement. Thus, the phenomenon of path dependency is undermined in the case of INVs.

As a result, for the PMI model, engagement decisions are very slow because there is a need to integrate the knowledge generated by market experience with the company's experience. There is therefore a sequential progression of the internationalization process allowing SMEs to slowly move towards foreign markets. On the other hand, for INVs, rather than following a slow speed of internationalization resulting from a long learning process as described in the step-by-step

model, they tend to build their own strategy of rapid internationalization by engaging in foreign markets more quickly in the early phases of international expansion, and this by leveraging different resources and knowledge, thus providing competitive advantages, indispensable in accelerating the speed of internationalization.

B. Impact of the Entrepreneur's Personal Resources on Internationalization Behavior

The literature review on international entrepreneurship emphasizes that the entrepreneur's personal resources are one of the major determinants influencing the internationalization behavior of SMEs ([18], [28], [32], [45], [46]-[55]). First, many researchers agree that the international vision of leaders is important in conducting the rapid and early internationalization of start-ups. Reference [56] shows that one of the main characteristics of the entrepreneur of a young international company is his global vision, through which he will seek opportunities beyond national borders. This vision is characterized by an international orientation from the very inception of the company and by a proactive attitude of the manager towards risk taking when building relationships abroad [32]. Moreover, the fact that the company is very strongly oriented internationally allows the entrepreneur to depend not only on his domestic market and thus to avoid the phenomenon of "path-dependency" in relation to the domestic market. The international vision of the entrepreneur then appears as the preferred starting point for several researchers in international entrepreneurship to analyze the phenomenon of early and rapid internationalization. It is therefore due to his personality, his motivations turned towards the international and his awareness of cultural diversity that the entrepreneur will build an international vision and an upstream reflection for internationalization. This vision, which is partly supported by the positive attitude and professional experience of the entrepreneur, also promotes rapid and proactive internationalization to psychologically distant countries ([1], [28], [47], [48], 49, [55]). We can therefore formulate the first hypothesis as follows:

H1. The international vision of the entrepreneur affects the dynamics of internationalization behavior of young companies.

H1a. The international vision of the entrepreneur affects the internationalization behavior at international startup.

H1b. The international vision of the entrepreneur affects the speed of internationalization.

The past international experience of the entrepreneur is another central individual variable in explaining the development of young companies in foreign markets. In order to situate its impact on internationalization behavior, several authors have examined this relationship ([4], [41], [42], [48], [9], [10], [49], [12], [53], [60], [56]-[11]). Indeed, entrepreneurs can succeed in a rapid and early internationalization process of their young company through their past international experiences. Based on their experience, entrepreneurs will have a higher degree of

knowledge that will lead companies to start internationalizing from the very beginning. Previous experience is a factor that reduces uncertainty because of a good knowledge of the foreign market and the risk factors that can hinder the company's development [38]. The entrepreneur is then able to perceive and exploit opportunities in foreign markets that others do not perceive. Reference [4] showed that new companies run by managers with experience abroad were able to internationalize their businesses more quickly and successfully. For [20], companies whose management teams already have international experience can avoid some intermediate steps. Reference [10] stipulate that companies with managers who have received training in foreign countries are significantly more likely to become international than those whose managers have trained only in their own country. In addition, [54] argue that the higher the level of entrepreneurial experience, the more important it is to overcome the constraints of the "foreignness" factor and consequently ensure better international results for the company. Similarly, [42] added that international work experience and experience in the same industry increases the emergence of young international companies. Similarly, [60] and [39] reveals that the entrepreneur's prior experience, particularly internationally, promotes the early internationalization of start-ups. References [11], [18] and [25] also show the importance of the company's pre-existing knowledge, crystallized by the entrepreneur's past international experience, among other things, in the internationalization process. The field of research on international entrepreneurship clearly shows that the entrepreneur's experience, which can be seen as the sum of the knowledge accumulated and learning over the years, represents the foundation on which the orientations of the new company are based ([50], [51]). Their past international experience allows them to develop the international contacts necessary for the start-up and international development of the young company. Their past international experience enables to develop the international contacts necessary for the start-up and international development of the young company. We can therefore develop the second hypothesis as follows:

H2. The past international experience of the entrepreneur affects the dynamics of internationalization behavior of young companies.

H2a. The past international experience of entrepreneur affects the internationalization behavior at international startup.

H2b. The past international experience of entrepreneur affects the speed of internationalization.

The network theory is also mobilized to understand the rapid and early internationalization of young companies ([43]). Several contributions suggest specific roles that social networks can play in the internationalization process ([5], [7], [23], [26], [49], [13], [34], [37], [44], [56]). Indeed, social networks play an informational role by providing reliable information, which makes it possible to promote rapid learning and lead to more informed decision-making. By

integrating into these social networks, entrepreneurs obtain free information, necessary for identifying opportunities, building the vision and reducing market uncertainty and ambiguity ([16], [37]). Social networks also have a moderating effect and are a trigger for the process of international expansion resulting from the information made available and the sharing of experiences ([43], [48]). Finally, networks have a leverage effect on both tangible and intangible resources of the SME ([16], [58]) by promoting their development, which makes it possible to influence the start and speed of internationalization. In order to gain intangible resources such as customer credibility or trust in new markets with new products, entrepreneurs use networks. This attention given by the literature to the entrepreneur's social networks shows that they are very crucial in the early stages of internationalization where the company does not yet have a solid foundation in new markets. They can overcome psychological distance and increase the speed of penetration of foreign markets ([44], [49]). Based on the developments above, we then present this hypothesis:

H3. The social networks of the entrepreneur affect the dynamics of internationalization behavior of young companies.

H3a. The social networks of entrepreneur affect the internationalization behavior at international startup.

H3b. The social networks of entrepreneur affect the speed of internationalization.

To explain the dynamics of the rapid internationalization of start-ups, various studies suggest that entrepreneurs need to develop various knowledge and competencies to orient their companies internationally ([18], [27], [55]). These competencies can be described as strategic or fundamental in the sense of [6]. They are specific to the firm and difficult to imitate, thus constituting one of the key determinants of competitive advantage. In addition to the traditional skills available to local entrepreneurs, managers of young international companies have specific skills and capacities related to international development. According to [56], these entrepreneurs have unique skills that allow them to perceive and identify opportunities that others do not see. Reference [45] argues that human capital influences internationalization in SMEs. Indeed, entrepreneurial leaders who adopt international strategies are more often able to master multiple languages, manage risks, adapt to change and show tolerance towards other cultures by internationalizing to psychologically distant countries. Networking skills are also a resource for entrepreneurs who want to orient their business internationally. Thus, the studies of [15] and [32] show that the ability of managers to establish contacts was an explanation of their firm's propensity to internationalize. Consequently, the entrepreneur's distinctive competence must be examined in relation to his ability to integrate into and enrich networks ([34], ([44])). Dynamic networking skills combined with entrepreneurial opportunity seeking behaviour then reduce the risk associated with decisions to enter foreign markets. Reference [35] also demonstrates the advantage of international marketing skills in the development of rapidly

and early internationalizing companies. In this regard, we will test the following hypotheses:

H4. The international competencies of the entrepreneur affect the dynamics of internationalization behavior of young companies.

H4a. The international competencies of entrepreneur affect the internationalization behavior at international startup.

H4b. The international competencies of entrepreneur affect the speed of internationalization.

The training of the entrepreneur is also mentioned in the literature as one of the reasons for the early and rapid internationalization of young companies. There is a positive relationship between entrepreneur training and positive attitudes towards rapid and proactive international expansion. The trained owner-manager is more likely to pursue an internationalization strategy than the less trained one, as training is generally associated with more entrepreneurial behaviour. Reference [18] shows the importance of entrepreneurial education as a dimension of the human capital needed for the internationalization of SMEs. We then assume that:

H5. The academic training of the entrepreneur affects the dynamics of internationalization behavior of young companies.

H5a. The academic training of entrepreneur affects the internationalization behavior at international startup.

H5b. The academic training of entrepreneur affects the speed of internationalization.

It appears from the above that research conducted in the field of international entrepreneurship agrees that the dynamic resources of the entrepreneur are real factors influencing the internationalization of young companies. Based on this observation, it was concluded that the international vision, previous international experiences, social networks, international competencies and academic training of entrepreneur are key factors in differentiating between companies with rapid and early internationalization and companies that follow a gradual process of internationalization as assumed in the PMI model.

In this paper, we also try to test the hypothesis relating to the relationship between the behavior at the international start-up and the speed of internationalization. To develop this last hypothesis, we refer to the internationalization theories "INV" and "PMI". The literature on internationalization from an entrepreneurial perspective shows that companies with rapid and early internationalization are characterized by an early orientation, even from the beginning, to internationalization and by rapid growth. This is validated with regard to the evidence from the review of research in the field of international entrepreneurship. Alternatively, the literature on internationalization according to a traditional and procedural perspective suggests that SMEs respond reactively to international opportunities by starting the internationalization process late after gaining experience in the local market. These step-by-step models are the result of a very long learning process and a highly valued perception of

psychological distance (geographical and cultural). Supporters of this procedural perspective corroborate the late and reactive internationalization of the firm at a slow speed to increase international engagement, due to the absolute and determined progressiveness of the internationalization process. In this article, we wish to extend the scope of these findings and make the following synthesis hypothesis:

H6: The speed of the company's internationalization differs according to the behavior at the international startup. In other words, proactive internationalization is associated with a rapid cadence of internationalization, and internationalization with reactive behavior is associated with a slow cadence of internationalization.

In order to highlight the articulation between the variables of our research, Figure 1 illustrates our conceptual model.

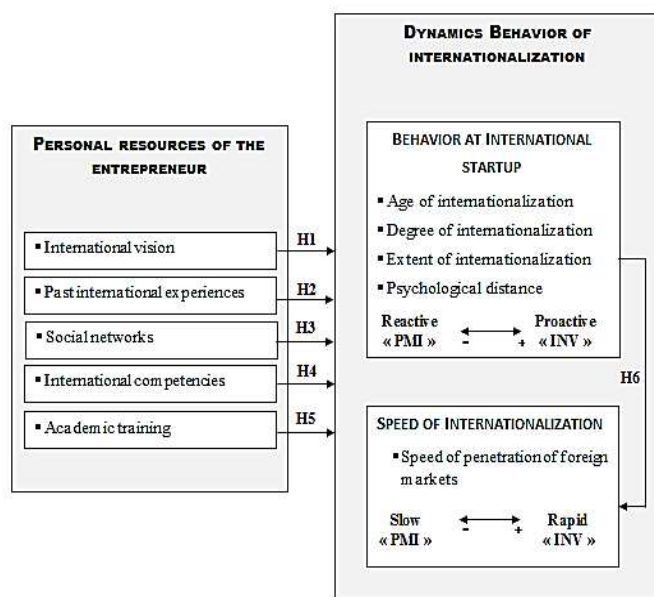


Fig 1. Conceptual Model

The theoretical framework used to develop the conceptual model is the resources and competencies approach, and more particularly the dynamic resources stream. According to our model, dynamic internationalization behaviour appears to be the result of a combination of different resources and skills. According to the dynamic resources approach, the presence of certain personal resources of the entrepreneur explains the behavioral difference and international commitment of companies, by proactively internationalizing from the outset as postulated by the INV approach or reactively in steps as described by the PMI model.

III. RESEARCH METHODOLOGY

A. Sample and Data Collection

The most appropriate methodology to answer the research question and statistically verify our hypotheses is a quantitative method. To obtain a homogeneous sample, we paid attention to several criteria. First of all, we chose as a study unit a young Tunisian company totally or partially

exporting, commercializing directly or indirectly finished or semi-finished products. It is agreed that the manufacturing sector is the most relevant and appropriate for this research, given that the industrial sector is the most dynamic sector in terms of exports in Tunisia. We also limited our analysis to companies with fewer than 200 employees. This choice avoids comparing SMEs with large companies. In addition, to analyze the evolution of international activity and thus judge the speed of penetration of foreign markets, it will be more relevant to consider a minimum period of three years for an international presence. Finally, and due to the reluctance of some executives and managers, our final sample includes 56 companies, 20 of which are totally exporting and 36 partially exporting. These companies are distributed over the different industrial sectors in Tunisia (Food, mechanical and metallurgical, Building materials, ceramics and glass, electronic, chemistry, leather and shoes and various industries).

The measuring instrument for this research is the questionnaire. We chose the face-to-face questionnaire as the administration method to optimize the return rate. In terms of questionnaire architecture, we were careful to formulate the questions unambiguously so that they were easily understood by respondents. Different scales of measurements were used. Thus, nominal or categorical scales, ordinal scales and Likert-type nominal scales were the most commonly used in the questionnaire. The following sections describe in detail the operationalization of the different search variables.

B. Operationalization of Dependent Variables

To measure internationalization behavior, we use in this paper a dynamic perspective by including temporal variables. To reflect this dynamic, we then propose two dependent variables: the internationalization behavior at the international starting and the internationalization speed.

1) *Internationalization Behavior at Startup*: Concerning the first dependent variable related to internationalization behavior at the international startup, we use a multidimensional approach and base the analysis on several relevant criteria found in the literature. Thus, the measurement of internationalization behavior is carried out through four dimensions: the age of internationalization, the degree of internationalization, the extent of internationalization and the perception of psychological distance.

- The age of internationalization is defined in the literature as the time interval between the inception of the company and the initiation of international operations ([48], [53], [57]). We therefore measure this dimension by the number of years elapsed between the inception of the company and the first international operation.
- The degree of internationalization indicates the extent of international sales in relation to the company's sales ([57]). It is also the share of international sales in relation to total sales ([48]). For the purposes of this

research, we therefore used the percentage of export sales divided by the company's total sales in the first year of export as a measure of the degree of internationalization at the international startup.

- The extent of internationalization refers to the number of countries in which the company operates ([48], [57]). For our work, the international extent of the company is then measured from the number of targeted countries.
- Psychological distance is defined as all factors influencing the flow of information between the firm and foreign markets. These factors may include language differences, cultural or business practice differences, or the level of industrial development between the destination country and origin country ([29], [30], [31]). For the purposes of this research, and in the absence of a scale measuring psychological distance in the literature, we opt for an ordinal measurement scale with 5 points ranging from (1) "Countries very similar psychologically" to (5) "Countries very distant psychologically".

2) *The Speed of Internationalization*: The second dependent variable concerns the speed of internationalization. We opt for a one-dimensional measure and consider it by the speed of penetration of foreign target countries ([48]). Specifically, we measure the speed of internationalization by the ratio: total number of countries penetrated since the first international operation divided by the number of years since the company's first international expansion. The higher the ratio, the higher the speed of internationalization.

C. Operationalization of Independent Variables

The independent variables refer to the entrepreneur's personal resources in terms of international vision, past international experiences, social networks, international competencies and academic training.

1) *Strategic Vision*: The strategic vision was identified through the following three dimensions:

- Strong intention to develop business abroad and to be a truly international firm;
- Strategic approach to long-term internationalization
- Planning of activities abroad and pursuit of clear objectives abroad mobilized by an internationalization project from the inception.

These dimensions are identified according to the perception of the leaders, using a 5-point Likert-type scale ranging from 1 "Strongly Disagree" to 5 "Strongly Agree".

2) *Past International Experiences*: According to the literature review, entrepreneurs can gain international experience in two ways: first, by residing abroad for educational or professional reasons; and second, by working for an international company. Two main sources of experience are therefore defined in the study, namely a generic experience and a specific experience. To these two dimensions, which constitute points of consensus in the

literature, we considered it relevant to add the diversity of entrepreneurs' experiences as a determinant of internationalization. We have therefore retained these three dimensions in order to characterize the entrepreneur's international experiences at the time of the international start-up. Each component is measured as follows:

- Generic international experience is represented by the number of months spent abroad by the entrepreneur. This consists of summing up all travels abroad for business and/or personal reasons. This dimension was measured with a 5-point ordinal scale ranging from (1) "less than three months" to (5) "more than 12 months".
- Specific international experience is measured by the number of years of professional experience related to international activities. This dimension was measured with a five-point ordinal scale ranging from (1) "no international professional experience" to (5) "more than 6 years".
- The diversity of experiences is measured in the survey using a 5-point ordinal scale ranging from (1) "very limited" to (5) "very extensive".

3) *Social Networks*: The entrepreneur's social networks were measured through four characteristics identified from the literature review ([17], [48]), referring respectively to the size, duration, strength and density and variety of the network.

- The size of the social network: it is indicated by the number of actors activating in the network. This dimension was measured with a five-point scale ranging from (1) "fewer" to (5) "very many".
- The duration of the relationship: it is indicated by the length of the relationship of the actors and the time spent together. This dimension was measured with a five-point scale ranging from (1) "less sustainable" to (5) "very sustainable".
- The strength of the relationship: it is indicated by the frequency of contacts between the actors, intimacy, trust and mutual services. This variable was measured with a five-point scale ranging from (1) "Very low" to (5) "Very high".
- Density and variety: it is indicated by the diversity of the connections that are the channels of circulation between the actors. This dimension was measured with a five-point scale ranging from (1) "Very Low" to (5) "Very High".

4) *International Skills*: International skills were measured through a set of skills provided in the international entrepreneurship literature that refer to language skills; ability to take risks; ability to tolerate psychological distance; ability to set international goals; ability to establish a network and to negotiate; and international marketing skills. A 5-point ordinal scale, ranging from (1) "Minimum Required Skills" to (5) "Excellent Skills", is used to measure each of these skills.

5) *Academic Training*: The academic training of the entrepreneur reflects the level of education achieved. Indeed,

the last year of studies obtained by the entrepreneur determines the level of education. As a result, a 5-point scale has been designed to operationalize this explicative variable, ranging from (1) "primary or secondary study" to (5) "master's or doctoral degree at university".

IV. RESULTS

To analyze the dynamics of the internationalization behavior of young companies, we use different statistical techniques. First, we carried out a Principal Component Analysis and a Reliability Analysis of the measurement scales. Then, we proceeded to a Discriminant Analysis to verify hypotheses about the impact of the entrepreneur's personal resources on the dynamics of internationalization behavior. Finally, we carried out a Chi-Square Analysis to test the last hypothesis.

A. Results of Principal Component Analysis and Reliability

For all multi-item variables, we first performed principal component analyses with "Varimax" rotation and using the Kaiser-Meyer-Olkin (KMO) criterion and the *Bartlett Sphericity Test*. Then, we performed a reliability analysis based on the *Cronbach alpha* study (α). In sum, we present the results obtained in Table I. This table shows that the results of the factor analyses for all variables are all acceptable with respect to the significance of the *KMO* and *Bartlett sphericity* indices and the significance of the variances explained. In addition, the reliability of the measurement scales has been validated by the Cronbach alpha indices, which range from 0,879 to 0,944.

TABLE I
 FACTORIAL ANALYSIS AND RELIABILITY

Variables Analyzed	Extracted factors	KMO Indices	Total Var. Exp.	Cronbach's Alpha
Behavior of internationalization at startup (4items)	[BEHAV]	0.701 (0,000)*	74.60	0.879
International Vision (3items)	[VISION]	0.692 (0,000)*	85.479	0.915
Past International Experiences (3items)	[EXPER]	0,729 (0,000)*	83.370	0.895
Social Networks (4items)	[NETW]	0,807 (0,000)*	85.862	0.944
International Competences (6items)	[COMP]	0.878 (0,000)*	70.886	0.910

* *Bartlett sphericity test (Sig)*

B. Results of the Discriminant Analysis and Hypotheses Verification

The purpose of discriminant analysis is to study the relationships between a qualitative variable and a set of quantitative explanatory variables. Discriminant analysis examines data from groups that are known a priori. As a result, we first divided the companies in the sample into two

groups according to their internationalization behaviour at the international startup to study the first sub-hypotheses (H1a/H2a/H3a/H4a/H5a), and according to their speed of internationalization to study the second sub-hypotheses (H1b/H2b/H3b/H4b/H5b).

In the first instance and according to the "BEHAV" factor, which reflects the four dimensions (Age, degree, extent and psychological distance), two groups of companies were identified: proactive internationalization versus reactive internationalization. This is the first dependent variable related to the internationalization behavior at startup.

In a second step and depending on the speed of penetration of foreign markets, we highlighted two groups of companies: companies with a rapid internationalization speed and companies with a slow internationalization speed. This binary variable is our second variable to explain.

The results of the discriminant analysis associated with these two dependent variables are presented in the Table II.

TABLE II
 TEST OF EQUALITY OF GROUP MEANS

	Behaviour at International Start-up			Speed of Internationalization		
	Wilks' Lambda	F	Sig.	Wilks' Lambda	F	Sig.
International vision	0.396	82.499	0.000	0.394	83.080	0.000
International past experiences	0.417	75.582	0.000	0.418	75.182	0.000
Social networks	0.472	60.342	0.000	0.422	73.964	0.000
International competencies	0.540	45.940	0.000	0.337	106.051	0.000
Academic Training	0.813	12.387	0.001	0.919	4.743	0.034

The analyses of the tests of equality of group means verify the existence of significant differences between the two groups of companies. In the table II, the Wilks' Lambda coefficient corresponds to the proportion of variance not explained by group affiliation. The smaller the Wilks's Lambda, the more important the independent variable to the discriminant function.

The tests of equality of group means indicate that the international vision variable has the most significant influence on behavior at the international startup. Indeed, Wilks' lambda is equal to 0.396, moreover the F test confirms that this international vision is the most discriminating (F = 82.499; p = 0.000). In addition, the results indicate that this variable significantly influences the speed of penetration of foreign markets. The Wilks lambda is equal to 0.394, and the F test is significant (F = 83.080; p = 0.000) when it is about the speed of internationalization as a dependent variable. These results justify the works of [32], [49], [55] and [56] which demonstrate that the leader's vision and perception of the international environment is one of the decisive factors for adopting a rapid and early international development approach. We can therefore confirm our first hypothesis (H1)

which stipulates that the entrepreneur's vision towards the international affects positively the dynamics of the internationalization behaviour of the young company.

The empirical results visualized in the table II also show that the entrepreneur's international experience determines the behavioral nature of the company's internationalization. Indeed, the statistics of Fisher (F = 75.582, p = 0.000) and Wilks' Lambda (0.417) largely validate that experience is a determining factor in internationalization behavior at the startup. The results show also that the entrepreneur's experience influences the speed of the company's internationalization. Indeed, the statistics of Fisher (F = 75.182, p = 0.000) and Wilks' Lambda (0.418) allow us to verify the significance of the variable in question. These results are in line with various studies that have shown that new companies with managers having experience abroad were able to internationalize their businesses more quickly and with more active behavior than those whose managers lack previous knowledge and experience and who are rather reactively engaged abroad ([4], [9], [25], [39], [47], [48]-[56]). It follows from this that the second hypothesis group (H2a and H2b) is validated.

We also postulated that entrepreneur's social networks influence the way SMEs internationalize. The results of the tests for equality of group means show that a relatively low Wilks' Lambda value of 0.472 and a relatively high F value of 60.342 with a p = 0.000. These analyses indicate that the social network variable influences the internationalization behavior of SMEs when they start up internationally. In this sense, the more social networks managers and entrepreneurs have, the more proactively foreign markets will be approached. Concerning the speed of internationalization, analyses show that social networks significantly influence the speed of market penetration (Wilks' Lambda = 0.422 and F = 73.964 with a p= 0.000). These results are in line with social capital theory and the network approach to internationalization ([5], [13], [16], [17], [42]-[44]) and reflect the fact that entrepreneurs' relational resources play a decisive role in the internationalization of SMEs. All these findings allow us to confirm the third hypothesis (H3).

In addition, statistical tests very significantly conclude that the international competencies possessed by entrepreneurs influence both the internationalization behavior at the startup and the speed of internationalization. These results are in line with the literature review ([16], [28]- [55]) which states that the international skills of the management team determine the model of internationalization behaviour so that companies lead by managers with skills in international business are more active and faster to act internationally than managers without such skills. These results make it possible to accept the fourth hypothesis (H4) so that international skills positively affect the early and rapid internationalization of young companies.

Finally, the results show that entrepreneur academic training seems to have an influence on the internationalization behavior at the startup of young companies (Wilks' Lambda =0.813 and F = 12.387; p = 0.001) and also on the

internationalization speed in terms of Wilks' Lambda value (0.919) and the Fisher test ($F = 4.743$; $p = 0.034$). These results are in line with the conclusion of [18] showing that entrepreneur training is a key dimension of human capital and determinant of dynamics of internationalization behavior both in terms of proactivity at the start and in terms of the speed of the internationalization after the start. These results support the fifth hypothesis (H5).

In this paper, we also choose to present the relevance of predictive variables related to the entrepreneur's personal resources in the analysis of the dynamics of young companies' internationalization behavior. The Tables III and IV present respectively the quality of the classification according to startup behavior and the speed of internationalization.

TABLE III
 CLASSIFICATION RESULTS ^(a)

Internationalization behavior at start-up		Predicted Group Membership		Total
		Reactive	Proactive	
Original	Count	Reactive 27	Proactive 3	30
	%	Reactive 90.0	Proactive 10.0	100.0
		Reactive 3.8	Proactive 96.2	100.0

a. 92.9% of original grouped cases correctly classified

TABLE IV
 CLASSIFICATION RESULTS ^(a)

Internationalization Speed		Predicted Group Membership		Total
		Slow	Rapid	
Original	Count	Slow 33	Rapid 0	33
	%	Slow 100.0	Rapid 0.0	100.0
		Slow 8.7	Rapid 91.3	100.0

a. 91.3% of original grouped cases correctly classified

Regarding international startup behavior as a differentiating variable between the two groups, the classification results shows that 92.9% of companies are correctly classified. The rate of incorrect rankings is very low (7.1%). More specifically, 27 companies in the "reactive behavior" group were well reclassified with a percentage of 90% (27/30) and three cases were misclassified, with a percentage of misclassified as 10% (3/30). Similarly, for the group of companies with proactive internationalization, only one company was incorrectly classified (3.8%) and 25 well classified (96.2%).

With respect to the speed of internationalization as a differentiation variable, the analysis of the classification results in Table IV shows that, overall, 96.4% of companies are correctly classified. This percentage is the sum of the elements of the table diagonal divided by the sample size $(33 + 21) / 56$. The rate of incorrect rankings is very low at around 3.6% (2/56). More specifically, the companies in the "Slow speed of internationalization" group have been 100% well reclassified. No case in this group has been

misclassified. With regard to the group of companies with "Rapid internationalization speed" only two cases were misclassified with a percentage of 8.7%. The rest of the group's companies, i.e. the 21 entities, were well ranked. The percentage of well classified is in the order of (91.3%).

In summary, the results of the tests of equality of means and the results of the classification verification clearly show the validity of the discriminant analysis. Therefore, the importance of the variables introduced into the analysis that succeeded in establishing perfect discrimination between groups.

Turning now to the examination of the relationship between internationalization behavior and internationalization speed. To analyze this relationship, we use a cross tabulation analysis and a Chi-Square analysis. Crosstabulation is a basic technique for examining the relationship between two categorical variables. Concerning our study and according to the Crosstabulation (Table V), 93.9% of companies with reactive behaviour are in favor of a slow speed of internationalization. At the same time, 80.8% of companies with proactive startup behavior are in favor of a rapid speed of internationalization in terms of penetration of foreign countries.

We push again the analysis by performing a Chi-Square Test of Independence to be able to verify our last hypothesis. It should be recalled that the Chi-square test is used to determine if there is a significant relationship between two categorical variables. It can also be said that this test verifies the independence hypothesis of these variables. To perform this test, two assumptions must be advanced:

- The null hypothesis: The null hypothesis assumes that there is no association between the two variables. In our case, there is no link between internationalization behavior at startup and internationalization speed.
- The alternative hypothesis: The alternative hypothesis assumes that there is an association between the two variables. In our case, it shows that "internationalization behavior at startup" and "internationalization speed" are dependent.

Based on Table VI, we observe that the Chi-square statistic had a value of 31.601. In order to determine whether this evidence is sufficient to reject the independence hypothesis, the expected distribution is observed, which is given at the bottom of the table. Since this value is lower (10.68), we can then reject the null hypothesis at the 0.05 level and deduce that the variables are related. Thus, the behavior of young companies in international startup and the speed of internationalization are dependent and linked. We can therefore affirm that there are significant differences between companies with proactive startup behavior and those with reactive behavior with regard to the speed of internationalization. More specifically, proactive internationalization is associated with a rapid cadence of internationalization, and internationalization with reactive behavior at startup is associated with a slow cadence of internationalization. All this enables us to validate our last hypothesis (H6).

TABLE V
 INTERNATIONALIZATION BEHAVIOR AT START-UP * INTERNATIONALIZATION SPEED CROSSTABULATION

		Internationalisation Speed		Total	
		Slow speed	Rapid speed		
Internationalization behavior at start-up	Reactive	Count	28	2	30
		% within Internationalization Behavior at Start-up	93.3%	6.7%	100.0%
	Proactive	Count	5	21	26
		% within Internationalization Behavior at Start-up	19.2%	80.8%	100.0%
Total		Count	33	23	56

TABLE VI
 CHI-SQUARE TESTS

	Value	ddl	Asymptotic Significance (2-sided)	Exact Significance (1-sided)	Signification exacte (unilatérale)
Pearson Chi-Square	31.601 ^a	1	.000	.000	.000
Continuity Correction ^b	28.614	1	.000		
Likelihood Ratio	35.685	1	.000		
Fisher's Exact Test					
Linear-by-Linear Association	31.037	1	.000		
N. of Valid Cases	56				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 10.68

b. Computed only for a 2x2 table

V. DISCUSSION AND CONCLUSION

The objective of this paper is to focus on the role of the entrepreneur's personal resources in the dynamics of the internationalization behavior of young Tunisian manufacturing companies. Our proposal was to explain the internationalization behavior of young companies through the mobilization of the resource and competency-based approach. This choice is supported by the arguments arguing that the resources and skills possessed by the young company are likely to reduce the obstacles related to its small size and its beginner nature, which prevent it from an entrepreneurial internationalization. In this perspective, our research aims to enrich existing work by focusing on the behavioral dynamics of young companies during internationalization. As a result, we have incorporated temporal variables to assess internationalization behavior. By the results that it presents, our study shows the importance of the entrepreneur's personal resources in the early start-up and the rapid speed of international expansion. More specifically:

To engage proactively internationally, it appears that the entrepreneur-manager needs an international orientation to identify and exploit market opportunities. Thus, the entrepreneur, as the main actor in the decision to internationalize, must have a clear vision with a favorable attitude towards internationalization in order to be able to orient his activities internationally. In addition, it has been concluded that past experience abroad is a very important prerequisite for rapid and early internationalization. Entrepreneurs who were then involved in international

business before they started their own companies adopt a proactive and entrepreneurial internationalization behavior by targeting several geographically and culturally distant countries in the first year of inception. The entrepreneur's social networks are also critical in explaining the dynamics of the internationalization behaviour of Tunisian companies. In fact, available relational capital is an important catalyst for early internationalization decisions and an important accelerator of subsequent engagement speed, notwithstanding psychological distance. Moreover, the behaviour of rapid and early internationalization is largely dependent on the skills and dynamic capacities of entrepreneurs. Indeed, these skills refer to the ability to take risks, the ability to define international objectives, the ability to tolerate psychological distance, language skills, networking skills and international marketing skills. These skills play a central role in discriminating against firms with early internationalization who are proactive in their behavior and against firms with late internationalization who are reactive in their behavior. In fact, without a considerable level of these strategic skills, it is difficult for the entrepreneur to conduct his business in foreign markets, or even to fail. The entrepreneur's ability to develop rapid and early international behavior is also the result of his academic training. However, although the link between the entrepreneur's level of education and international entrepreneurial behavior is positive, the empirical study clearly shows that this relationship is much less significant compared to the other variables both in startup behavior and for subsequent engagement in terms of the speed of foreign market penetration. If we refer to the

statistical analyses, the training variable is the last one in the discrimination of the two groups of companies with different behaviors (proactive vs. reactive) and different internationalization speeds (fast vs. slow).

The study finally synthesized that the companies whose behaviour is proactive in international startup are, themselves, the companies whose speed of internationalization is rapid; and consequently the companies with reactive internationalization in startup are, themselves, the companies with slow internationalization speed. Thus, the study shows that companies that engage quickly, even from the outset, and proactively in foreign markets, continue to venture internationally at such a rapid pace, as a result of international entrepreneurial behavior.

In summary, our empirical study supports the proposal of INV theorists, who admit that entrepreneurs, as "opportunity seekers", are the real drivers of internationalization, drawing on the resources and dynamic skills at their disposal.

It is important to note that our results should only be understood in relation to the limitations of the research. On the theoretical level, we referred only to internal factors related to the entrepreneur's resources to explain the dynamic behaviour of companies' internationalization. Our research model does not take into account other internal factors, which also provide competitive advantages for companies with rapid and early internationalization, such as, advantages related to the use of technology, product advantages, advantages related to marketing activities, etc. Our model also does not take into consideration the factors related to the company's external environment. Another limitation to be highlighted is the one-dimensional nature of the speed of internationalization. Indeed, the study conceptualizes this concept only by the number of countries served internationally and did not take into account other dimensions of subsequent international engagement such as growth in international sales and increased modes of penetration of foreign markets, etc. The sample size of the study can be also considered small and does not represent Tunisian manufacturing industry.

Thus, to exceed the limits presented above, we recommend proposing more complex models including internal and external variables and tested on a larger sample. In addition, we recommend new avenues of research. We suggest examining the impact of internationalization behavior on business performance through an advanced analysis approach based on a categorization of internationalization processes. Four processes can be identified through a crossover of the two dimensions: age and internationalization speed (Young age / Slow speed; Young age / Rapid speed; Adult age / Slow speed; Adult age / Rapid speed). We advise to test their respective impacts on the international performance of companies. Therefore, studying the impact of these processes on performance provides a new perspective on the relationship between internationalization and performance by including time variables such as age and speed of internationalization.

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On the Predicting Supply Chain Performance: Incremental and Stable Neural Networks Training Algorithm

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Abstract—A supply chain performance predicting system is the starting point for developing good strategies to deal with performance variability in today's increasingly complex and competitive markets. Several studies in the literature propose a system for predicting, each with its own advantages and limitations compared to other approaches. This motivates the development of artificial neural networks (ANN), to make intelligent decisions while taking advantage of current processing power. Indeed, the choice of appropriate training and topological design of artificial neural networks are important issues for large applications. This paper discusses a contribution that will highlight ways to improve the quality of predictions through the application of the feedforward neural networks (FNN), training algorithm. Compared to the incremental strategy and to the Lyapunov's stability, the combination of both approaches provides a high level of generalization as well as a stable training process.

Keywords—supply chain management, Supply chain performance predicting system, Neural models, Incremental algorithm, adaptive learning rate.

I. INTRODUCTION

In the supply chain literature, numerous authors present miscellaneous definitions. On the one hand, [6] define the supply chain as “a complex structure including a constant flow of information, products and funds between different phases”; on the other hand, [8] state that “a supply chain is the set of entities involved in the design of new products and services, the supply of raw materials, the processing into semi-finished and finished products, and their delivery to the end customer”. Thereby, the supply chain is typically characterized by a method that encompasses three important phases: supply, production and distribution, which involves manufacturers, suppliers, transporters, warehouses, retailers and customers themselves that performs the function of procurement of materials, transformation of these materials into intermediate and intermediate and finished products, and the distribution of finished products to customers [5].

In addition, a supply chain management (SCM), It may be defined as “the management of flow of goods and services”. It includes the movement and storage of raw materials, of work in process inventory, and of finished goods from point of origin to point of consumption [7]. In a few words, it is a mechanism that includes order generation, order taking, information feedback and the efficient and timely delivery of goods and services. In this context, managing the performance of an organization and its critical first and second tier suppliers can improve considerably the quality of services and goods provided by supply chain [15].

Several studies have proposed conceptual or quantitative models to deal with supply chain performance assessment. In general, the conceptual models propose a set of performance metrics which involve financial and mostly nonfinancial measures associated with the business processes of strategic, tactical and operational levels [12]. In contrast, quantitative models for supply chain performance appreciation suggest the use of multicriteria decision-making techniques, simulation, mathematical programming methods, statistical, and artificial intelligence techniques to quantify the performance of supply chains [10].

The notion of ANN, an extraordinary computing information, was produced from the imitation of the human brain neurophysiology. Thus, ANN very helpful method at detecting complex nonlinear relationships in high dimensional data [11]. The majority of business applications were reported to use multilayered feedforward neural networks with the backpropagation learning algorithm which is a gradient decrease method to minimize the squared output error. Therefore, the prediction using ANN backpropagation yields high level accuracy [2].

In this study, modeling of supply chain performance system is assumed through a neural model whose architecture is chosen based on an approach derived from the combination of two strategies for neural network synthesis. This method leads to a reliable incremental learning algorithm Refer to Lyapunov theory. The rest of this work is distributed as follows. Section 2 the modelling of supply chain performance system is described. Also, several approaches based on neural networks are presented. Section 3 illustrates the results of the simulations obtained. Finally, the concluding observations are presented.

II. THEORETICAL FOUNDATION

This research based on fused underlying theories, supply chain performance, neural networks and data analytics. The combination between theories is shown on Fig. 1, supply chain performance predicts using the best network topology for each ANN model.

A. Conceptual Framework

Performance predicting systems are used to assess the results of delayed measurements (production variables) against the performance levels of the main measures (input variables), which are specified either by estimation or by actual performance data. Most performance prediction systems are based on artificial intelligence techniques that map mathematical functions concerning cause-and-effect relationships between metrics, which is done using learning algorithms [11].

There are some predicting systems in the literature that support decision making in the supply chain world. [16] designed a seminal performance prediction system that was implemented in a textile company and an industrial printer manufacturer. A Mamdani fuzzy inference system was installed to predict the supplier's performance on delivery times with the objective of identifying potential problems. The choice of input variables, the setting of internal parameters and the validation of results were based on the opinion of the company's employees. Another performance prediction system that use artificial intelligence techniques was proposed [4] and [11]. Utilizes a set of ANNs to predict the values of flexibility, responsiveness, costs and returns assets.

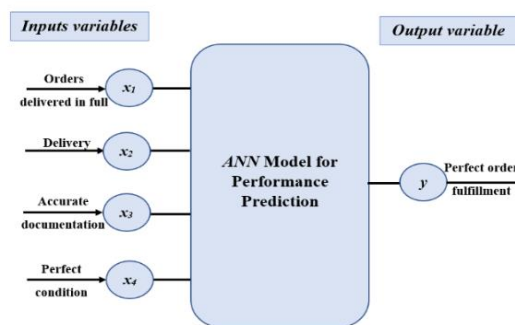


Fig. 1. Neural model for decision making

B. Neural Modeling and Synthesis

Artificial neural networks have enjoyed increasing success in recent decades in several fields, including: pattern recognition, failure detection and anomaly diagnosis, dynamic systems modeling, time series prediction [17].

The use of neural networks during a process identification problem is increased by the fact that they ensure the correct approximation of non-linear functions. This is guaranteed to the ability to reproduce fairly complex behaviours and dynamic learning performance offered by neural networks. In fact, neural modeling is robust to the parametric variations and disturbances that may accompany the operation of the highlighted system.

The design of a neural model requires, among other things, the selection phase of its structure, which is a crucial step. Indeed, this phase should lead to the determination of significant inputs and the choice of the simplest architecture providing a satisfactory approximation of the dynamics of the process under study.

The learning of multilayer networks was treated using the gradient method. Thus, the literature on non-linear optimization approaches applied to this type of problem is very rich. However, we focus the study on the error backpropagation algorithm, which is still the most popular and most widely used [13] and [18]. It is an optimization algorithm that seeks to minimize a cost function that focuses on the difference between the desired response and that delivered by the network.

In this work, develop an improved constructive training algorithm for feedforward neural network using Lyapunov stability theory is developed. It uses an incremental training approach where training patterns are learned one after the other. The Lyapunov stability theory has been put in place to adapt to the evolution of the learning rate, a ensuring the stability of training process.

C. Lyapunov stability theory optimizes training algorithm

Training based on (BP) algorithm can lead to inadequate results. In the same way, this algorithm has inevitable disadvantages such as its slow convergence and its inability to establish global convergence. To solve this problem, Lyapunov's stability theory was used to obtain an adaptive learning rate that would increase the speed of convergence.

A simple (FNN)s with a single output is represented in Fig. 2.

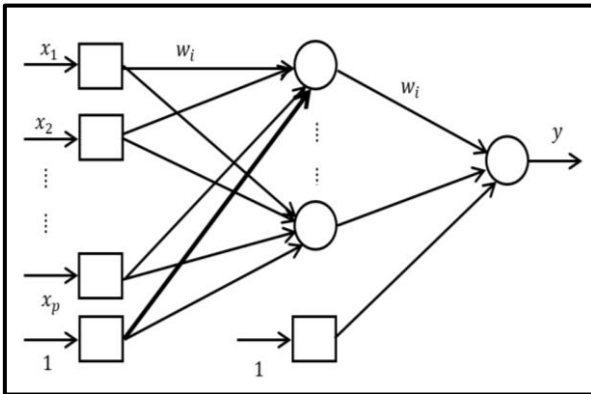


Fig. 2.: Feedforward Neural Network (FNN)

This neural network is modelled according to its weights, where:

$$w = [w_1, w_2, \dots, w_m]^T \in \mathfrak{R}^m \quad (1)$$

The training data can be summarized in N models \$\{x^p, y^p\}, p= 1,2, \dots, N\$.

In the aim of deriving a law for updating weights, a Lyapunov function has been defined as:

$$V_1 = \frac{1}{2} (r^T r) \quad (2)$$

Where r signifies the difference between the real output and the desired output, as:

$$r = [y_d^1 - y^1, \dots, y_d^p - y^p, y_d^N - y^N]^T \quad (3)$$

The stability conditions (\$\dot{V} \le 0\$) give the weights update law with an adaptive learning rate which can be written:

$$w(k+1) = w(k) + \varepsilon \frac{r_p^2}{\gamma + \|J_p^T r_p\|^2} J_p^T r_p \quad (4)$$

Where:

\$r_p\$ denotes the error for sample \$p\$, as:

$$r_p = (y_d^p - y^p) \in \mathfrak{R} \quad (5)$$

\$p\$ is the instantaneous value of the Jacobian, as:

$$J_p = \frac{\partial y^p}{\partial w} \mathfrak{R}^{l \times m} \quad (6)$$

\$\varepsilon, \gamma\$ are a constant and a very small constant to avoid numerical instability when error signal goes to zero respectively, which are selected heuristically.

More information about this algorithm noted LF1 can be obtained from [3].

In the next section, we introduce some improvements made to the above algorithm to handle an incremental structure of (FNN)_s.

D. Improved incremental algorithm based on Lyapunov stability theory

[9] elaborated a new constructive training algorithm for Feedforward Neural Network. In his approach, the training starts with a single training pattern and a single hidden-layer neuron. The aim is to find a neural network topology such that the overall error of training is less than a specified error tolerance. In this instance, while the constructive learning strategy can provide a neural network with a small structure, the neural model may lead to over-trained beings. To remedy this problem, a modified version of this algorithm that eliminates poor generalization performance based on the regularization technique (early termination) has been developed in [1]. Early-stopping is the process of stopping the learning when a medium value of drive error is reached. In fact, at first, the criteria for learning and generalization are beginning to decline. In a later phase, the learning criteria continue to decrease, but the generalization is starting to rise. At this time, the training must be stopped [7] and completed [8].

It is to be noted that we are interested in a multi input-single output model and the weights update is based on the "equation (4)", furthermore, the suggested incremental learning algorithm can be presented as follows:

First step: select one pattern from the training base (\$L=1\$). Train the neural network with one hidden node using the selected pattern and compute the EQMA (1), where: EQMA denotes the average quadratic error of training, which is defined as:

$$EQMA = \sqrt{\frac{1}{N_A} \sum_{p=1}^{N_A} r_p^2} \quad (7)$$

\$N_A\$: indicates the number of samples in the training set.

\$r_i\$: the difference between the real output of sample \$i\$ and output estimated by the neural model, respectively.

Second step: if (\$L < N_A\$), choose the next pattern (\$L=L+1\$) and go to step 3 for training; else (\$L=N_A\$), end of the algorithm.

Third step 3: train the neural network with \$N_c\$ hidden nodes using \$L\$ patterns from the training set and calculate the values of EQMA(\$L\$) and EQMV (\$N_c\$), where EQMV designates the average quadratic error of validation,

$$EQMV = \sqrt{\frac{1}{N_v} \sum_{i=1}^{N_v} r_p^2} \quad (8)$$

Here: N_v indicates the number of samples in the validation set.

If $(EQMA(L) < EQMA_{tol})$, return to second step; otherwise, move on to fourth step for growing where $EQMA_{tol}$ signifies a tolerated value average quadratic error of training.

Fourth step: if $(N_c = 1)$, then, $(N_c = N_c + 1)$ and return to third step; else $(N_c > 1)$, two tests must be carried out to decide on the evolution of the network structure.

In the case of the growth of the generalization criterion ($EQMV$) with a value greater than a tolerated threshold ($EQMV_{tol}$), the algorithm should go to fifth step. The similar step will be executed when the generalization criterion decreases. These cases are summarized as follows:

if $\left\{ \begin{array}{l} (EQMV(N_c) > EQMV(N_{c-1})) \\ \text{and } (EQMV(N_c) > EQMV_{tol}) \\ \text{or } (EQMV(N_c) < EQMV(N_{c-1})) \end{array} \right\}$, then go to fifth step.

These tests are particularly satisfied in the beginning of the learning step when the generalization criterion can have an oscillatory behavior.

In the third case and when the generalization criterion grows with a value lower than $EQMV_{tol}$, then increase slightly the $EQMA_{tol}$ and re-execute the third step. This case is summarized by:

if $\left\{ \begin{array}{l} EQMV(N_c) > EQMV(N_{c-1}) \\ \text{and} \\ (EQMV(N_c) > EQMV_{tol}) \end{array} \right\}$, then $(EQMA_{tol} = \alpha EQMA_{tol})$ where α is a constant slightly higher than 1, and go back to step 3.

In this matter, the network structure has appropriate hidden nodes and the neural network achieves a high learning performance with a generalization error that tends to increase. In this instance, the $(EQMA_{tol})$ is increased in order to slow down the recruitment of hidden nodes.

Fifth step: maintain the weights of the last-successfully trained neural network, augment the number of hidden neurons by one and attribute its initial weights. Move on to the third step.

E. Experiments and discussions

In this part, we expose the simulation results. The sufficiency of the suggested algorithm is analyzed. We utilize this algorithm for the neural identification of a supply chain performance.

The main goal of our simulation is to find the adequate structure of the input-output neural model which describes the dynamics of the supply chain performance by using the approach presented in previous section.

The supply chain performance parameters used in simulations are illustrated in “Table. I” [14]:

TABLE I. DESCRIPTION AND MEASUREMENT UNIT OF THE METRICS OF THE PROPOSED PREDICTION SYSTEM

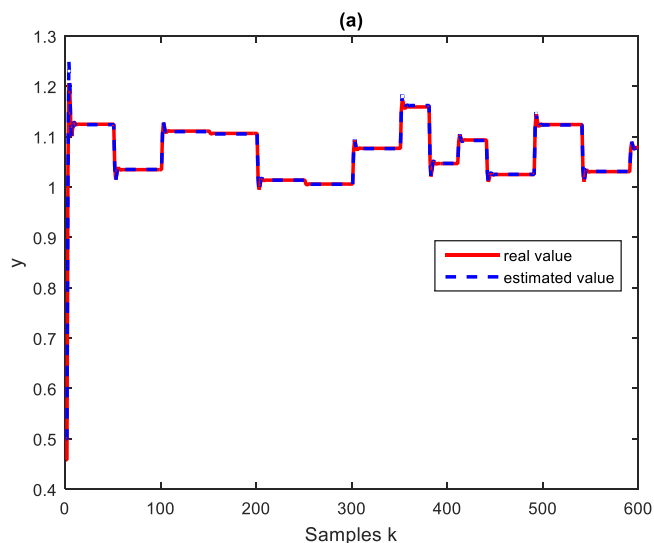
Model	Variable	Description	Measurement unit	Universe of discourse
ANN Model	x_1	Orders delivered in full:	Dimensionless	[0; 1]
	x_2	Delivery performance:	Dimensionless	[0; 1]
	x_3	Documentation accuracy	Dimensionless	[0; 1]
	x_4	Perfect condition:	Dimensionless	[0; 1]
	y	Perfect order fulfillment:	Dimensionless	[0; 4]

It can be shown that the suggested algorithm offers more efficient convergence characteristics in the training and validation phases than the LF1 and incremental algorithms.

“Table. II” illustrates the importance of the combination of the constructive approach and the LF1 algorithm. Indeed, we can see that the incremental algorithm provides a good performance but with a slow convergence time. In the same way, the LF1 algorithm has a minimum convergence time with degradation of the performance of the model acquired. The resulting algorithm guarantees both rapid convergence and higher learning and generalization capabilities.

The simulation result, which involves selecting the number of hidden neurons using Lyapunov's stability theory, an incremental learning algorithm, is illustrated in “Fig. 3” and “Fig. 4”. Noted that the input is set of random values that varies in [0, 1] are presented over 600 examples.

The simulation results describing the performances of algorithms presented in this paper are illustrated in “Table. II”.



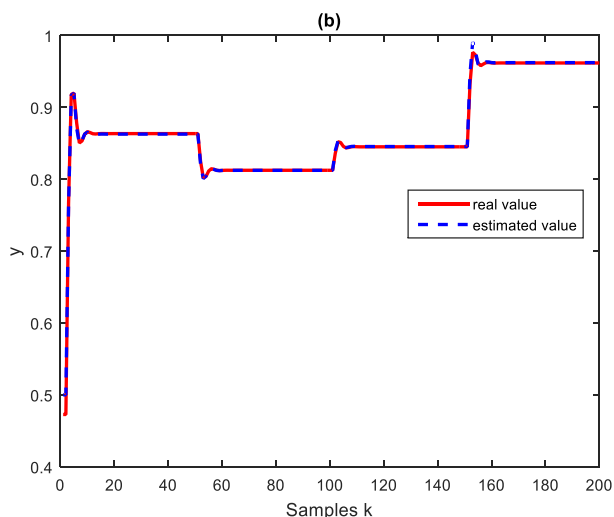


Fig. 3. Training and validation phases for the proposed algorithm ((a): training phase, (b): validation phase)

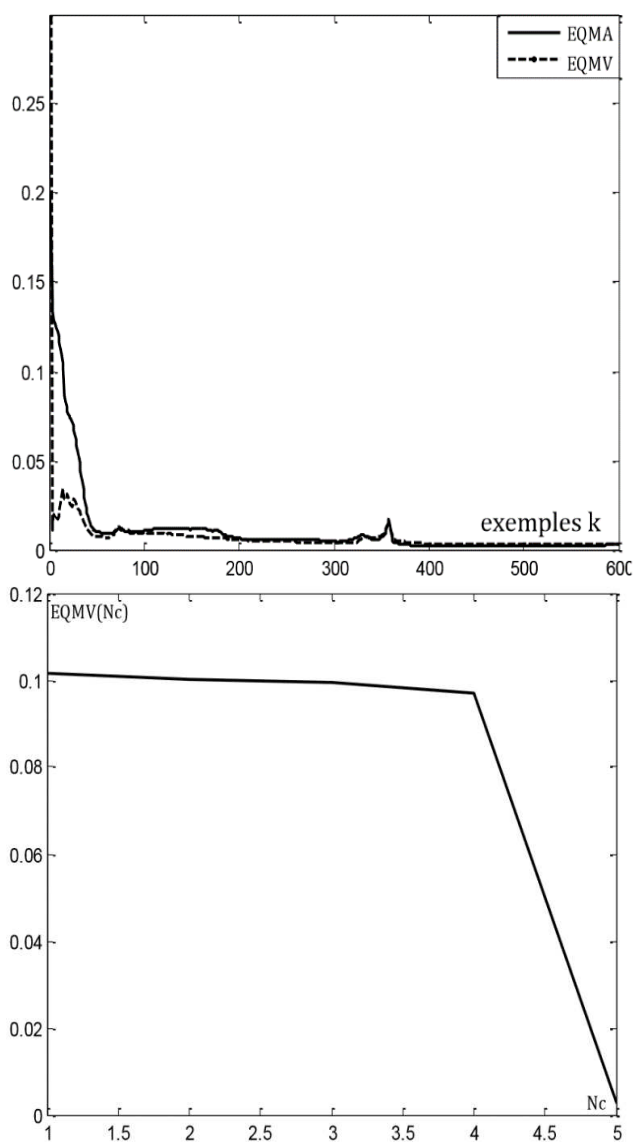


Fig. 4. Training and validation performances for the proposed algorithm $EQMA$ and $EQMV$, $EQMV(N_c)$

TABLE II. PERFORMANCES OF DIFFERENT ALGORITHMS

Algorithm	Numerical simulation parameters	EQM A	EQM V	N_c	Run time
LF1 (fixed structure)	$\varepsilon = 0.56, \beta = 0.00012$	0.0054	0.005	5	8'55
Incremental algorithm	$\alpha = 1.03, EQMA_{tol} = 0.037, EQMV_{tol} = 0.047$	0.0037	0.0034	5	16'70
Incremental algorithm with LF1	$\varepsilon = 0.56, \beta = 0.00012, \alpha = 1.03, EQMA_{tol} = 0.037, EQMV_{tol} = 0.047$	0.0041	0.0030	5	12'

III. CONCLUSION

This study proposed an advanced approach for neural models selection. The main contribution of this method is to demonstrate the upotential of the Lypunov stability theory for the synthesis of neural networks. To validate the reliability of the developed algorithm, neural modeling of the supply chain performance prediction system is used. The simulation results have showed that the advanced algorithm not only improve the training and generalization skills, but also reduces the runtime, which substantially improves the feasibility of this algorithm in both theoretical and real problems.

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Internationalization of Tunisian SMEs with Entrepreneurial Perspective: Contribution in terms of human, social and financial resources

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Abstract— This article examines internationalization within SMEs from an entrepreneurial perspective. Its main objective is to contribute to the enrichment of knowledge about international entrepreneurship by identifying the key factors for the success of internationalization, in particular, human, social and financial resources. To do this, we first proposed a review of the literature on the theories underlying the internationalization of SMEs. Then, we developed research hypotheses based on the resource and skills-based approach, the network approach and the International New Venture - INV approach. To carry out our empirical analysis and validate our hypotheses, we rely on a quantitative research approach based on a sample of 250 Tunisian SMEs with activities abroad. The results consist in a better understanding of the phenomenon of internationalization. Indeed, the work carried out has led to the conclusion that the profile of the entrepreneur-Manager, in terms of training, attitude and international experience, favors the company's international orientation. Finally, empirical analyses have shown that the human skills, social networks to which the company belongs and the financial resources also facilitate the internationalization of SMEs.

Keywords— International Entrepreneurship, Resources and Skills, International Strategic Orientation, International Entrepreneurial Orientation, Internationalization Commitment.

I. INTRODUCTION

In the context of the globalization of markets, the phenomenon of internationalization of companies, this has been the subject of much attention with a strong interest in small and medium-sized enterprises (SMEs). Indeed, the environment business has evolved considerably over the past two decades, with the united international trade has seen a significant expansion related to the opening of trade economies. This increase in trade between various countries reflects hyper-competition in national and international markets. This requires SMEs in particular to follow this trend of trade globalization if they wish to ensure their performance or even maintain their survival [13]. In this globalized context, the international opening of the economy has aroused the interest of academics since the 1990s, giving rise to the emergence of a new discipline, that of international entrepreneurship, which is positioned at the intersection

between corporate strategy, international management and entrepreneurship.

More specifically, international entrepreneurship is considered as «the discovery, the engagement, evaluation and exploitation of opportunities, beyond borders to create future goods and services» [108]. In view of the importance of SMEs internationally, recent research indicates that it is imperative to involve these companies in the reflection on the process of internationalization. However, the literature shows a lack of consensus on the work devoted to the study of the internationalization process in the context of specific to SMEs. Reference [110] have shown that the internationalization of SMEs is a very important theme in the literature dedicated to international entrepreneurship and remains a topical issue given the context that is constantly changing. It follows from this that the question of the development of SMEs abroad is quite interesting thanks to their significant contribution to the economic vitality of countries. Hence, the importance of taking an interest in the phenomenon of their internationalization. In view of the above developments, we are positioning our work in the literature on international entrepreneurship. The willingness to explore this field of research leads us to focus our attention on the phenomenon internationalization of SMEs in Tunisia. More specifically, this means proposing the following research problem:

What are the key resources for the success of the internationalization of SMEs with entrepreneurial perspective?

The central issue of this article is therefore to explain internationalization in the particular context of SMEs through the identification of the key resources for the success of such an approach.

In this context, the identification of resources and skills that influence the internationalization of SMEs is still a central issue in the literature on international entrepreneurship due to the multiplicity of research attempts aimed at understanding the dynamics of international entrepreneurship of internationalization. In addition, the contributions of the resource-based approach and skills are considered to be sources of the factors that promote the expansion of companies internationally. Indeed, the internationalization strategy

adopted by the company reflects a combination of the personal resources of the management team with those of the company. This ensures a better understanding of the factors that encourage SMEs to expand internationally. To conduct our work, we conducted various researches to design a well-consistent structure for our conceptual model explaining the determinants of internationalization in the particular context of SMEs. Our starting point is to try and identify the factors that favor the development of companies abroad. In order to meet this objective, our work will be divided into three parts. First, we will conduct a literature review to focus on the concepts central to research. Then, the presentation of the conceptual framework and research methodology adopted. Then, we will present the results of our empirical research with Tunisian SMEs with activities abroad. Finally, at the end of this article, we present, through the general conclusion, a reminder of the strong points of this work, emphasizing also the limitations of this study, as well as recommendations for the orientation of future research in our field of research.

II. LITERATURE REVIEW

Internationalization can also be defined as controlled and progressive integration in the global economy in terms of trade in goods and services. This is not about in the event of a temporary economic phenomenon. It is an irreversible revolution in behavior of the various actors in the face of economic and social survival, a behavior dictated by the need to take awareness of market needs. However, it is not done in any one of them conditions. Internationalization therefore requires a long-term vision of the company and of its market and aims to improve its competitiveness. This vision has evolved into due to changes in the business environment. The acceleration of the means of communication and the liberalization of the globalized economic world require flexibility rapid organization, an almost instantaneous reactivity of the actors.

A. *The Emergence of International Entrepreneurship*

Since the late 1980s, international entrepreneurship has been building a body of knowledge at the intersection of entrepreneurship and international management. In fact, international entrepreneurship is an integration of the theoretical contributions of entrepreneurship and international management to explain the context, causes and process of internationalization of the entrepreneur [93]–[107]. Research in this area is conducted by researchers from around the world and supported by various community structures, conferences and journals [24]. Several definitions of international entrepreneurship have been proposed, due to the proliferation of this field of research. This wealth is partly explained by the fact that international entrepreneurship is being structured, but also by the fact that it is at the junction of the issues of international management and entrepreneurship [23]. Thus, to better understand international entrepreneurship, it is necessary to integrate the paradigms and methods of international management and entrepreneurship [93]. Advancing knowledge

in these two disciplines feeds and accelerates the development of international entrepreneurship [40]–[41].

B. *The Internationalization Behaviors*

The research enhances the definition of international entrepreneurship with the concept of entrepreneurial behavior, including the themes of cognition, learning and strategy. This entrepreneurial behavior refers to the processes, practices and activities related to decision-making. In a similar vein, reference [96] defines the notion of international entrepreneurship based on three variables, namely innovation, proactive behavior and risk-taking. International entrepreneurship is "a combination of proactive innovation and risk-taking behaviors that cross national borders and are intended to create value in organizations". Thus, reference [108] considers that international entrepreneurship "includes the discovery, engagement, evaluation and exploitation of opportunities, beyond national borders to create future goods and services". In the same vein, Reference [135] proposes a definition that highlights the internationalization of the entrepreneurial process: "It is the process of creativity, discovery, and exploitation of opportunities outside the national market in order to pursue a competitive advantage". Market and entry selection is a key element of the internationalization process. Market selection depends on knowledge and needs as well as geographical and psychological proximity [62]. The choice of markets and the order of penetration depend on the maturity of the sector of activity and the degree of internationalization of the company [4]. The results of reference [88] also suggest that innovation, product characteristics, advertising intensity, export intensity and industry have positive effects on the choice of engaging high-level resources in foreign markets.

C. *Towards an Articulation of the Different Approaches*

In view of the diversity of theoretical approaches explaining the internationalization behavior of SMEs, it is important to find a general theoretical framework that brings these approaches together [26], [53]–[60]. Indeed, it is necessary to combine the contributions of these different approaches while taking into account the specificities of the SMEs world [77]. To do this, we will briefly review the concept of resources and skills and then propose a review of these approaches in terms of this founding concept. Insofar as the internationalization of a company requires the mobilization of all the resources and skills of a company, the concept of resources and skills appears to be a founding element of different traditional approaches [81]. Each of them is based, more or less, implicitly, on this concept by favoring certain resources and skills over others. The literature review proposes different theoretical approaches to internationalization.

1) *The step-by-step approach*: Is the first angle of approaches to the internationalization of SMEs, which still remains today as an essential reference for any internationalization study. Traditionally, the literature on corporate internationalization has been largely dominated by step-by-step internationalization models. These models assume

that the internationalization of companies should be gradual in order to reduce and control the uncertainty inherent in foreign markets. Following this logic, companies follow an incremental step-by-step process that is triggered by the conquest of foreign markets that are psychologically very close. Reference [35] indicates that the process of internationalization of SMEs continues to follow several stages, but that their engagement with foreign markets can increase, decrease and increase again. Two ways of analyzing internationalization are proposed by this theory, namely: the Uppsala model [65]-[68] and internationalization through innovation I-model [15], [31]-[114]. The Uppsala model (U-model) was initially developed by the Swedish school [65]-[68] in the 1970s, and remains an essential reference for any study of the internationalization of SMEs today. Among the major contributions of this Swedish school, two concepts seem essential to us: that of the gradual learning process and that of psychological distance. Also, the internationalization of the company can be understood as an innovation decision-making process [66]-[71]. In addition, existing research suggests that organizational learning, innovation and internationalization are linked in complex ways [21]. Reference [48] used further research to examine how various "competing forces affect the form and direction of internationalization". We argue that research on business model innovation in host countries will offer new perspectives on the internationalization process, as business model innovation is not only about supply, but also about demand [95]. However, the inability of this approach to explain some of the behavior of SMEs internationally has paved the way for other approaches, including the economic and network approach [26], [53], [60]-[87].

2) *The economic approach*: A second perspective of internationalization approaches has emerged that focuses on organizational capacities (financial, material...) to explain the internationalization of companies. It is then the production capacities, the financial capacities that would explain the internationalization. According to the logic of the concept of resources and skills, these capacities are tangible assets owned or controlled by the company [3], [10]-[73].

3) *The network approach*: A third perspective of internationalization approaches was born; this approach finds its foundations in the extension of the work of the Uppsala school. This approach favors relations with the environment as a dominant factor or resource in explaining the internationalization of companies. However, these resources can only be fully exploited if the SMEs have a high "networking" capacity. SMEs without this capacity would be led to internationalize incrementally and gradually. From the point of view of the concept of resources and skills, the relationships forged in the network can be considered as intangible assets or even relational resources [73].

Indeed, different approaches to internationalization have shown that all theoretical approaches explaining the dynamic process of SMEs internationalization converge more or less in the approach based on the concept of resources and skills. The concept of resources and skills mainly concerns the central

role of the entrepreneur in the internationalization of SMEs and has been proven by a number of researchers in the internationalization literature [61], [109]-[112]. The skills of the entrepreneur and the management team are essential for the coherence of a number of internationalization factors. The entrepreneur's international experience [85], the attitude and perceptions of the international market [126], are the essential elements in the process of internationalization of SMEs. Thus, productive, financial and technological capacities are considered important characteristics for SMEs [37], [112]-[126]. Thus, the concept of resources and skills plays a central role in the international development of PME [81].

D. The Internationalization Approach 'International New Venture (INV)'

The business environment has changed significantly since the 1990s thanks to the development of information and communication technologies and the dissemination of companies' successful internationalization experiences [5]. This has allowed the development of other faster internationalization models that challenge the assumptions of step-by-step models. These models suggest an internationalization of companies from the outset, represented in particular by the International New Venture "INV" model. Reference [106], the first to propose a theoretical framework specific to international entrepreneurship by presenting the concept of International New Ventures (INV) defined as "A company that, since its creation, tends to obtain a significant competitive advantage from the use of resources and the sale of products in several countries". Reference [105] adds that young companies with intangible resources tend to internationalize quickly and successfully. Reference [104] adds another definition to the INVs: "companies whose foreign links (e.g., sales efforts, investments) can be observed in a short period of time conventionally accepted after their training". They define that this short period can be considered as less than six years by convention.

Early studies that attempted to explain the INV phenomenon identified three interrelated factors of the emergence of these new firms [79], [82]-[106]. The first factor is new market conditions that include the increasing specialization associated with the emergence of niche markets, the international networks that characterize many companies and the globalization of the financial system that allows executives to seek financing. The second factor, the acceleration of development resources and the transfer of Information and Communication Technologies (ICT) are factors that facilitate specialization and the emergence of niche markets. The third factor is the high level of international skills and experience of the entrepreneurial leaders and management team.

E. Heading The company's Resources and Skills Abroad

In the literature on international entrepreneurship, different determinants have been identified as influencing internationalization. It is possible to identify the company's skills and resources, including entrepreneur training, international vision, past international experiences, social

networks and skills related to international human resources activities as well as the company's characteristics.

1) *Entrepreneurial Leader Profile*: The entrepreneur may have some impact on the degree and extent of a company's internationalization. Reference [106] sought explanations for the internationalization of newly created firms by examining owner behavior and business form. They noticed that from the very beginning of the company, entrepreneurs had an international vision. They also showed that new companies run by entrepreneurs with experience abroad were able to internationalize their businesses more quickly and successfully. Thus, the entrepreneur's previous experience, particularly at the international level, promotes early internationalization [137]. In short, internationalization decision-making comes from an intention consisting of a vision of the business owner, his motivations and attitudes towards internationalization [69], [100]-[106]. The main conclusion is that the international experience of entrepreneurs feeds into the knowledge of the international market for entrepreneurial enterprises, which has a positive effect on the engagement of the international market and the level of internationalization of these enterprises. In terms of theory, the study broadens our understanding of entrepreneurial enterprises by revealing the role of entrepreneurs' international experience in their international expansion [8]. Thus, reference [2] is also interested in the relationship between the attitude of the manager and the internationalization of SMEs. It shows that entrepreneurial leaders who have a positive attitude and a clear vision for internationalization tend to make proactive decisions internationally. As a result, he demonstrates that the attitude and vision of the leader as key factors in proactive internationalization.

2) *Human and Social Capital*: Different skills related to the company's human resources have been identified as influencing the process of international business expansion. Thus, reference [119] acknowledges the role played by the entrepreneurial skills of the management team in the decision to internationalize SMEs. In addition to the traditional skills available to local entrepreneurs, the company's human resources had skills and capacities specific to international development. In this context, reference [78] also demonstrates the advantage of international marketing skills in the development of international SMEs. As a result, the ability to define international objectives, the ability to take risks, the ability to tolerate psychological distance, the ability to network, language skills and international marketing skills act as key factors in the internationalization of SMEs. Thus, empirical research in international entrepreneurship shows the importance of social networks for internationalization [115]. The analysis of the literature on the relationship between the internationalization of SMEs and social networks suggests that social networks play an important role in the internationalization process.

3) *Company Profile*: With regard to company characteristics, the empirical results obtained were mixed for the role of company age in internationalization, some studies show the positive impact of company age on internationalization [76]. Younger companies have more openness to international expansion [134]. Reference [22] finds no statistically significant relationship between age of enterprise and internationalization. While firm size is positively correlated with the internationalization of SMEs through the importance of its resources and skills in reducing risks and barriers related to international activities [90],[94]-[111]. In addition, the more financial resources the company has, the more it engages internationally [43].

III. DEVELOPMENT OF THE CONCEPTUAL FRAMEWORK AND RESEARCH METHODOLOGY

In the light of the main relationships identified in the literature, we first propose a specific conceptual model for analyzing the determinants of internationalization. Then, we will formulate research hypotheses retracing the relationships of influence between variables belonging to the different conceptual levels of the model to test the impact of a set of variables on the internationalization of SMEs. The construction of the conceptual model is based on the main theoretical works concerning the determinants and strategies of internationalization. The state of the art of the models devoted to this theme leads to a preference for a multidimensional approach over a one-dimensional approach. This choice is explained by the fact that only this approach provides an analytical framework for conceptualizing the interdependence between the different factors and identifying the actions to be implemented if internationalization is to be a success and if they are to achieve the specific objectives. This study is based on the proposals made by the work previously presented, in order to develop a model adapted to the identification of the most significant determinants. The profile of the manager, SMEs and human capital constitute the resources and skills constitute, while the internationalization of SMEs represents the commitment to internationalization, strategic orientation and international entrepreneurial orientation. The relationship between resource and skills factors and internationalization has already been the subject of several studies. They helped us to choose the concepts and variables of our model. The review of the empirical literature has shown that there are several factors that explain the integration of SMEs into globalization. Microeconomic factors are linked to the intrinsic qualities of the company (age, size), its financing method (equity, debt, subsidy), its organization (specificities linked to international markets) and human resources (social dynamism, openness to international markets, experience abroad, manager training; but also the level of employee qualification, number of languages spoken in the company). We try to explain through the research model, as presented in the figure, the impact of resources and skills on internationalization in the specific context of SMEs.

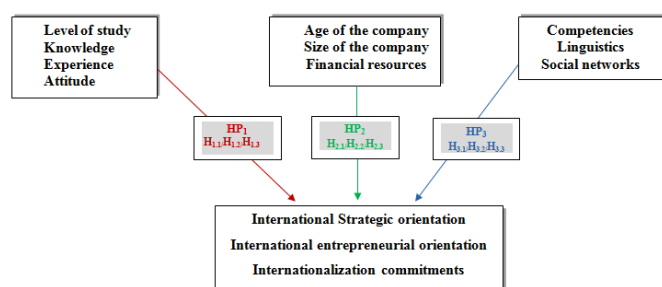


Fig. 1 The conceptual model specific to the determinants of SMEs internationalization

After presenting the general basis of our conceptual model, we will propose in the following to formulate hypotheses on the impact of resources and skills on internationalization.

A. The Impact of the Manager's Profile and Attitude on Internationalization

Several studies have shown that the leader has a fundamental responsibility in the internationalization strategy [36]-[118]. According to reference [127], higher foreign language skills, cultural knowledge, network connections in their home countries and a broader understanding of international business are advantages that entrepreneurs can have over their national counterparts. In this context, the manager's level of education contributes to developing his skills and instilling an international vision into his company. Studies have shown that the manager's knowledge of linguistics, his knowledge of foreign countries and his mastery of export techniques, which will be acquired through training or professional experience, have a strong influence on the magnitude and speed of international development [61], [115]-[117]. More generally, the entrepreneurial attitude of the manager would also defend this principle [9]. Thus, reference [18], determined the impact of the manager on the internationalization of the company, by presenting four characteristics: "the past professional experiences of the manager within a large multinational group abroad, which allowed him to accumulate experience and improve his knowledge of international markets; his personal skills, his international spirit, and even his enthusiasm for foreign markets and his personal, professional and institutional networks, which he manages and builds according to his needs". On the other hand, reference [39] suggests that ideas of internationalization can be developed through the acquisition of international experience abroad by leaders. In addition, reference [8] determines that the international experience of entrepreneurs and knowledge of the international market for entrepreneurial enterprises influences the internationalization of these enterprises. The manager's attitude and ability to take risks are also considered as key factors in internationalization. A positive attitude towards international activities motivates employees. So from these studies it can be said that the

manager's profile has a crucial role in the internationalization of SMEs. Hence the following assumptions:

HP1: The profile and attitudes of the leader have a direct and positive effect on internationalization.

- Hyp_{1.1}: The level of education of the manager has a significant and positive effect on the internationalization of their company.
- Hyp_{1.2}: The international experience of executives has a positive and significant effect on the internationalization of their company.
- Hyp_{1.3}: Knowledge, initiative and the ability of managers to make contacts are inherent to the internationalization of their company.
- Hyp_{1.4}: The manager's attitude towards internationalization has a significant and positive effect on internationalization.

B. The Impact of Human and Social Capital on Internationalization

In the literature on the internationalization of SMEs, much of the research has focused on the effect of human capital in the internationalization process [51]. Reference [103] determines that firm-level investment in employee human capital is essential for labor productivity and internationalization. In addition, human capital, training and professional or international experience, is one of the essential factors for the success of a company [7], [25]-[115]. Reference [99] also show that companies with a common language and international links are able to internationalize more quickly than others do not. A number of studies also acknowledge that networks are important in the company's internationalization process [58]-[66], whether the company is a "born-global" [113], a small or medium-sized company [56] or even a multinational [67]-[128]. Reference [46] suggests that networks reduce the risks associated with international expansion. Reference [80] argues that networks are positively correlated with the detection and capture of international opportunities. Reference [12] identifies the opportunities of international network dynamics throughout the internationalization process. Thus, the emergence of an international opening is rarely spontaneous; it develops within the framework of the frequency of human exchanges with foreign countries. From this literature review, we retain that, for a company that is going international, its human resources must possess certain qualities including patience, determination, motivation, competence, openness, dynamism, creativity, as well as self-confidence and a knowledge of foreign languages. Indeed, these studies have shown that investment in human capital, through training and skills development helps SMEs to develop internationally. Hence the following hypothesis:

HP2: The human and social capital has a significant and positive effect on internationalization.

- Hyp_{2.1}: The investment in human capital and skills development has a positive and significant effect on their productivity and subsequently on their international development.

- Hyp_{2,2}: The linguistic level of human capital has a positive and significant effect on the internationalization of SMEs.
- Hyp_{2,3}: Social networks have a positive and significant effect on their international development.

C. The Impact of The SMEs Profile on Internationalization

The literature makes it possible to highlight some of the business characteristics that play a role in the success of internationalization. In particular, the size of the company can influence the process of internationalization and can also slow down internationalization. According to reference [75], smaller companies will choose to internationalize in stages, unlike larger companies with more diverse resources. Reference [111] suggests that size is a discriminating factor in the internationalization of SMEs. In addition to size, which remains a central determinant of internationalization, the age of the firm has also been determined, in some studies, as an explanatory factor for the internationalization of firms. While there is a consensus in the literature regarding the positive and significant effect of size, it seems that this is not evident with regard to the question of the age of the organization. In fact, research that has examined the impact of business age on internationalization has led to divergent conclusions. Some research suggests that older companies are better able to develop an appropriate strategy and succeed in internationalization [76]. Others support a positive relationship between the age of enterprise and internationalization [122]. Indeed, old but innovative companies can be dynamic and succeed in internationalization. Reference [134] shows that the youngest companies with more openness to the outside world, act dynamically and more openness to the outside world than the old ones. Reference [22] on the other hand; do not find a statistically significant relationship between age of enterprise and internationalization. In fact, it is not so much the age of the company that affects the internationalization of PME, but rather through its dynamism, in terms of strategic choices. In our case, we believe that the age of the company has a positive influence on internationalization. This could be explained by the fact that the older the company is, the better its experience in conducting international business is. In another context, SMEs are financially vulnerable because of their almost exclusive dependence on bank financing as a source of external financing. Indeed, the problems encountered by small and medium-sized enterprises (SMEs) with international ambitions in accessing debt and equity financing for foreign direct investment (FDI) projects. Several arguments have explained why small and medium-sized enterprises face serious financing constraints for foreign investment [33]. In practice, the various means of financing are the subject of preliminary studies and a choice according to their respective conditions and costs. The development of a multi-year international investment financing plan often leads to a combination of several means of financing, namely: Investment in internationalization activities is carried out by equity capital, i.e. by contributions made by the individual entrepreneur or by the shareholders when the capital is built up.

Thereafter, by undistributed profits placed in reserves or self-financing, by new contributions in cash or in kind with a capital increase or in shareholders' current accounts. Investment in internationalization activities can thus be made by borrowing from financial institutions, banks or credit institutions and this remains the most normal way of accessing financing, the bank being an interlocutor familiar with public mechanisms that may be of interest to companies. Investment in internationalization activities may also be made through grants received from local authorities or state agencies or professional private organizations. According to, reference [113] access to finance is strongly determined by factors such as the size of the company, ownership, strength of legal rights and depth of credit information, the company's export orientation and the manager's experience. In order to examine the impact of the specific characteristics of the company that can help access international markets and with respect to what has been found in previous studies, we make the following assumptions:

HP3: The profile of SMEs has a significant and positive effect on internationalization.

- Hyp_{3,1}: The age of the company has a significant positive effect on internationalization.
- Hyp_{3,2}: The size of the company has a positive and significant effect on their international development.
- Hyp_{3,3}: The more financial resources the company has, the more it engages internationally.

D. The Research Methodology

Regarding the research methodology, we adopted a quantitative approach. For this purpose, we developed a questionnaire using a 5-point Likert scale. The questionnaire was self-administered and sent via the Internet to 250 managers of Tunisian SMEs that have carried out activities abroad. As a method of analysis, we used the multiple linear regression analysis method is the most commonly used statistical tool for studying multidimensional data. Finally, the data were processed through the SPSS software.

1) Operationalization of Variables:

TABLE I
 A SUMMARY OF THE OPERATIONALIZATION OF THE SEARCH VARIABLES

Concepts	Variables	Measures	Authors
Profile and Manager attitude	Experience	International experience. Frequency of international travel. Ability to define international objectives. Ability to have a clear idea of international developments. Ability to coordinate and organize activities on international fields.	[8],[14], [39],[49], [57]- [61]

	Education level	Obtaining a diploma from the leader (level of education).	[50]-[65]
	Knowledge	Knowledge of clients abroad. Knowledge of products abroad. Knowledge of foreign prices. Knowledge of promotion/advertising practices abroad. Knowledge of the market environment abroad. Mastery of international financial techniques. Fluency in languages.	[47],[55],[83],[97],[101]-[127]
		Attitude	Positive attitude towards growth strategies through internationalization. Positive attitude towards the risks inherent in internationalization. Internationalization decision based on proactive motivations. Successful export attempts in the past.
Capital humain and social	Skills	Technological skills. Skills in international marketing management. Ability to integrate into groups. Know-how. Ability to interact with new ideas and manufacturing processes. Ability to define international objectives.	[7],[10],[11],[16],[19],[25],[44],[82],[102],[115],[129]-[132]
	Linguistics	Languages skills of employees. Linguistics in the company: one of the collaborators of the management team masters at least one foreign language. Number of languages mastered.	[30],[99]-[131]
	Social networks	Relationship networks. Partnership: Participation of the manager in social and/or societal activities. Develop and manage networks.	[57],[61],[70],[77],[125]-[130]

Profil of SMEs	Size	Number of employees.	[75],[90],[94],[111]-[116]
	Age	Number of years in operation during the year the survey was conducted.	[75]-[94]
	Financial resources	Debt. Equity. Subsidies.	[1],[34],[45]-[113]
Internationalization	International entrepreneurial orientation	Proactive behavior in seeking business opportunities abroad. Marketing of innovative products abroad. Strong tendency to undertake high-risk foreign projects abroad.	[78],[106],[107],[115]-[135]
	International Strategic orientation	Strategic approach to long-term internationalization. Prefer markets perceived as culturally similar or close. Prefer markets perceived as geographically close. Scope of internationalization: number of international markets. Invest in a very profitable and high-risk project.	[72]-[120]
	Commitment to internationalization	Engage in research and development (R-D) activities. Engage in the development of new products/services abroad. Engage in the improvement of marketing and commercialization activities abroad. There is an information and technological monitoring department.	[74]-[124]

2) *Description of the Characteristics of the Sample:* In this section, we will discuss a portrait of the companies that were the subject of the statistical survey. Thus, 250 questionnaires were well filled in by Tunisian international PME belonging to different industrial sectors. Through a descriptive analysis, the characteristics of the sampled companies will be presented using traditional indicators. These characteristics refer to the level of education of the manager, the age and size of the

companies, the sector of activity and the mode of internationalization. The descriptive analysis shows that on average, managers have at least completed the first university cycle. In addition, 78% of managers have a university degree. So the sample is highly educated. On the other hand, 16.4% of executives have completed their postgraduate university studies. The distribution of the study sample by sector shows that the SMEs surveyed come from all sectors of activity. However, the survey shows that the most represented sector is the "agri-food" sector with (25.6%). Thus, "agriculture and fishing" companies represent (19.6%) of the respondents. In addition, 1/3 of the companies that responded to our questionnaire are companies less than 5 years old. We can say, then, that the companies in our sample are relatively young. The survey allows us to measure the size of the companies surveyed through the total number of employees in the company, including scientific, technical and administrative staff. We have therefore divided the companies into five categories according to their size. The results show that 82.4% of companies have fewer than 50 employees. It is precisely noted that the majority of the companies in the sample belong to the size range according to the effective criterion [20; 50 [, with a percentage of 35.6%. In addition, out of the 250 SMEs surveyed, 44 companies have a workforce of more than 50 employees, 4.4% of which have between 100 and 200 employees. Finally, the sample of respondents is largely composed of exporting SMEs (82%) while other modes of internationalization are poorly adopted.

IV. STATISTICAL ANALYSIS AND INTERPRETATION OF RESULTS

The purpose of this section is to present and interpret the results of statistical analyses conducted to test the research hypotheses associated with the determinants of internationalization. The first section will be devoted to the descriptive analysis of the different research variables in order to carry out validation tests of the measurement scales. First, we present an analysis of the homogeneity of the variables by referring to a main component analysis and a reliability analysis. The second section will be devoted to the formulation of empirical models specific to the factors of internationalization of SMEs. Next, we will discuss the presentation and interpretation of the results obtained. To do this, the results will be presented in two stages. First, the global characteristics of the models will be presented by studying the global significance of the models and their explanatory powers. Then, the research hypotheses formulated will be tested through a multiple linear regression analysis. As a conclusion to this chapter, a third section will be devoted to the interpretation and discussion of the results.

A. Analysis of the Homogeneity of Variables: PCA and Reliability

We present a Schedule that summarizes all the results of the analysis into a main component and a reliability analysis through the Cronbach alpha index of the different variables. The results confirm the validity of the principal component

analysis (PCA) and the reliability of the scales used to measure the research variables.

TABLE III
 Table Summary of Results PCA and Reliability

Variables :	Number of items:	KMO Index:	Bartlett Test:	α the Cronbach
Experience	5	0.719	0.000	0.910
Knowledge	7	0.898	0.000	0.897
Attitude	4	0.720	0.000	0.927
Skills	6	0.833	0.000	0.883
Linguistics	3	0.722	0.000	0.894
Social networks	4	0.783	0.000	0.905
Financial resources	3	0.664	0.00	0.813
International Strategic Direction	5	0.741	0.000	0.845
Commitment to internationalization	4	0.713	0.000	0.920
International entrepreneurial orientation	3	0.695	0.000	0.860

B. Verification of Assumptions and Interpretation of Results

After the formulation of empirical models specific to the determinants of SMEs internationalization, we will discuss the presentation and interpretation of the results obtained. As a result, the results are presented in two stages. First, the global characteristics of the models will be presented by studying the global significance of the models and their explanatory powers. Then, the research hypotheses formulated will be tested through a multiple linear regression analysis.

1) *Presentation of the Global Characteristics of the Regression Models:* The Schedule presents the quality of the regression testing the impact of the determinants on the internationalization of SMEs.

TABLE IIIII
 Quality of Regression Testing the Impact of Determinants on the Internationalization of SMEs

	R ²	R ² adjusted	F	Sig.
Model 1- Intstrag*	0,895	0,895	3976,100	0,000
Model 2- Intentrep*	0,867	0,867	3473,407	0,000
Model 3- Intcomm*	0,776	0,775	2312,760	0,000

Model 1 (*): Variable to be explained in the regression: Intstrag-International strategic orientation.

Model 2 (*): Variable to be explained in the regression: Intentrep-International entrepreneurial orientation.

Model 3 (*): Variable to be explained in the regression: Intcomm - Internationalization commitment.

The observation of the above schedule also shows the overall significance through the fisher statistics (F) and the importance of the explanatory powers measured by R2 of the different models, that is to say, the models are important to explain the determinants of internationalization and their impacts on the commitment to internationalization, the international strategic and entrepreneurial orientation. Thus, our models explain respectively, 89% for the first model, 86% for the second model and 77% for the third model of the variation in internationalization of SMEs. We now proceed to test the research hypotheses associated with these models.

2) *Verification of Hypotheses Testing the Impact of Determinants on the Internationalization of SMEs:* For the results on the impacts of independent variables on the internationalization of SMEs, the schedule presents the linear regression coefficients corresponding to the direct effects between the variables. In this schedule, the standardized coefficients β show the magnitude of these effects and the Student t values express the relationships between the variables in the model and thus allow the research hypotheses to be tested. A relationship between two variables is considered statistically significant only when the value of Student's t is greater than 1.96 and the value of his p is less than 0.05. As a result, several of our assumptions were confirmed and some others were rejected. It should be recalled that we considered internationalization through three variables to be explained, referring respectively to the international strategic orientation, the international entrepreneurial orientation and the internationalization commitment. Therefore, we present the specific results obtained from the multiple linear regression analysis.

TABLE IVV

Estimation of the Regression Model Establishing the Effect of Executive Manager's Profile Variables on Internationalization

The relationship between the manager's profile and internationalization				
Link	Hypothesis	β	T	P
Exp→Intstrag	H1.1.1	0,147	3,578	0,000
Levstud→Intstrag	H1.1.2	0,036	4,476	0,000
Know→Intstrag	H1.1.3	0,027	2,636	0,009
Attit→Intstrag	H1.1.4	0,089	3,002	0,003
Exp→Intentrep	H1.2.1	0,143	4,602	0,000
Levstud→Intentrep	H1.2.2	0,017	2,642	0,009
Know→Intentrep	H1.2.3	0,021	2,513	0,013
Attit→Intentrep	H1.2.4	0,095	3,301	0,001
Exp→Intcomm	H1.3.1	0,239	6,100	0,000
Levstud→Intcomm	H1.3.2	0,017	2,317	0,021
Know→Intcomm	H1.3.3	0,034	3,701	0,000
Attit→Intcomm	H1.3.4	0,076	2,524	0,012

The results show that the level of training of the Tunisian entrepreneur-director has an influence on international expansion. The most trained are more involved in a process of internationalization, which is confirmed by the literature review. In particular, the more experience the manager has, the more easily he adapts to the foreign market, which leads his company to internationalize more quickly. In addition, our results show that the entrepreneur's knowledge seems to have a positive and significant influence on international development. In addition, the results show a positive and significant relationship between the manager's attitude and internationalization. Indeed, the manager's attitude is a key explanatory factor in internationalization. These results clearly confirm that the internationalization of SMEs is an entrepreneurial act that depends on the profile of the manager [18], [36], [39], [59], [64]-[127]

TABLE V

Estimation of the Regression Model Establishing the Effect of Human and Social Capital Variables on Internationalization

The Relationship between human and social capital and internationalization				
Link	Hypothesis	B	T	P
Comp→Intstrag	H2.1.1	0,074	2,824	0,005
Lingui→Intstrag	H2.1.2	0,288	7,544	0,000
Socnetw→Intstrag	H2.1.3	0,080	2,378	0,018
Comp→Intentrep	H2.2.1	0,065	2,466	0,014
Lingui→Intentrep	H2.2.2	0,190	4,232	0,000
Socnetw→Intentrep	H2.2.3	0,097	2,162	0,032
Comp→Intcomm	H2.3.1	0,073	2,931	0,004
Lingui→Intcomm	H2.3.2	0,252	5,682	0,000
Socnetw→Intcomm	H2.3.3	0,072	2,350	0,020

In the same context, concerning the relationship between the profile of human capital and internationalization, our results show that human resources have a significant and positive influence on the internationalization of SMEs. This important role of human capital in the internationalization of SMEs has been identified by reference [103], where they demonstrated that investment in human capital improves the company's productivity, which facilitates its international development, which is consistent with our results. In particular, our empirical results show that human skills have a positive and significant influence on international expansion. The more the company has the developed human skills, the faster it will tend to internationalize, which is confirmed by the literature

review. Thus, language skills make inter-organizational communication easier, which encourages companies to expand internationally. Similarly, belonging to international social networks allows the company to develop internationally. These social networks guide SMEs towards business opportunities abroad. These results are in line with those of reference [12], who identified the opportunities and dynamics of international networks throughout the internationalization process. Thus, the internationalization of SMEs is an entrepreneurial act that depends on the human and social capital of the company [12], [51], [58], [63]-[103]

TABLE VI

Estimation of the Regression Model Establishing the Effect of SMEs Profile Variables on Internationalization

The Relationship between the profile of SMEs and internationalization				
Link	Hypothesis	B	T	P
Fina→ Intstrag	H3.1.1	0,048	2,514	0,013
Age→ Intstrag	H3.1.2	0,001	0,305	0,761
Size→ Intstrag	H3.1.3	0,016	2,055	0,041
Fina → Intentrep	H3.2.1	0,060	3,888	0,000
Age→ Intentrep	H3.2.2	-0,058	-4,388	0,000
Size→ Intentrep	H3.1.3	0,053	4,256	0,000
Fina → Intcomm	H3.3.1	0,085	4,808	0,000
Age→ Intcomm	H3.3.2	0,013	2,137	0,034
Size→ Intcomm	H3.3.3	0,011	2,168	0,031

Hypothesis (H3) relates to the determination of the relationship between the profiles of SMEs, in particular age, company size and financial resources at the time of internationalization, and the phenomenon of internationalization expressed in terms of internationalization commitments, strategic and entrepreneurial orientations of the company. Our results confirm the decisive role of company size and financial resources in international expansion, and also the decisive role of the company's age in the commitment to internationalization. In particular, the results show in particular that the means of financing influence internationalization commitments, strategic and entrepreneurial international orientation.

In addition, the involvement of SMEs in international activities depends on access to sources of finance. Companies with significant financial resources have fewer obstacles and problems in the face of internationalization. In addition, the results show that a significant and positive relationship

between the size of the company measured by the workforce and internationalization. As a result, the larger the company, the more resources and skills it will have to compete in international markets. Thus, the results show that the young age of Tunisian companies is very important for triggering the process of internationalization in an international entrepreneurial context. On the other hand, the results show that older companies are fully engaged in internationalization activities because of their high level of understanding of foreign markets, much higher than younger SMEs (positive and significant relationship between age and international engagement) This result is consistent with the theoretical foundations provided by the Uppsala model. According to these results, the internationalization of SMEs is an entrepreneurial act that depends partly on the company profile [54], [86], [111]-[113].

V. CONCLUSIONS

Our research aims to identify the factors that influence the dynamics of internationalization of Tunisian SMEs In order to address our problem related to the development of SMEs abroad; we conducted a review of theoretical literature, descriptive and explanatory analyses on the dynamics of internationalization and on the key factors of internationalization of SMEs. In the first part, we conducted a theoretical review on the internationalization of companies by comparing the following theoretical approaches: the incremental-stage approach to internationalization, the International New Venture- INV approach, the economic approach and the network approach. In addition, we have conducted research in international entrepreneurship that seeks to explain the determinants of internationalization of SMEs. This research shows that the internationalization of SMEs is an entrepreneurial act [18]. Indeed, we presented a theoretical basis for the influence of internal and external factors on the internationalization of SMEs, more particularly factors related to the company's resources and skills. All these conceptual clarifications allowed us to construct a conceptual model and deduce research hypotheses to explain the suggested relationships that are articulated on the theoretical foundations of the internationalization process of companies as described by the Uppsala model [91], the Laghzaoui model (2009) [81], the Lemaire model (2013) [84], and the contributions of international entrepreneurship. In the second part, we presented the general framework of the research by cutting through our conceptual model and research hypotheses, the methodological framework of the research and the presentation of statistical analyses, results and their discussions. The theoretical framework used to develop the conceptual model is that of the resource and skills approach and the network approach. In this perspective, our research contributes to the identification of the determinants of entrepreneurial internationalization of SMEs. It shows a strong interrelationship between the company's resources and skills. This interrelation aims to enrich the traditional framework of the analysis of the dynamics of internationalization, by taking into account the personal resources of the entrepreneur-

manager, human skills, the networks to which the company belongs and the characteristics of the company.

- Synthesis of the results: This article focuses on the identification of the determinants of SMEs internationalization presented by resources and skills. In particular, resources and skills are defined by the profile and attitude of the manager, human and social capital and the profile of SMEs. The results clearly demonstrate the decisive role of the entrepreneur in the international expansion of SMEs. Thus, it can be seen that knowledge related to international business, past international experiences, level of education and attitude of the entrepreneurial leader, constitute the key variables for development towards foreign markets. It turned out from the empirical study that the entrepreneur profile is a key determinant of the internationalization of Tunisian SMEs. Thus, the empirical analysis of the responses collected made it possible to draw significant conclusions that confirm previous work and enrich the empirical literature [35], [39]-[64]. The results also show that human resources are identified as key factors in the internationalization dynamics of the SMEs in our sample. Indeed, the skills of SMEs staff remain a key factor in achieving international strategic objectives, given their direct interaction and close relationships with customers. As a result, the intention to engage in international business is due to human qualifications in terms of language skills and level. Also, the international networks to which companies belong influence the expansion abroad and subsequently the formal and informal links of the company's human capital with other foreign individuals play a key role in internationalization, particularly through the information they provide. In addition, the results show that the more financial resources the company has at its disposal, the easier it will be to implement the internationalization process. The results obtained confirm the positive link between the size of the company and internationalization. However, statistical analyses do not support a positive relationship between age and internationalization except at the level of internationalization commitments. The results obtained show that age does not affect the strategic orientation of the SMEs in the sample studied. In addition, the analysis shows that age is negatively related to international entrepreneurial orientation. As a result, the significant relationship attributed to age and international entrepreneurial orientation is negative, contrary to the expected effect. Moreover, the analyses show that the younger the company, the more it seems to have an international entrepreneurial spirit. As a result, the age of the company significantly and positively affects the commitment to internationalization, which implies that older and larger companies are more involved in international collaborative relationships.

- Contributions and implications of research: On the theoretical level, the first contribution of this research lies in a more in-depth reflection on the internationalization of SMEs as an entrepreneurial act. Indeed, we proposed a multidimensional model that integrates the lessons of the step-by-step, network and INV approach in explaining the success of international SMEs development from an entrepreneurial

perspective. Thus, the conceptual model of this research borrows from this three-dimensional analytical logic: international entrepreneurial orientation, international strategic orientation and internationalization commitment. The second contribution is to contribute to the enrichment of the still limited research work on the determinants of internationalization in the context of SMEs. We have therefore proposed an analytical framework that integrates factors related to skills and resources, which contributes to a better understanding of the phenomenon of internationalization of SMEs. Through the results it presents, this research has provided a grid of key success factors for the internationalization of SMEs with an entrepreneurial perspective. At the managerial level, the results of our research have practical implications, both for managers and for political organizations responsible for promoting internationalization through the creation of favorable conditions. As a result, our research makes it possible to raise awareness among managers about the main determinants. Thus, raise managers' awareness of the main determinants that promote internationalization in order to make the right decisions in the management of internationalization activities. Finally, providing a grid of determining factors for internationalization could be a reference base that can be used by business leaders who wish to develop international activities.

- Limits and perspectives: The conclusion of this article is an opportunity for a critical reading of the work done. This reading leads to a discussion of the limits, which are sources of the first research perspectives. Others have emerged mainly as a result of new readings on the internationalization model for SMEs. Our study was based only on a study based on the determinants of internationalization, so it would be interesting to propose as a research approach to study the behavior and process of internationalization across dimensions such as age, degree and speed of internationalization. In addition, our study takes a static and non-dynamic view of the factors affecting the internationalization of SMEs, so it would be important to conduct a longitudinal study over time could better inform us about the dynamics of internationalization. Thus, the sample size is considered small and not representative of all SMEs, so the study sample must be expanded to better generalize the results. Finally, we recognize that the data analysis strategy is quite traditional, so it would be interesting to use more sophisticated statistical methods in future research such as the structural equation method and neural networks. These different perspectives lead to further research in the direction of a better understanding of the internationalization of SMEs.

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The transition to renewable energy in Tunisia: The case of the photovoltaic system connected to the Grid

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Abstract—This paper presents the situation and the guidelines Tunisia energy and the network-connected photovoltaic systems. Moreover a photovoltaic energy system connected to the grid under solar irradiation and temperature levels has been presented. For this purpose photovoltaic with maximum power point tracking model based on Perturb & Observe method (P&O) is developed and applied. Some reliable simulation results are provided to check the efficiency of the proposed algorithm for connection between the photovoltaic model and the grid.

Keywords—Energy; Prosol; Grid; Economic development; Sustainable development; Environment; Photovoltaic panel; P&O; DC/DC boost converter; DC/AC converter.

I. INTRODUCTION

Maghreb cities are characterized by a strong demographic and migratory boom. In Tunisia, the urban population increased from 37.5% to 66.9% between 1960 and 2009. This movement of urbanization, correlated to the national economic growth, induces increased energy needs and increased environmental impacts (Ministry Environment and Spatial Planning, 1995) [8;9,16].

Tunisia is one of the first developing countries to pursue a proactive energy saving, production and use of renewable energy technologies. There are no energy policies in Tunisia explicitly dedicated to the urban environment. We support the idea that the urban solar energy market has, in fact, developed as a result of the establishment of government support mechanisms. The implementation of these policies is a major focus of our thinking because the introduction of new sustainable energy consumption modes also contributes to a new management of the city. It is a question of how to build and of which the sustainable city is built through the question of the dissemination of solar equipment to Tunisian households. The impact of government programs on domestic consumption has been greater in the residential sector, primarily targeted [5;7].

The production of the Photovoltaic energy provide DC voltage who is converted to AC voltage with the DC/AC converter in order to be connected to the grid [3;11;14].

Usually the photovoltaic panel use a maximum power point tracking control unit to run the system at the optimized point.

Different control strategies MPPT using DC/DC converter have been proposed in literature. Among these, the most widely used ones are Perturb and Observe (P&O), Incremental Conductance (INC) and Fuzzy Logic algorithms [1,2;4;15].

Grid-connected PV systems are traditionally classified by power capacity, which are listed as small-scale, intermediate-scale, and large-scale. PV generators that are less than 50 kW are usually considered as small scale PV systems. A system that can produce more than 1 MW is commonly considered as large-scale or utility-scale, although this category now covers systems up to tens or even hundreds of MW. Systems between these two ranges are designated as intermediate-scale [3].

In this paper, the photovoltaic powered system mainly consists of a photovoltaic panel, DC/DC converter and DC/AC inverter.

This paper is organized as follows. In section 2, we introduce the situation and guidelines Tunisia energy. In section3, we presented the network-connected photovoltaic systems and the net-metering system. The promotion of renewable energies in Tunisia is described in section 4.

The fifth section deals the PV energy system. In section 6, we presented the Perturb & Observe MPPT algorithm. Then we discuss the numerical simulation results of PV model connected to the grid in section 7.

Finally, conclusions are drawn in the final section.

II. SITUATION AND GUIDELINES TUNISIA ENERGY: MECHANISMS FOR THE VALORISATION OF RENEWABLE ENERGY

Since the 1980s, the issue of energy sufficiency in Tunisia has gradually emerged as a major economic constraint. During the 1970s and 1980s, however, the energy sector played a key

role in Tunisia's economic development. With an annual output of over 5 million toe since the early 1970s, hydrocarbons have in fact largely contributed to economic growth and the strengthening of public finances. They have long been among the basic elements of the trade balance and the main provider of foreign exchange for the country [6;10].

However, from the 1980s, the decline in revenues from hydrocarbon exports and the significant growth in national energy needs, a direct consequence of changes in consumption practices and the improvement of the standard of living of the population, contributed to more than halving the energy sector's share of GDP; it has risen from 12.9% to 5.9% between 1980 and 1997. To cope with this situation, the public authorities have put in place a strategy based on two major axes. The first axis sought to intensify oil and gas exploration and exploration efforts; the second aimed at implementing a voluntarist policy of energy management, encouraging the rational use of energy and the development of renewable energies [9].

The commitment of the Tunisian state did indeed manifest itself very early in the field of energy efficiency and renewable energies. This initiative marks the institutionalization of the desire for greater energy control. A national coordinating agency for energy strategies and the National Agency for Energy Management have been created to respond to the various energy challenges facing the Tunisian state, including the depletion of fossil resources, the deficit the country's energy supply (and its impact on the state budget), and the continued growth in the global cost of energy.

In addition, from the 1990s onwards, environmental concerns emanating from a greater awareness of the international community (global warming, the greenhouse effect, etc.) become more global. In 1993, Tunisia signed the Framework Convention and then the Kyoto Protocol in 2002, thus showing its concern to participate in the global dynamic. Yet, like other developing countries, Tunisia has no binding commitments to reduce greenhouse gas emissions [7;13].

The solar photovoltaic sector remains, during this decade, very embryonic and it is a system of financing intended for the actions allowing the preservation of the environment [10;12].

Efforts to control energy are not without interest because they allow Tunisia to exploit the financing opportunities provided by international agreements on climate change. In the 1990s, for example, the marketing of individual solar water heaters in Tunisia aroused the interest of donors and the international community, especially since its impact is beneficial to the environment, on the sole condition to address the problem of investment cost. The United Kingdom and Belgium have granted Tunisia a grant of \$7.3 million to revive this project market. To ensure the sustainability of the development of this sector, the various stakeholders of the project, have taken measures to overcome the obstacles that have led to the failure of the diffusion of solar water heaters. One of the flagship initiatives was to put in place a non-

refundable 35% cost of investment for water heating system users [5;8].

In the field of renewable energy and energy efficiency, a series of regulatory, fiscal and financial measures, synthesized, have indeed marked the evolution of the sector (that of the solar water heater in particular) from 1985 to the 2000s.

III. NETWORK-CONNECTED PHOTOVOLTAIC SYSTEMS AND THE NET-METERING SYSTEM: AN UNPRECEDENTED TUNISIAN EXPERIENCE IN THE MAGHREB

The Energy Control Law n° 8-2009 of 9 February 2009 stipulates that "Any establishment or group of establishments operating in the industrial, agricultural or tertiary sectors and which produces electricity from renewable energies. for its own consumption, enjoys the right to transport the electricity thus produced, through the national electricity grid to its points of consumption and the right to sell surplus exclusively to the Tunisian Electricity and Gas Company ". This law specifies that the incumbent monopoly operator, STEG, must buy back the renewable electricity surplus produced by the private beneficiary of the Prosol. This system is called "net-metering". It differs from the feed in tariff mechanism in force in most European countries or in southern Mediterranean countries such as Israel and Algeria. The latter has a feed in tariff system, but it has created neither the supply nor the demand for solar energy. According to the law 13/09 on renewable energies, in Morocco, "installations for the production of electric energy from renewable energy sources can only be connected to the national electricity grid of medium voltage, high voltage or very high voltage"[9;13;16].

Households are connected to the low-voltage grid. Morocco therefore does not have a regulatory framework that allows the "marketing" and "domestication" of photovoltaic by individuals.

IV. THE PROMOTION OF RENEWABLE ENERGY IN TUNISIA

Tunisia can, despite many failures, have more than twenty years of experience in the promotion of renewable energies. However, the Tunisian government made a real change of scale only from 2005, the year of creation of the National Fund for the Control of Energy, itself at the origin of the so-called programs "Prosol".

Public action has been decisive in the creation of a domestic market for solar energy in Tunisia. By structuring the demand, in a few months, it has stimulated a remarkable business creation dynamic. However, if the short-term success of this Tunisian solar energy policy is partially demonstrated, it is not assured without government support that would support a national sector. Greater local industrial integration, which would engage the country in the longer term, would allow the sector to be autonomous with regard to ad hoc support mechanisms and would anchor these sustainable

consumption patterns more securely in everyday household practices Tunisian [7,8,9].

Moreover, the transposition of these solar equipment in a given urban environment comes up against technical requirements, while at the same time revealing socio-economic discrimination contrary to the challenges of sustainable development. The application of the Prosol programs, which underlies an attempt to democratize the use of solar energy, is a Tunisian singularity which, by showing its limits, makes it possible to take a step back on the means that the public authorities must deploy to concretely support the sustainability effort at the scale of the Mediterranean city [9,10;16].

V. PHOTOVOLTAIC SYSTEM ENERGY

The schematic global of the PV energy system connected to the grid is described in Figure 1.

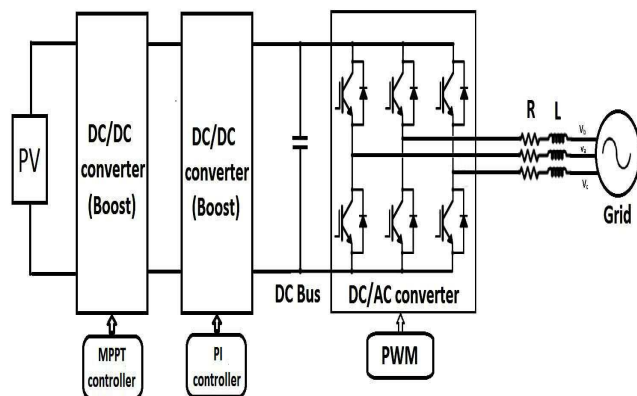


Figure 1. PV energy system connected to the grid.

1. Electrical PV Array Model

The photovoltaic cell can be modeled by the following equations [1]:

$$I_{pv} = n_p I_{ph} - n_p I_{rs} \left(e^{\frac{qV}{pKTn_s}} - 1 \right) \quad (1)$$

The generated current I_{ph} is given by the following equation :

$$I_{ph} = (I_{ph,n} + K_I \Delta T) \frac{G}{G_n} \quad (2)$$

where $I_{ph,n}$ is the rated current generated by the PV model under standard condition of irradiation and temperature ($G=1000W/m^2$ and $T=25^\circ C$).

I_{rs} is the reverse saturation current, is modeled by :

$$I_{rs} = I_{rr} \left(\frac{T}{T_r} \right)^3 \exp(qE_{gp} (1 - T_r - 1/T)) / pK \quad (3)$$

where I_{rr} is the reverse saturation current at the reference temperature T_r .

2. DC/DC Converter

When a direct connection is carried out between the source and the grid, the output of the PV panel is seldom maximum and the operating point is not optimal. To overcome this problem, it is important to add an MPPT controller with a DC/DC converter, between the source and the grid.

There exist many type of DC/DC converter such as Buck, Boost and Buck-Boost. In summary [2]:

- The output voltage of the DC/DC buck converter is: $V_{out} = \mu V_{in}$

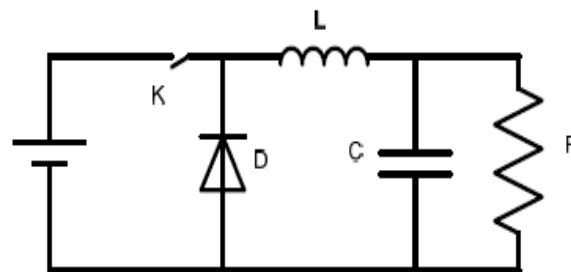


Figure 2. Buck converter.

- The output voltage of the DC/DC boost converter is: $V_{out} = \frac{1}{1-\mu} V_{in}$

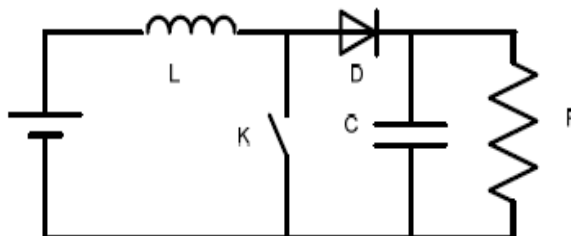


Figure 3. Boost converter.

- The output voltage of the DC/DC buck-boost converter is: $V_{out} = -\frac{\mu}{1-\mu} V_{in}$

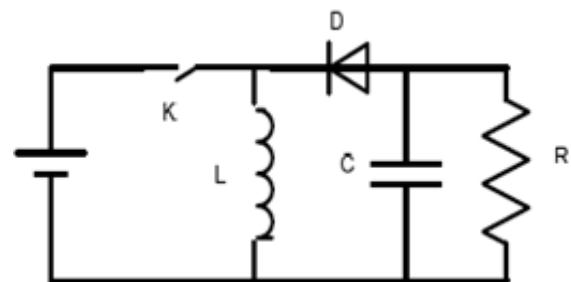


Figure 4. Buck-Boost converter.

where μ is the duty cycle varies between 0 and 1. In our case we use a DC/DC boost converter.

VI. PERTURB & OBSERVE MPPT TECHNIQUE

The maximum power point tracking used in this work is the Perturb & observe MPPT method (P&O). The principle of this command is to generate the disturbances by reducing or increasing the duty cycle μ and to observe the effect on the power delivered by the photovoltaic generator [2,4,15].

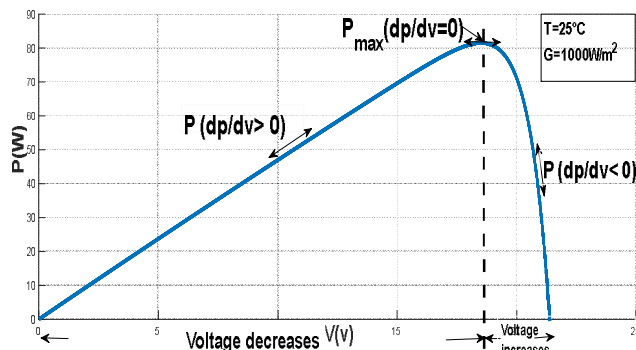


Figure 5. Characteristic of the power of the PV generator.

The algorithm of this command is shown in Figure 6.

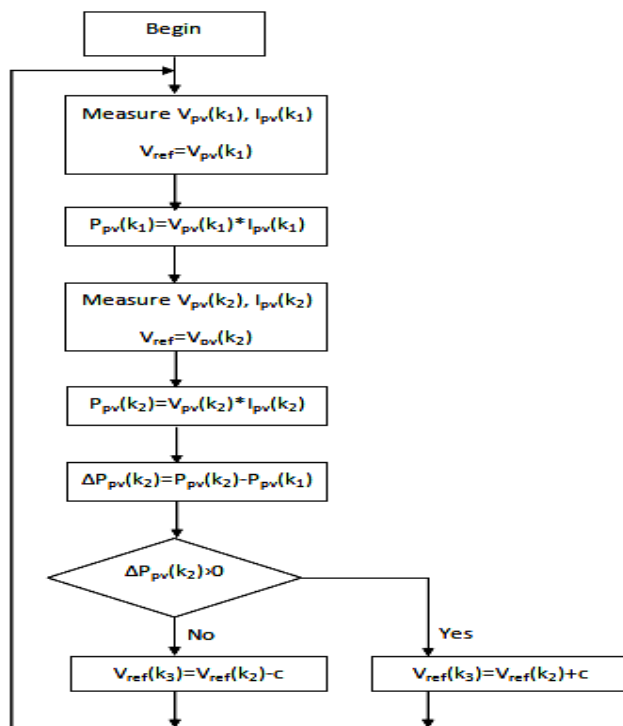


Figure 6. Flowchart of the Perturb and Observe method.

- If $dpv/dVpv > 0$, the voltage is increased, this induces an increase of the duty ratio $\mu(k) = \mu(k-1) + C$.
 - If $dpv/dVpv < 0$, the voltage is reduced, this results in a decrease in the duty cycle $\mu(k) = \mu(k-1) - C$.
- where C is an accretion constant.

VII. NUMERICAL SIMULATION

In order to check the performance of the P&O algorithm, we have selected four pairs of temperature and irradiation.

The evolution of irradiation and temperature are given by Figures 7 and 8.

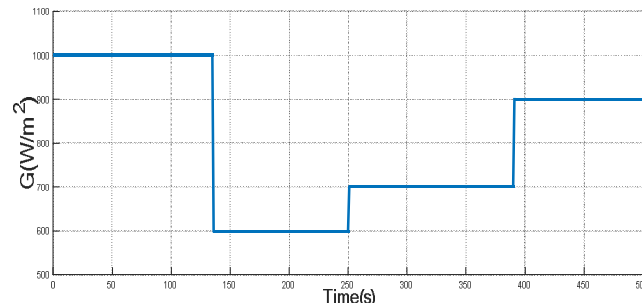


Figure 7. Evolution of irradiation.

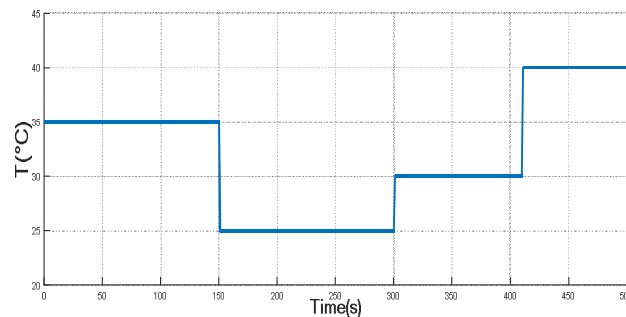


Figure 8. Evolution of temperature.

The evolution of the PV voltage, the error of PV voltage, the evolution of PV current and the error of PV current according to the P&O algorithm are presented respectively in Figures 9, 10, 11 and 12.

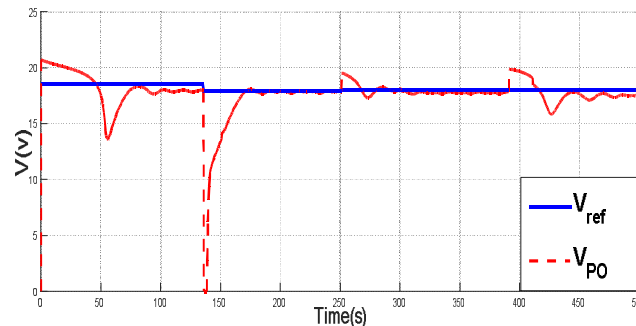


Figure 9. Evolution of the voltage for P&O algorithm.

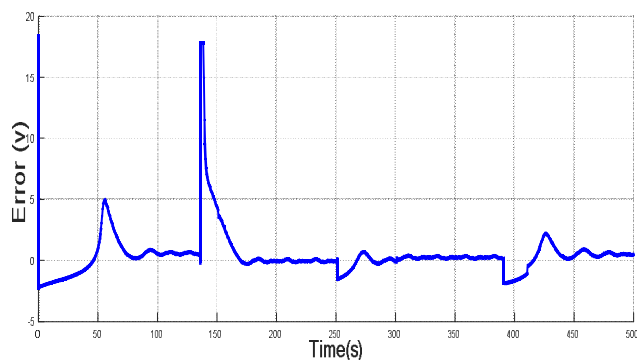


Figure 10. Evolution of the error PV voltage.

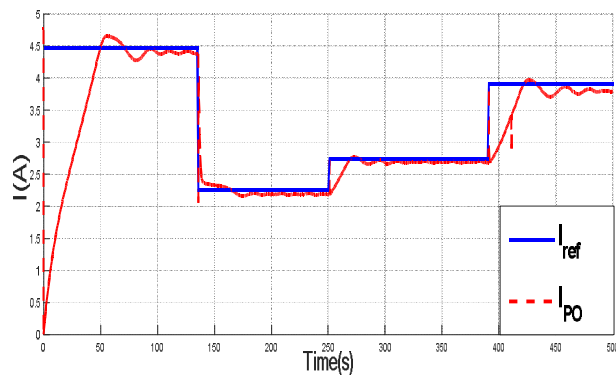


Figure 11. Evolution of the current for P&O algorithm.

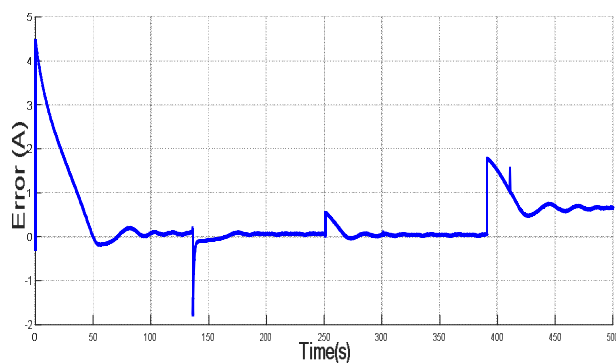


Figure 12. Evolution of the error PV current.

The Figure 13 shows the panel delivered power.

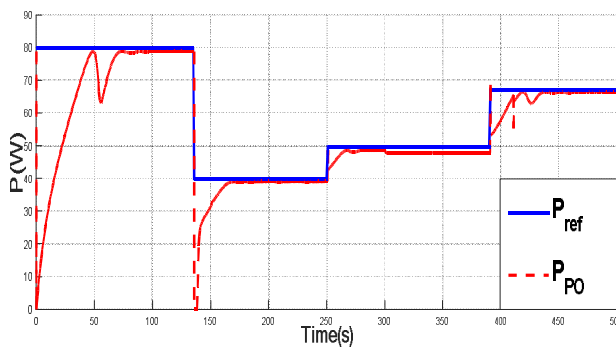


Figure 13. Evolution of the power for P&O algorithm.

In Figures 9, 11 and 13, we can notice momentary peaks, they are due by the abrupt and significant change in temperature and irradiation.

It can be seen in Figures 10 and 12 that the P&O algorithm present less oscillations and the errors tend towards zero.

We can observe that the P&O MPPT algorithm can be tracking the maximum power point of the PV panel.

In order to increase the output voltage of the DC/DC Boost converter, we used another DC/DC Boost converter with PI controller.

To achieve grid interconnection by converting the DC current from the PV panel to a sinusoidal signal synchronized with the grid you must using a DC/AC inverter with an RL filter to improve the waveform quality of the signal and to have the shapes of three-phases signal [3;11;14].

The Figure 14 shows the current signal waveform of the photovoltaic panel after connection with the DC/AC converter.

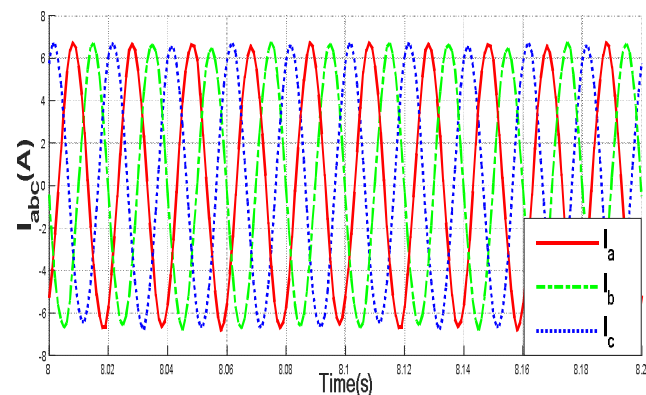


Figure 14. Currents at DC/AC converter connected to the grid.

It can be seen that the inverter currents have the shapes of three-phases signal.

In fact, the frequency, the current and the voltage signals from the photovoltaic process are been converted to the synchronous frequency of the utility grid by the DC-AC inverter.

VIII. CONCLUSION

In this work, the situation and the guidelines Tunisia energy and the network-connected photovoltaic systems and the net-metering system have been studied.

In addition, we have presented a photovoltaic energy system and the complete mathematical model for the PV panel and we have described the P&O MPPT algorithm for the

maximum power point tracking of the solar power generation system connected to the grid.

We can conclude that the simulation results show the performance and the efficiency of the proposed MPPT algorithm.

In a future work, we can realize the pumping system by using a PV process.

Nomenclature

T	Temperature
G	Irradiation
E_{gp}	Band-gap energy
q	Charge of electron
K	Boltzmann's constant
n_s	Number of serial PV cells
n_p	Number of parralel PV cells

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What impact does market dynamics have on the supply chain network and capabilities? - The case of the automotive industry in Morocco

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Abstract— Several operational supply chain models have developed, such as the agile model, to respond to markets that are more turbulent than ever before. This implies that the relationship already exists between the supply chain - with its capabilities and network - and market dynamics. The objective of this research is to effectively study this relationship in the context of the automotive industry in Morocco. The results reveal a dependence between market dynamics and the supply chain network. However, the relationship between the market dynamics and the supply chain capabilities has not been confirmed.

Keywords— Turbulent markets, market dynamics, supply chain network, supply chain capabilities, product customization, impact assessment.

I. INTRODUCTION

Nowadays, many markets are turbulent and this forces supply chains to adapt [1]-[2]-[3]. Researchers and practitioners are thus trying to develop operational models of the supply chain in order to face the volatile demand [4]-[3]. Like the agile model that is now designed to cope with turbulent markets [5]. However, some researchers and practitioners note that the agile models developed in the face of turbulent markets mask certain criteria as well as the complexity factor [6]. Indeed, as complex or hard customized products are studied, they challenge the agile model, which among its basic principles is to drive out complexity [7]-[8].

References [7]-[8] show that it is not possible to cope with turbulent markets in different situations ; each market situation requires a specific supply chain network. This is the point triggering our problematic. Do volatile markets characterized by complex products have an impact on the supply chain network ?

This study aims to study the impact of turbulent markets on the supply chain network and its capabilities. We chose the automotive industry in Morocco, given that the car is considered a complex product. Our questioning becomes the following : What impact does market turbulence have on the supply chain network and capabilities in the automotive industry in Morocco ?

II. AGILITY AND TURBULENT MARKETS

Reference [5] defines it as “[...] a business-wide capability that embraces organisational structures, information systems, logistics processes and, in particular, mindsets” to deal with market changes in terms of volume and variety. The agile model is designed to meet markets with volatile demand, high product variety and short product life cycles [9]. And for that, the agile supply chain is characterized by :

- Market sensitivity : “that the supply chain is capable of reading and responding to real demand”;
- Shared information between supply chain partners : by the use of information technology and creating virtual supply chain ;
- Process integration : collaborative working between buyers and suppliers, joint product development, common systems and shared information ;
- Focus on managing the core competency and outsource all other activities ;
- Postponement : creating a decoupling point and using generic or modular inventory ;
- Identifying strategic suppliers and create a closer relationship ;
- Reducing complexity : “includes not only design issues (e.g. the number of non-standard components in a product) but also excessive variety that does not contribute to greater customer or consumer value” [5].

Among the principles to be respected in agility, postponement and complexity reduction. These two principles make it possible to deliver a wide variety of products to the market without making a major change in the supply chain since the decoupling point is very close to the downstream of the supply chain [6]- [9].

III. HARD AND SOFT CUSTOMIZED PRODUCTS

However, it is not always possible to afford these two practices. Indeed, it is necessary to distinguish between products that allow reducing complexity called soft-customized product and products that do not allow it called

hard-customized product [7]-[8]. Hence, complexity requires to be integrated into models that study the supply chain in turbulent and volatile markets [6].

References [7]-[8] show that it is not possible to cope with turbulent markets in different situations ; each market situation requires a specific supply chain network. As far as soft customized products are concerned, these allow for long distribution channels, unlike hard customized products that require shorter distribution channels, the producer is required to deliver the products directly to the final consumer via dealers just as the case of the automotive industry or gardening machinery. Hard customized products affect also all suppliers and strong interactions are needed, some suppliers come even to settle near their customer's plant. Unlikely to soft customization which affects only swappable components suppliers.

However, when demand fluctuates in terms of volume, engagement with suppliers may be problematic. When demand increases some suppliers may become bottlenecks and not keep up [7]. When it goes down, the commitment with the suppliers would become a burden, and in general a very strong relationship with the suppliers risks making the supply chain less responsive to the variation of the demand in term of volume [7]-[10].

H1 : The level of complexity of the products demanded by the market (demand variety) and demand variability (market turbulence) have an impact on the supply chain network.

Otherwise, faced with the constant change in the market situation, the supply chain must have a cross functional teams ready to learn new working techniques and launch new products [11] - [12]. Moreover, reference [13] highlights the factor integration with customers and suppliers that allows the rapid flow of information and hence a better responsiveness. In addition, the turbulence of markets does not allow the company to invest in resources that can quickly become obsolete, it is therefore necessary to outsource the manufacture of certain components or processes [14]. And when it comes to processes not to be outsourced, the supply chain must rely on a reliable process reengineering [15].

H2 : Market turbulence has an impact on supply chain capabilities.

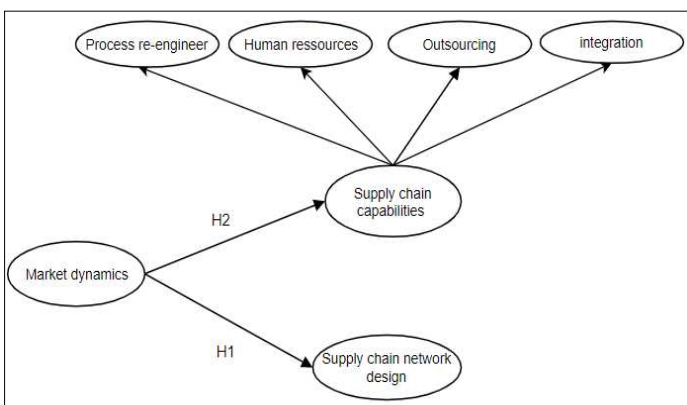


Fig.1 Structural model

IV. EXTERNAL MEASUREMENT MODEL EVALUATION

Before assessing the causality between the variables, it is necessary to check the reliability and the validity of the measurements. To evaluate convergent validity, it's necessary to consider the outer loadings or factor loadings of the indicators and the average variance extracted (AVE). The first must have at least a value of 0.7 or more, while the second must have at least a value of 0.5 which means that the construct explains more than half of the variance of its indicators. If not, more variance remains in the error of the items than in the variance explained by the construct [16]. It is therefore necessary to remove certain items with a factor loading of less than 0.7. However, those can remain if their factor loading is between 0.4 and 0.7 and allow the improvement of the AVE. But if it's less than 0.4 it must be removed [17]-[18]. Much like Cronbach's alpha, composite reliability measures the internal consistency, with a threshold of 0.7 [19].

TABLE I
 RESULTS OF MEASUREMENTS MODEL – CONVERGENT VALIDITY

Constructs	Items	Loading	CR	AVE
Market dynamics	AV	0,797	0,760	0,612
	HCP	0,768		
Process reingeniring	SPPD	0,941	0,869	0,770
	EID	0,809		
Human resources	HR2	0,834	0,742	0,591
	HR3	0,698		
Outsourcing	OS1	0,983	0,764	0,636
	OS6	0,553		
Integration	IC1	0,604	0,707	0,554
	IC2	0,862		
Supply chain network design	LDN2	0,695	0,761	0,617
	LSN	0,866		

The above tables show acceptable results and thus confirm the convergent validity, after which we move on to the discriminant validity which tests whether the construct is represented by itself. This implies that the measurement items do not overlap and do not measure another model construct either [16]-[20]. For this reason, an indicator's outer loading on the associated construct should be greater than any of its cross-loadings. It's also necessary to assess the discriminant validity by the Fornell-Larcker criterion. It compares the square root of the AVE values with the latent variable correlations, the objective is to avoid multicollinearity issues." [16]-[21].

TABLE II
 LATENT VARIABLE CORRELATIONS

	Human resources	Market dynamics	Outsourcing	Integration	Process reengineering	supply network design
Human resources	0,769					
Market dynamics	0,246	0,783				
Outsourcing	0,165	-0,239	0,798			
Integration	0,521	0,044	-0,044	0,744		
Process reengineering	0,335	-0,007	0,014	0,046	0,877	
supply network design	0,158	0,494	0,025	-0,143	0,354	0,785

TABLE III
 DISCRIMINANT VALIDITY- CROSS LOADING

	Market dynamics	Human resources	Integration	supply network design	Outsourcing	Process reengineering
AV	0,797	0,396	0,167	0,346	-0,146	0,093
HCP	0,768	-0,023	-0,106	0,431	-0,230	-0,111
HR2	0,174	0,834	0,445	0,162	0,272	0,295
HR3	0,212	0,698	0,349	0,070	-0,059	0,213
IC1	-0,349	0,313	0,604	-0,177	0,052	-0,035
IC2	0,278	0,450	0,862	-0,066	-0,087	0,080
LDN2	0,312	0,107	-0,044	0,695	-0,235	0,209
LSN	0,450	0,139	-0,162	0,866	0,197	0,332
OS1	-0,268	0,143	-0,021	-0,004	0,983	0,048
OS6	0,019	0,179	-0,123	0,145	0,553	-0,149
SPPD	0,013	0,354	0,169	0,241	0,015	0,941
EID	-0,041	0,204	-0,179	0,466	0,008	0,809

V. INTERNAL MEASUREMENT MODEL EVALUATION

In order to test the research hypotheses, the first step is to calculate the standard beta, standard error, t and p value and the latter (the p-value) must be less than 0.05 [16].

TABLE IV
 PATH COEFFICIENT OF RESEARCH HYPOTHESES

Hypo	Relationship	Std. Beta	Std. Error	T-value	P-value	Decision
H1	Market dynamics → capabilities	0.613	0.678	0.904	0.366	Rejected
H2	Market dynamics → supply chain network design	0.503	0.141	3.574	0.000	Supported**

According to the results shown in the table above, hypothesis 1 is rejected while the second is accepted.

TABLE V
 TEST OF MODEL QUALITY

Construct	R ²	Adjusted R ²	Q ²	f ²
Supply chain network design	0.244	0.223	0.098	0.323

Regarding the quality of the model, the R-squared must be greater than 0.1 [22]. Reference [23] suggests that the R-squared values of 0.67, 0.33, and 0.19 can be considered as substantial, moderate, and weak, respectively. In this case, our R squared of 0.223 ; between 0.19 and 0.33 and this relationship can be considered weak. The effect size f² is the degree of impact of each variable separately on the endogenous variable. The Effect size, on the other hand, is the degree of impact of each variable apart on the endogenous variable and which is, in our case, of a value of 0.323, being between 0.15 and 0.35. The effect in this case is medium [24]. The effect size Q² above 0 indicates that the exogenous variable has a predictive power over the endogenous variable, and in this case is 0.098.

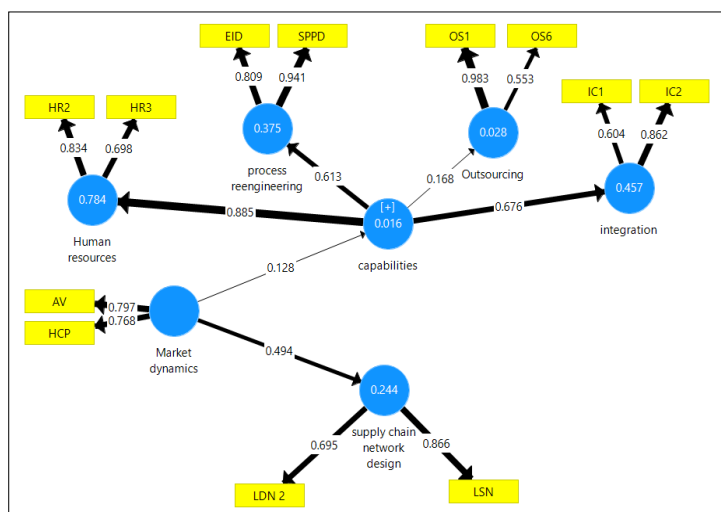


Fig.2 Conceptual model results

VI. DISCUSSION AND CONCLUSION

Through this study, the relationship between market dynamics and the supply chain network is confirmed and can be judged strong with p-value of 0.

We can deduce that the automotive supply chain network partly follows the nature of the market being characterized by a complex product. This is in line with the results of studies carried out in markets delivering complex products different from the automotive sector, such as gardening machines, microwaves and others [7]-[8].

These markets require that suppliers be located close to, or at least very close to, the manufacturer's plant so that they can make just-in-time (daily deliveries) or synchronous (delivery within a few hours) deliveries [25]. The results obtained in our study confirm this.

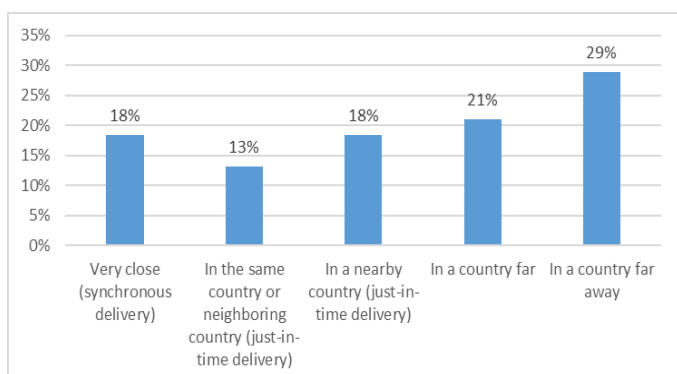


Fig3. Type of delivery made by the supplier

In our sample, 68% of companies report that their suppliers make synchronous or just-in-time deliveries. Synchronous delivery represents only 18%. But this result remains quite significant because this type of delivery is not easy to establish and requires a heavy investment, in addition to the long-term commitment with the supplier in question [25]. This is also due to the variation in demand in volume, which also does not encourage deep relationships with suppliers, as the supply chain may become unable to keep up with market trends and lack its adaptability [10]. If demand increases, suppliers may become bottlenecks [7].

With regard to the distribution chain of responding companies, 8% deliver synchronously and 55% deliver just on time for the same reasons cited for procurement.

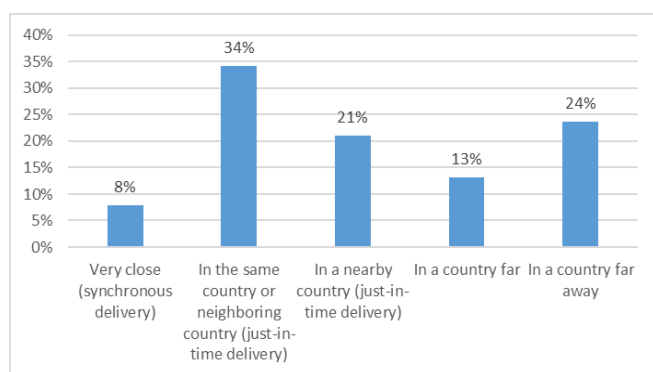


Fig.4 Type of delivery made by responding companies

On the other hand, the relationship between market dynamics and supply chain capabilities has not been confirmed. The capabilities of the automotive supply chain in Morocco do not follow the market trend and can be explained by other factors. This is not in line with the results of other studies [6]. Capabilities may depend on other factors as well as performance [26]. Some companies focus on financial performance and in particular productivity rather than customer satisfaction and responding to market trends. The new supply chain lessons encourage to avoid this mentality by confirming that competitiveness can be conditioned by lower productivity [27].

If the market becomes more unstable in the future, it is possible that supply chain capabilities will have to follow the market trend, which is not currently very unstable. Figures 4 and 5 shows that only 37 % of companies face a highly variable demand.

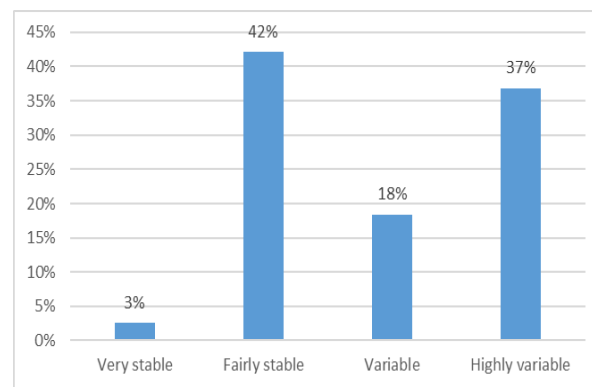


Fig.5 Variation in demand (in volume)

But demand variety is high, this is explained by the high level of customization / complexity of products in the automotive sector; the finished product, i. e. the car and equipment. Further research can study, in the same context, the impact of the supply chain capabilities and network on performance.

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Microeconometric analysis of the duration of unemployment for university graduates

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Abstract—

This study is a contribution to the analysis of the professional insertion process of young university graduates in Tunisia. Two orientations are processed. The first is to analyze the factors that may explain the duration of unemployment and the second is to estimate the duration. The methodology used in this work is quite answered in the study of employability and has never been used, to our knowledge, for the Tunisian data. The data discussed in this article are the result of the dynamics of employment and adequacy of training survey among university graduates, conducted jointly by the World Bank and the Ministry of Employment and Employability .n 2005 early 2006 , with a sample of 4763 graduates of 2004 different levels and teaching specialties distributed over the entire national territory. This is an analysis duration models. The interest of the analysis is to identify the key factors that influence positively or negatively the interval between the graduation date of the first job.

Keywords— Higher graduates, Unemployment, duration model.

I. INTRODUCTION

Although the period of rapid population growth in Tunisia is gone, the pressure of inflows in the labor market is still strong. Not only young adults entering the market are becoming more numerous, but they are also more educated, consequences of considerable efforts by the state to promote the accumulation of human capital. Given this new direction, how certain individual characteristics (demographics, training) they influence access duration to the first employment of young graduates of higher education?

The problem of unemployment in Tunisia is quite complicated by the interference of multiple dimensions. The stabilization of the national unemployment rate around 14%, conceals a creeping increase in unemployment of higher education graduates accounted for only 13.6% of the total number of unemployed in 2005, before recording a significant increase in be at a level of 20.9% in 2007. Employment of graduates is a social issue but also a matter of research. It was the subject of several studies that have used different concepts and instruments both theoretical and empirical (search job, human capital, filter, signal, employment policy¹).

The theory of the quest (Mortensen and Nagypal Shimer 2006) studied the process of professional integration in a clearer way. This theory is used to analyze the determinants of employment access times and their impact on the professional process of young graduates.

From an empirical point of view, studies on the Tunisian data bases were often limited to investigative reports or briefs with descriptive analyzes of the data and / or active employment policies. After recalling some elements of debates and results, we propose, from a longitudinal type of survey to study the duration of unemployment of the young university graduate. In this article, we will attempt to answer the following questions: What determines the period between graduation from the date of first use? Are graduates face the

¹ Couppier and Mansuy 2004

qualification adequacy training / job? Are there a gender effect at the insertion?

Thus, the main objective of this work is to model the duration of search for employment of higher education graduates in Tunisia generation 2004 and therefore their employability. The use of duration models estimates will conclude on the effect of individual characteristics and time on the time between graduation of the first job. To do this, we start with an exploratory analysis of the database. Then we will use specific econometric techniques to study the duration between graduation from the date of first use.

Recent years have seen a proliferation in Tunisia and abroad studies based on the exploitation of longitudinal data as to lead the work of the employment Assistance assessment to analyze the insertion process of young people.

The data discussed in this chapter are the result of the dynamics of employment and adequacy of training among university graduates conducted jointly investigated by the World Bank and the Ministry of Employment and Employability in late 2005 early 2006, with a sample of 4763 graduates of 2004 of different levels and specialties of teaching spread over the entire national territory.

Methodologically, the approach includes two additional steps: we seek, at first, to describe the structure of data and secondly, to use the results of this description to estimate duration models.

Thus, our work is divided as follows: the first part provides a descriptive analysis of our database. The second part is devoted to the econometric implementation and the results and their interpretations.

The SAS software will be a tool for both the descriptive part for the econometric part

Access to employment is related to individual characteristics (age, gender, marital status ...) and the characteristics of the economic model (the request for qualification). The level of education (Masters or senior technician or engineer), the training program (economics, human science, ... etc.) And the home institution are so many factors that can influence professional integration.

The econometric studies that have accompanied the development of the literature on search theory (Mortensen) have contributed, from the first insertion surveys (1976 CEREQ), to explain the influence of individual characteristics (Ahn-Ugidos Olazabal) and public employment policies (Christopher McKenna Bonnal Fern Serandon) on individual transitions on the labor market.

Previous analyzes generally use micro data on the duration of unemployment. Devine and Kiefer (1991) conducted a review of all of this work since 1977. In Belgium, several studies have been conducted on this issue, from micro data. Spinnewyn (1982) estimated the relationship between the output rate of unemployment and the individual characteristics of the unemployed. More recently, Mahy (1994) and Plasman analyzed the duration of unemployment in Wallonia. These studies include a correction for unobserved heterogeneity or unobserved individual characteristics, ie for non considered by the researcher variables. The restriction at the specification of the distribution period, recovery in the various studies, may bias their results.

Other empirical studies have attempted to identify the profile of unemployed youth, to account for the duration of unemployment and its evolution, and to identify the determinants. For the most part, they focus on individual determinants of long-term unemployment (Cases and Lollivier 1994) whether demographic (gender, age, nationality and marital status) or socioeconomic (initial training, qualification, professional background and length of unemployment).

II. LITERATURE REVIEW

In the analysis of the explanatory factors of individual transition from unemployment to employment, some econometric studies have focused their attention on the influence of individual characteristics and policies in place to improve the chances of finding employment 2.

Few empirical analyzes have so far dealt with this issue on the basis of Tunisian data. This is mainly explained by the fact that employment issues are of particular political dimension. Regarding international sources, especially the expertise of organizations such as the World Bank, one is tempted to believe in impartiality.

III. PRESENTATION OF STATISTICAL DATA AND DESCRIPTIVE ANALYSIS

The database is following the investigation insertion 2004 conducted by the Ministry of Vocational Training and Employment in Tunisia. The sample of 4763 university graduates, was investigated twice on the employment situation: a year and a half after graduation and two years later. The first round began in February 2004 and ended in March 2006 (26 months).

The second began six months before the date of the end the first pass.

Thus graduates in our sample were interviewed a second time on their professional situations from the month of October 2005 (not March 2006) until November 2007. As a result, graduates were surveyed twice for the six month period of October 2005 to March 2006.

In order to have a sufficient number of observations, we combined two passes. However, this merger gives us two answers for each interviewed for the six months mentioned above. In order to overcome the memory problem, we chose to keep the answers on the second pass; only the missing values were replaced by those of the first passage and this in order to have a full schedule.

This section first describes some characteristics of the population, and then reports the results of the survey itself.

A. Variables:

Hafaiedh evokes unemployed graduates as "a social category". University graduates, unemployed graduates, are not a homogeneous group, they have different levels of qualifications, social background and geographical variety, have attended universities and various institutes, did not follow the same chains and know heterogeneous paths in their professional integration.

Therefore, it is important to clarify description of variables that will be introduced in our models (see Tab.1) and the first duration of unemployment. In order to explain this time the classic repressors come first, such as gender, level of education, the specialty; there are also variables related to the past history of the labor market as the number of busy periods before unemployment in the different states (stoppages, measurement and inactivity). Finally, there are the variables characterizing the family situation of young graduates at the time of the survey (marital status, father's occupational status, employment status of the mother).

Variable	Definition	Variable Status
Di	Number of months graduation from the date of first employment	Dependent variable
Cencered	= 1 if the graduate has never held a job during the 45 months following graduation and 0 if not	Dependent variable
Igen	= 1 if the graduate is sex male and 0 if not	Explanatory variable
Ieta-civ	= 1 if the graduate is married and 0 if not	Explanatory variable
Itech	= 1 if the degree is higher technician and 0 if not	Explanatory variable
Imait	= 1 if the graduate is maitrisard and 0 if not	Explanatory variable
Iing	= 1 if the graduate is an engineer and 0 if not	Explanatory variable
Iarc	= 1 if the graduate is architect and 0 if not	Explanatory variable
Imed	= 1 if the graduate is a doctor and 0 if not	Explanatory variable
Ilic	= 1 if the graduate is licensed fine arts and 0 if not	Explanatory variable

Imaitre	= 1 master and 0 if not explanatory variable	Explanatory variable
Isit-Prop	= 1 if the employment status of the father is employed and 0 if not	Explanatory variable
Isit-prom	= 1 if the mother is at home and 0 if not	Explanatory variable
Age	variable indicates the age of the graduate on the date of graduation	Explanatory variable
Nbseqchg	Variable indicating the number of unemployment sequence	Explanatory variable
Nbseq for	variable indicating the number of training sequence	Explanatory variable
Nb seqétu	variable indicating the sequence number of study	Explanatory variable
Nb seq inac	variable indicating the number of idle sequence	Explanatory variable

TABLE 1: Definition of variables

The explanatory variables collated with the professional insertion of young graduates are commonly gender, degree level, post graduate education, marital status and specialty.

Professional status date of the survey: What was the situation of graduates at the time of the survey?

INS (Insert): this is a binary variable that equals 1 if the graduate is employed at the time of the survey (three years after graduation) and 0 if not.

	Inserted	Not inseted	Total
Workforce	2296	1455	3751
Percent	61.21	38.79	100

TABLE 2: Insert rate

In the sample of 4763 graduates, we have 3751 observations without missing values (see Tab.2). For these, we have an insertion rate of 61.21% over the period.

As for the duration variable, it is expressed in months and presents the period between the graduation date of the first job.

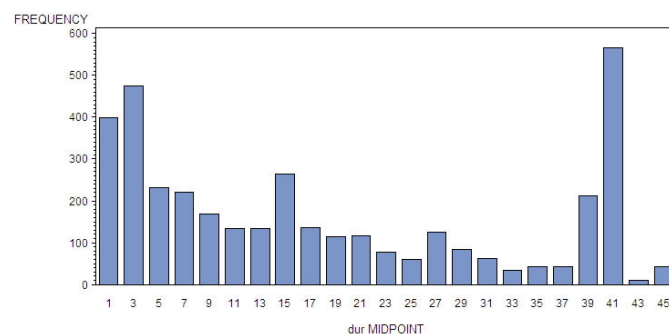


Fig.1: Duration of unemployment of university graduates

According to the graph (Fig.1), about 20% of individuals had to wait three to nine months after the end of their studies before obtaining their first job and almost 30% had to wait more than 45 months.

The average time to wait before the first job is 17.85 months and 50% of inserted had to wait 14 months before taking a position.

1) Demographics:

Women are proportionately more unemployed than men Saïid Ben and Eric Gobe Sédrine say "In the access to employment, social environment is a factor much less discriminating than sex." In our work, it is a binary variable that takes the value 1 if the individual is sex male and 0 otherwise.

	Mean	Median
Man	15.54	12
Woman	19.58	16
Total	17.85	14

TABLE 3: Timeout by genre

Unemployment is a major problem among new university graduates. In fact, 38.79% of active young people did not have a job 45 months after graduation. The phenomenon is most acute among women; the unemployment rate for is more than 40% against only 30.3% for men (see Tab.4).

	Inserted	Not inserted	Total
Man	1132(69.7)	492 (30.3)	

	30.55	13.12	
Woman	1165(55)	963 (45)	
	31.06	25.67	
Total	2296	1455	
	61.21	38.79	100

TABLE 4: Integration by gender

	Inserted	Not inserted	Total
≤23	793	1213	2006
	21.14	31.35	53.49
[24-26[589	960	1549
	15.7	25.58	41.28
≤ 27	73	123	196
	1.96	3.28	41.28
Total	1455	2296	3751
	38.79	61.21	100

TABLE 5: Integration by age of graduates

The age of graduates included in the socio-professional category.

Thus, we observe that the age group of less than 23 years includes the most of graduates. Almost 40% of graduates in this age group are integrated. At the same we notice a significant share (41.28%) of young people in our population in the age group (24-26) years. Two out of five young graduates (38.2%) in this age group is working. This age group most contain the most frames. The category of people aged 27 and over, contains a negligible (5.24%) of the population considered.

	Inserted	Not inserted	Total
Single	1877	1069	2946
	50.04	28.5	78.54
Married	414	385	800
	1104	10.29	21.33
Other	5	0	5
	0.13	0	0.13
Total	2296	1455	3751
	61.21	38.78	100

TABLE 6: Integration

	Insert	Not	Total
--	--------	-----	-------

	ed	inserted	
Father's professional situation			
Employee	847	517	1364
	22.58	13.78	36.36
Free lancer	324	216	540
	8.64	5.76	14.4
Boss	29	19	48
	0.77	0.51	1.28
Retired	782	500	1282
	20.85	13.33	34.18
Unemployed	106	52	158
	2.83	1.39	4.21
Other	208	151	359
	5.55	4.03	9.57
Total	2296	1455	3751
	61.21	38.79	100

TABLE 7: Integration according to father's professional situation

	Insert ed	Not inserted	Total
Mother's professional situation			
Employee	177	124	301
	4.72	3.31	8.02
Free lancer	17	8	25
	0.45	0.21	0.67
Boss	1	2	3
	0.03	0.05	0.08
Retraîtée	43	31	74
	1.15	31	1.97
Unemployed	3	0.83	4
	0.08	0.03	0.11
Housewife	2014	1264	3278
	53.69	33.7	87.39
Other	41	25	66
	1.09	0.67	1.76

TABLE 7: Integration according to mother's professional situation

2) *Training characteristics:*

	Inserted	Not inserted	Total
Senior technician	773	549	1322
	20.61	14.64	35.24
License	1172	827	1999
	31.25	22.05	53.29

Ingénieur	203	53	256
	5.41	1.41	6.81
Architect	25	2	27
	0.67	0.05	0.72
Medecin	36	12	48
	0.96	0.32	1.28
Fine arts Licenses	24	12	36
	0.64	0.32	0.96
Maître	63	0	63
	1.68	0	1.68
Total	2296	1455	3751

TABLE 1: Integration according education level

Destination states:

Destination States	Effectif	Percentage	Cumulative Percentage
CDD	991	55.61	55.61
CDI	418	23.46	79.07
Emploi aide	373	20.93	100
Total	1782	100	

TABLE 10: Destination states

IV. ECONOMETRIC METHODS:

Compared to regression models by ordinary least square method, the duration of models can account for episodes including the end date is not known, as pathways to integration. The term length is used generally to refer to the time that elapses in a state. That period is interrupted when making an event that can be interpreted as a transition from an initial state to another.

A) Basic model:

If we consider, initially, the outgoing university system as homogeneous, each of them is likely to get a first job during the observation period.

Let T be a non-negative random variable representing the time spent in a given state and / or separating two events. Probability

distribution can be studied T conditional on the completion date of the event.

Five kinds of specifications of this distribution are conceivable:

- The probability density $f(t)$ is defined as the limit when $\delta t \rightarrow 0$ of the probability that the time δt belongs to the interval $[t; t + \delta t]$ divided by δt :

$$F(t) = \lim_{\delta t \rightarrow 0} \frac{P(t \leq T \leq t + \delta t)}{\delta t}$$

- Note that: $-f(t)$ has values in \mathbb{R}^+
- The distribution function $F(t)$ measures the probability of fit at the latest at time t . It is defined by the following formula:

$$F(t) = \int_0^t f(u) du$$

- The survival function $S(t)$: the probability that the event of the insertion T is realized after a time t :

$$S(t) = P(T \geq t) = 1 - P(T \leq t) = 1 - F(t)$$

- The hazard function $h(t)$: (hazard function for the Anglo-Saxon), it is interpreted as the density of integration in t conditioned by unemployment before. Formally, it is the limit when $\delta t \rightarrow 0$, the probability of experiencing the event in $t + \delta t$ knowing that we had not known until the date t :

$$h(t) = \lim_{\delta t \rightarrow 0} \frac{P(t \leq T \leq t + \delta t / T \geq t)}{\delta t} = \frac{f(t)}{S(t)} = \frac{f(t)}{1 - F(t)}$$

Note that the functional estimation (or nonparametric) aims to approximate one or more different functions characterizing the observed distribution (usually F or h) without making assumptions about them

V. APPROACHES REGRESSION:

Duration models are suitable for various types of estimates: parametric, semi-parametric and nonparametric.

A) *Non-parametric modeling (Kaplan-Meier):*

The Kaplan-Meier estimator is a nonparametric duration models. It applies to the case of independent duration data, and law, so there are no variables or heterogeneity. In other words, it is particularly suited to the sample homogeneity assumption. This data can possibly be censored.

This estimator allows to study the data across risk functions and functions of survival. They have a description of the role that they allow to have a representation of the distribution of durations. However, the central concept of the Kaplan-Meier method is the conditional probability of exiting unemployment (hazard function), then a detailed presentation of the laws of distribution of a variable length définit the hazard function or function risk (Fenelon Grelet and Houzel 1997).

Either a sample of durations T. The estimator of the survival $S^{KM}(t)$ is calculated for each time t ; $j = 1; 2; \dots; J$ observed in the sample. The observed periods are increasingly ordered: $t_{(1)} < t_{(2)} < \dots < t_{(J)}$ with $J < T$.

The number of individuals experiencing the event by t_j (equal periods t_j) is already. The number of individuals censored between t_j and t_{j+1} m_j . The population exposed to "risk" just before t_j is:

$$n_j = \sum_{i=j}^k (d_i + m_i)$$

The Kaplan-Meier estimate of survival is:

$$S_{KM}(t) = \prod (1 - \frac{d_j}{n_j})$$

B) *Parametric estimation:*

The parameter estimates assume that the shape of the basic distribution is known. Thus, the base hazard function $h_0(t)$ can, for example, be distributed according to an exponential or Weibull. The parameters are then estimated by the conventional method of maximum likelihood.

For the exponential regression, $h_0(t) = \rho$, $\rho > 0$, $t \geq 0$. In this specification, $h_0(t)$ is constant that is to say, the conditional probability of finding a job for the individual whose characteristics correspond to zero values of the explanatory variables, does not depend on unemployment already past time.

$$h(t, X, \beta) = \exp(X\beta)$$

For the Weibull regression, $h_0(t) = \alpha\rho(\alpha t)^{\alpha-1}$ with $\alpha \geq 0$, $\rho \geq 0$ and $t \geq 0$ is the estimated configuration parameter from the data. In this specification, $h_0(t)$ is a monotonically increasing function of the duration of unemployment when $\rho > 1$, and monotonically decreasing when $\rho < 1$. When $\rho = 1$, $h_0(t)$ is equal to the constant and found the exponential distribution.

- *Exponential* : The reference law for the duration models is the exponential law. It has an important property: it is the only one with a constant hazard. The value of this chance is the only parameter of the law. This means that at any time, the probability of changing state is the same. Thus, the exponential specification of the hazard function assumes that the conditional release rate is independent of the length, only the X_i variables explain this rate. In other words, the probability of exit is constant regardless of the duration, lack of memory it speaks of the property of the exponential distribution.

- Density: $f_j(t) = \exp(X_j'\beta_j) \exp(-\exp(X_j'\beta_j)t)$

- Survival: $S_j(t) = \exp(-\exp(X_j'\beta_j)t)$

- The hazard rate: $h_j(t) = \exp(X_j' \beta_j)$

- *Weibull*: The Weibull law generalizes the exponential law. The hazard function in this specification depends on the time given power; it is monotonically increasing (if $\alpha > 1$) is monotonically decreasing (if $\alpha < 1$).

The specification of dependence vis-à-vis the time is represented by: $h_{0j}(t) = \alpha t^{\alpha-1}$:

- Density:

$$f_j(t) = \alpha t^{\alpha-1} \exp(X_j' \beta_j) \exp(-t^\alpha \exp(X_j' \beta_j))$$

- Survival: $S_j(t) = \exp(-t^\alpha \exp(X_j' \beta_j))$

- The hazard rate: $h_j(t) = \alpha t^{\alpha-1} \exp(X_j' \beta_j)$

-The *log-normal* law and the *log-Logistics* Law: log-normal and log-logistic laws can represent hazards fashion with increasing then decreasing. The duration T will be such that $\frac{\log T - m}{\sigma}$, follows respectively a normal distribution $N(0, 1)$ or a logistic curve.

c) *Semi-parametric estimation: the Cox model:*

The Cox model known as the model name proportional chance, is distinguished by its ability to estimate the relationship between the accident rate and the explanatory variables without putting any assumptions about the shape of the baseline hazard function. The instant risk function is as follows:

$$h(X_i, t) = h_0(t) \exp(\beta' X_i)$$

where X_i is the vector of explanatory variables for individual i at time t . The event's occurrence of risk depends on both the explanatory variables (Through the term $\beta' X_i$) and basis risk (through the term $h_0(t)$). The Cox model is thus proportional hazards model.

This specification assumes that the effect of the explanatory variables X on the conditional

probability of exiting the state does not depend on time. This means considering different values of X and correspond to distinct individuals, the ratio of hazard rates between two individuals is constant. These proportional hazard models take the form:

$$-\alpha \text{Log}(t) = X\beta + \varepsilon$$

For this type of model, Cox proposed a method to estimate the vector of explanatory variable coefficients without any specification of the function of random basis $h_0(t)$. This method is to maximize a likelihood function partial obtained by considering only the second risk category. The failure to maximize the full likelihood lead to estimated coefficients less efficient. However, this loss of efficiency is considered low. The Cox model is most frequently used in this type of study. It appears more robust than parametric approaches and to better understand the impact of the explanatory variables.

Most duration models assume that the time scale is continuous. Times are measured continuously and the risk varies continuously. It may be, however, that survival times are measured on a discrete time scale (a year for example) and this must be taken into account in the estimate.

The dependent variable takes the value 1 if the graduate is employed and 0 if not. To have a discrete time scale affects the implemented methodology. This method assumes that the probability for individual i know the event in period t (either P_{it}) is written in terms of variables and time using the following formula:

$$\log \frac{P_{it}}{1+P_{it}} = \alpha_t + \beta_1 X_{it1} + \dots + \beta_k X_{itk}$$

where $\alpha_t = \log h_0(t)$. The function $h_0(t)$ can be considered as the risk function of an individual i for which the explanatory variables are irrelevant (they are all equal to 0).

The advantage of the Cox model is not having to specify this function. t is a collection of constants, one for each time t and may vary arbitrarily from one period to another.

In so far as the Cox model estimates that the partial likelihood function T are considered nuisance parameters and are not estimated. Only β_t are. S_{it} is a maximum of J times when the event may occur, there J terms in the partial likelihood:

$$PL = \prod_{j=1}^J L_j$$

Where L_j is the partial likelihood of the event j

More specifically, the partial likelihood from the second state (L_2) corresponds to the following question: If k individuals (out of n) changed status at $t = 2$, what is the probability that the event will occur on these k specific individuals rather than k other (belonging to the same group of n individuals)?

VI. ESTIMATION RESULTS

To consolidate the descriptive analysis, econometric analysis is performed in order to obtain more advanced and thorough results. Here we evaluate the duration of access to the labor market for young people from the Tunisian higher education. For this we use duration models. These allow to account for the change from one state to another of the individual, in this instance the transition to an employment situation.

We build our dependent variable. We seek to estimate the access time for a first job. The duration of access to employment D_i is the difference between the date of graduation and the date of first use. During this period the young graduate can know different states, different sequences (unemployment, training, study, inactivity). The times of access to employment are therefore calculated by aggregating the length sequences stoppages before the first use. Note that the term is only partially observed, the variables are therefore subject to a phenomenon of censorship (Lollivier). The DUROBS observation period (45 months) of the survey can not be considered long enough. We are building a CENS variable to control the right censoring variables. This variable distinguishes individuals by at least two methods that classify

individuals as they experienced the event (individuals uncensored) or not (censored individuals). In our case, this variable can take two values:

Modality 0 indicates that individuals employed as the modality. 1 indicates that they are still unemployed, hence:

$$\begin{aligned} \text{CENS} = 0 & \implies D_i = \text{DURATION} \\ \text{CENS} = 1 & \implies D_i = \text{DUROBS} \end{aligned}$$

To estimate the duration of access to a first job after leaving the university system, the explanatory variables used here are socio-demographic indicators: gender, age, marital status, level of degree,

The occupation of the father, the professional activity of the mother, the unemployment number sequences, the number of training sequences, the number of study sequences and the number of idle sequences.

The objective is to control these variables to estimate whether, all things being equal, the access time for a first job is longer for some of these young Tunisian from higher education than their colleagues whose degree level and individual characteristics are different.

The equation constructed to estimate is the following:

$$D_i = c_0 + c_1 I_{\text{homme}} + c_2 I_{\text{eta-civ}} + c_3 I_{\text{age}} + c_4 I_{\text{sit-prop}} + c_5 I_{\text{sitprom}} + c_6 I_{\text{tech}} + c_7 I_{\text{ing}} + c_8 I_{\text{med}} + c_9 I_{\text{lic}} + c_{10} I_{\text{Nbseqfor}} + c_{11} I_{\text{Nbseqetu}} + c_{12} I_{\text{Nbseqch}} + c_{13} I_{\text{Nbseqfor}} + w_i$$

The data processing was performed using SAS software.

6.1 Non-Parametric Analysis of access to the first job durations:

To consolidate the descriptive analysis of the sample, we estimated survival rates in unemployment state by applying nonparametric analysis proposed by the Kaplan-Meier method. This estimator allows us to understand the

characteristics of the residence times in the state of unemployment, regardless of observable factors heterogeneity between graduates.

As we have already discussed in the theoretical part of this research, the use of nonparametric estimation allows to study the periods of access to employment through the examination of the functions of survival or risk.

The survival function: Recall that $S(t)$ is the probability to remain unemployed until $(t + 1)$ at least months. It is calculated by dividing the number of people unemployed for months and does more, by the total number of individuals.

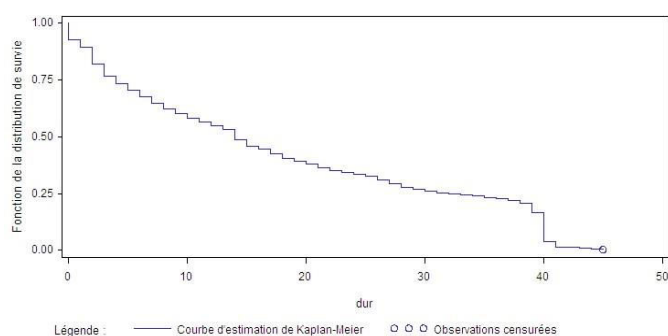


Figure 2: Evolution of the unemployment duration

For 3751 sample observations, this function decreases in a remarkable way up to 12 months from 1 to less than 0.5 and it decreases to a lower manner between 12 and 24 months (range 0.08). After 24 months the decline was less sensitive.

Before addressing their second year, graduates are characterized by a probability of survival of very decreasing unemployment. But once they failed to land a job for two years, we can say that they have more difficulty entering the labor market.

The time spent unemployed can also influence the behavior of the job seeker in his research work. The longer the period of unemployment is likely to harm the moral and psychological situation of individuals. Demotivation can reduce steps to gather information on potential job offers, even a judgment of any active research. In these

circumstances, the probability of leaving unemployment may decrease sharply beyond a certain time threshold increased unemployment. The S graph (t) (see Fig.2) shows that the proportion of graduates now unemployed decreases very rapidly during the first few months of observation. However, this decrease is lower for the third of individuals with more than five months of unemployment.

To study in more homogeneous populations, we were driven to use the non-parametric method stratifying by level of degree.

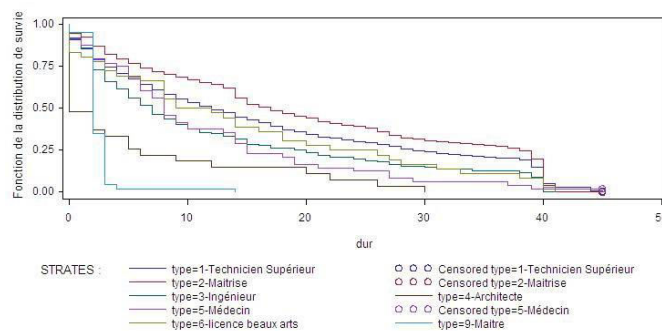


Figure 3 : Evolution of the duration of unemployment by educational attainment

Examining the graph (see Fig.3) also indicates that the probability of not finding a job is different by level of degree. Note that the higher the level is increasing its curve is at a lower level. This contradicts the idea that the pursuit of study is considered to be an investment in human capital and hence a decisive choice for the professional integration (Gire 1998). This result confirms the principle of the theory of job search that a job applicant accepts leaving unemployment than if the wage offered is higher than the reservation wage (Mortensen 1986). This increases proportionately with the level of training.

Of the total sample, the graph shows that the average unemployment decreases with the level of education. In months, the chance of leaving unemployment decreases but the gap between levels is almost the same for the entire period. It may also represent the instantaneous output rate of unemployment resulting from the non-parametric

analysis. This shows an increasing function of time, which makes us think that the parametric distribution will be a function Weibull.

The hypothesis of a differentiation of the unemployment duration by educational level can be tested through a comparison of the distributions of living functions depending on the level. Tests that can be implemented to compare subpopulations are the test and log-rank test Wilkson. The results showed that the p-value is below 5%. This indicates that the null hypothesis that the distributions of living functions are similar in each of the populations considered, should be rejected.

Note here that the Kaplan-Meier estimators are useful for a representation of the distribution of access times. However, they are purely descriptive. Thus they have no explanatory nature.

B) Parametric Analysis of access to the first job durations:

The four forms of distributions presented in the theoretical part of this work have been taken into account in estimating the duration of unemployment. Although the results of the different distributions indicate similar coefficients, differences appear for certain variables. To guide our choices on the most appropriate distribution, we need to consider a selection criterion.

The criterion Akaike has been introduced when the comparison between the duration models by simple comparison between the values of maximum likelihood. The principle of this test is simple while taking into account the value of the maximum likelihood, it introduces the auxiliary parameters of each model and by the following formula:

$$AIC = -2 (\log\text{-likelihood}) + b^2 (c + p + 1)$$

where c is the number of explanatory variables and p is the number of auxiliary parameters. The chosen model will be the one whose AIC is lowest.

Estimates have led us to retain the Weibull regression. Thus, the interpretation of results will

only affect this distribution. Recall here $qu_{.il}$ must consider the opposite sign of the coefficients of the variables in the table of estimated results for identifier the direction of the link between the explanatory variables and random base model. The underlying logic is that if a variable is negatively on the duration of unemployment, it increases the baseline hazard function and thus increases the instantaneous probability of finding employment at time t.

Online reading the table of estimation results shows that individual characteristics play an important role in the duration of unemployment.

Differences between the sexes are significant: Male graduates have a chance to access to employment 33% higher than that of female graduates.

The variable "marital status" is significantly positive sign: being single increases job search duration. This can be explained primarily by the nature of Tunisian society. Parents provide accommodation for their children financially and this reassures the graduate and makes him maintain his reservation wage at a relatively higher level.

The coefficient for the predictor age is positive sign an additional year in age of the graduate, a positive effect on the duration of access to the first job. This result is explained by the gradual demotivation over time graduate implying the use of least effort in research.

Do not be a housewife, increases search time for a job.

The parametric estimation shows that as the degree level affects the duration of unemployment significantly and for different type of distribution. A different level of degree, we find that the duration of unemployment, before the first employment is sensitive to the type of degree: the significance of the coefficients for all distributions considered and the negative sign of the coefficients relating to the type of degree variables (other than mastery) us towards the conclusion that maitrisard take longer than their colleagues to get a first job. Thus, mastery is a diploma poorly absorbed by the Tunisian labor market.

The graduate professional history is the period of unemployment significantly: the econometric estimation gives us negative coefficients and that both the number of training sequences for the sequences of inactivity.

Other variables were introduced to estimate the duration but they do not prove significant. It is the age, employment status of the father, the employment status of the mother, number of unemployment sequence and number of study sequence.

C) Semi-parametric Analysis of access to the first job durations:

This work is essentially empirical. Its originality consists in not from predetermined patterns, which are often given conflicting meanings in different countries, because of organizational and academic traditions of different contexts, but to build them from comparable data.

The comparability of data is ensured by the fact that they come from a single survey, but their declarative character puts them however not totally immune to differences in perception, national or disciplinary.

The exploitation of the investigation, however, shows that graduates answers from the same training program are consistent.

As we have already mentioned in the theoretical part of this work, the semi-parametric approach and especially the proportional hazard Cox model to estimate the relationship between the accident rate and the explanatory variables without putting any hypothesis based on the form of chance. Recall that we chose to work with a proportional term life model which is in the form:

$$-\alpha \text{Log}(t) = \beta X + \varepsilon$$

Thus the variable is $-\alpha \text{Log}(t) = \beta X + \varepsilon$, so a positive value induces greater unemployment output probability and duration is lower.

In this regression, a part of unobserved heterogeneity model is absorbed in the time underlying risk (basic risk). Thus we can conclude the robustness of the sign of the estimated coefficients as features that can change the intensity of the studied risk.

VII. CONCLUSIONS

In Data processing through the duration models indicates that the unemployment duration depends on a set of explanatory variables by characteristics of the graduates first-seekers Tunisia. The variables that contribute to the lengthening of the duration of unemployment are those which, all things being equal, lengthen the time between the graduation date of the first job. These include gender, marital status and level of degree.

Analysis of the Tunisian labor market in recent years reveals the sharp rise in rates among university graduates of all assets and the high exposure of these unemployed.

To study the process of employment of university graduates, we use a sample from the survey on the employment of graduates of higher education, conducted jointly by the World Bank and the Ministry of Employment and the Professional insertion of Youth in Tunisia with a sample of 4763 graduates of 2004.

The analysis of the determinants of duration of unemployment after obtaining a university degree is carried out by the econometric estimation of a duration model.

Young graduates see their chances of getting a job significantly decrease from the second year. Furthermore, this extension has negative effects on the job applicant behavior.

This analysis allowed us to see that the time for obtaining a first job depends on the level of degree from an inversely proportional manner.

However, other variables, such as the work status of parents does not influence the duration of access to the first job. This is significant in the sense that graduates of history does not matter in terms of getting a job.

The estimation of our model by a semi-parametric analysis confirmed and consolidate previous achievements, strengthening the analysis and interpretation based on this estimation.

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EXAMINING THE IMPACT OF SOCIAL CAPITAL DIMENSIONS ON COOPERATIVES LONGEVITY

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Cooperatives' longevity: a theoretical framework.

Abstract:

The cooperatives are popular for creating jobs and generating profits. However, many cooperatives struggle to realize their value-added potential. Why do some cooperative succeed while others fail, and how may those struggling succeed?

Combining collaboration and social capital perspectives into the conversation of cooperatives, we examine the factors necessary for cooperative success. Addressing the link between social capital and collaboration, we use the three dimension framework: relational dimension, structural dimension, and the cognitive dimension. To explore how these dimensions of social capital influence collaboration and therefore their impact on cooperatives' longevity.

Keywords: cooperatives, social capital, structural dimension, relational dimension, cognitive dimension, longevity

Introduction

The concept of social capital is a multilevel theoretical perspective. Social capital offers access to resources embedded in social relationships which enables their mobilization to benefit individuals and/or organizations. The concept of social capital concerns human interactions and connectedness (Tzanakis et al, 2013).

Researchers generally adopt two different approaches. The first one categorizes Social Capital as a public good (Coleman, 1990; Putnam, 1993), while the other classify Social Capital as an individual

good that can be collected by a person (Bourdieu, 1986; Burt, 1997).

Coleman and Putnam analyze the social capital from a global perspective (Aguilar and Sen 2009). Putnam (2000) defines social capital as a concept that encompasses the social networks of individuals and the resulting norms of reciprocity and trust. Coleman (1988) defines the social capital by its function, considering it as a variety of entities (trust, obligations, expectations and information flows) which enables certain actions for an individual within the structure. On the opposite, Burt highlights that weaker ties have more potential to be sources of new knowledge and resources. While Bourdieu *treats social capital as resources that accrue to an individual or a group by possessing a durable network of the relationship of mutual acquaintance and recognition*. Researchers of the social capital extended the concept from an individual asset to a feature of communities and even nations. Bhandri and Yasunbo (2009) view social capital as a collective asset in the form of standards of values, beliefs, relationships of trust, networks, social relations, and shared institutions, facilitating cooperation, and action in the interest of all. There is a lot of contradicting and confusing theories trying

to explain what social capital is. Social capital is applied to so many phenomena and in so many various contexts (Portes 1998). We conclude that the definition of social capital depends on the context and the field of research. For this reason, Payne et al, (2011) developed a four-quadrant classification. According to them, the concept of social capital provides an important opportunity to better understand multilevel management and organizational phenomena. Their typology enables us to identify whether the subject of research is individual or collective. Also, based on Adler and Kwon's (2002) work on internal and external ties, they recognize the source of social capital is either internal or external to the structure. In general, researchers link social capital to the resources that an individual or group attain through a network of relationships or social structure (Lin, 2001). Cooperatives are organizations based on social capital and its availability in cooperative organizations has high importance (Valentinov, 2004). Cooperatives are at the same time a cooperative enterprise and a cooperative society. These two organizational units tend to follow different logics. The cooperative enterprise is interested in profit, performance, and competitiveness. While the cooperative society is characterized by human relationships: closeness kinship and

friendship (Hendriske et al, 2011). These two contradictory logics make it difficult to align the organization of the members with the organization of the enterprise. Cooperatives manage a common good (SAIKOUK and BADRAOUI 2016) we can discuss a social dilemma among cooperative organizations. Luo and Wang (2013) confirm the role of social capital as an instrument for solving the collective action dilemma in Chinese farmer cooperatives.

It is known that social capital plays a major role to address cooperative challenges due to their social characteristics (Nilson et al., 2012). Zhou et al (2017) studied the influence the social capital has on the way farmers use chemical input. Liang et al (2018) conducted an exploratory study to find the link between social capital and formal governance in farmer cooperatives. Tregear (2016) used the social capital and collective action to examine a case of producer cooperative in the Scottish shellfish sector, Muniady et al (2015) conducted an empirical analysis to investigate the impact of social capital dimensions on the performance of micro-enterprises owned and managed by women in Malaysia. Although, Writings that study cooperative using a social capital perspective are still limited (Chlebicka and Pietrzak 2018). Besides, there is scarce

literature related to the contribution of social capital to business sustainability (Tsai & Ghoshal 1998; Muniady et al 2015). Moreover, the manufacturing industry is the most explored by researchers (Y. Park, Shin, & Kim, 2010)

As we have mentioned above, social capital is still an abstract construct. That is why many studies do not directly measure social capital but rather they explore the source(s) of social capital. The measurement of social capital is done in various ways in the literature, based on the objectives and the scale of the study (Gallaher et al., 2013; Krishna, 2002). Putnam (1993) provides a macro-level scale of measurement that encompasses: networks, trust, and norms. Macke and Dilly (2010) argue that social capital is a multidimensional concept and several authors base their work on Nahapiet and Ghoshal's (1998) conceptualization and solid framework. They divide social capital into three main dimensions: structural dimension defines as network properties and interactions within the network, relational dimension referring to the personal and emotional ties of actors within a network, and finally the cognitive dimension described as shared languages, values, interpretations and, codes. Krause, Handfield et al. (2007) used the three dimensions of social capital to study

buyer-supplier relationship management. Avery (2010) used the three dimensional model to analyze the impact of social capital on supplier-buyer performance. Other scholars use bonding and bridging effects, such as Cao et al., (2015) that conducted a study about CEO social capital and entrepreneurial orientation of the firm. As stated by Bouma et al., (2008) field experiments such as trust games can be also a tool of measurement of social capital. The definition and measurement of social capital in farmer cooperative have not yet been broadly investigated and there is little empirical evidence to support the concept in these organizations (Liang 2015). Furthermore, the validation of the link between collaboration and cooperatives' longevity could help confirm the value of pursuing collaboration between partners.

In our case, we look at social capital from two aspects, the individual one (members) and the organizational one (the cooperative). The definition of Nahapiet and Ghoshal (1998) of social capital is suitable for our study since it unifies the two approaches view of social capital. For this reason, we will refer to their analytical framework. This focus will preclude a deep examination of how the social capital dimensions could contribute to cooperatives' longevity. This perspective

has not played a large role in cooperatives' research.

What is the composition of social capital in farmer cooperatives?

Does social capital influence members' collaboration in the cooperatives?

What is the impact of collaboration on cooperatives' longevity?

Theoretical framework

Social capital dimensions

The distinction between the three dimensions of social capital was challenging (Nahapiet and Ghoshal 1998). For this reason, they referred to the work of Granovetter (1992) about relational structural and relational embeddedness to identify the concept belonging to the structural dimension and the concept linked to the dimensional one. Then, the cognitive dimension was presented separately.

Prior studies have proven the existence of positive interactions between the three dimensions of social capital. Frequent interactions between groups of people increase their mutual trust (Putnam, 1996; Aguilar and Sen 2009). As Al-Tabba and Ankrah (2016) said relational trust emerges from positive emotions and appreciation developed from regular interactions. According to Bonfim (2017), another

attribute in the structural dimension influencing trust is network memory or past ties. Bonfim (2017) also stated that the shared codes and common understanding of the cognitive dimension increased the trust and emotional commitment of the relational dimension.

The relational dimension

The relational dimension is defined as the personal relationship, developed through interactions (Granovetter, 1992). This concept includes all the aspects that impact: respect and friendship, sociability, acceptance, and prestige. We can have two parties in a network with similar positions but their reactions, attitudes may be totally different due to their behavioral component. The relational dimension indicates the personal relationship including personal and emotional attachment. This dimension is based on norms, expectations, and obligations (Yim & Leem 2013). The relational assets are created based on unique relationships (Muniady 2015). The relational dimension is established through trust (Yim 2013, Lin 2005; Nahapiet 1998; Uzzi 1996), commitment: (Avery 2010, Lin 2005; Uzzi 1996), socialization (Yim & Leem 2013 Cousins et al, 2006, Avery 2010) and reciprocity (Yim & Leem 2013 Lee 2005).

Trust is one of the most common variables used to describe the relational capital (Nahapiet and Ghoshal, 1998). Trust includes four aspects: belief in the good intent and concern of exchange partners, belief in their competence and capabilities, belief in their reliability, and belief in their perceived openness (Mishra, 1996; Nahapiet and Ghoshal, 1998). Bradach and Eccles (1989) describe “*trust as a type of expectation that alleviates the fear that one’s exchange partner will act opportunistically.*”

The socialization process conducts each individual to learn about their partner’s culture, potential, vision. Socialization enables building inter-personal relationships and trust within these exchange relationships creating a stock of relational capital (Kale et al., 2000) Socialization helps connecting actors in a network and promoting mutual trust and respect in the relationships (Hollenbeck 2015).

Commitment refers to a belief that the relationship with the other partner is so important to dedicate efforts to maintaining it (Morgan and hunt 1994). Commitment promotes the establishment of a relationship based on sacrifice and stability (Yang et al, 2008)

Reciprocity is a commitment to perform an activity in return (Nahapiet and Ghoshal 1998) Reciprocity is a social norm indicating that every action performed by an actor from a network should be compensated by the other actors (Houston and Gassenheimer 1987). Rokkan, et al., 2003) suggest that reciprocity guides the actions of an individual in a relationship by impacting their present behavior with future expectations.

The structural dimension

According to (Coleman 1990) the structural dimension is related to the presence or not of relationships among the individuals, the network’s configuration, illustrating the types of connections, with variables as density, connectivity network configuration, stability, and ties. The social capital is described by Burt (1992) as “whom you reach and how you reach them”. As reported by Tsai and Ghoshal (1998) the structural dimension, encompasses the actor social position and social interaction or social ties. That enables him to have easy access to opportunities, information, and knowledge. It refers to the network’s properties and the different personal linkages (Yim & Leem 2013). The structural dimension includes different variables: Network ties (Nahapiet et Ghoshal, 1998; turner 2011, Rochelle 2011, Mercy 2013, Muniady 2015)

Network appropriateness (Nahapiet 1998, Yim et Leem 2013); Network configuration (Nahapiet 1998, Yim et Leem 2013); and we will add Relationship stability.

Network ties or social ties represent the social link between actors (Hollenbeck 2015). Network ties provide access to resources in a network. Network ties are recognized as the main key measures of social capital (Nahapiet and Ghoshal, 1998).

Strong ties enable the socializing process outside of the workplace, which will generate stronger reciprocity and greater trust (Granovetter 1985). Avery (2010) indicates the existence of social ties is necessary for the development of personal relationships.

And enhance the elements of the relational dimension.

Network ties affect positively trust

Network ties affect positively socialization

Network ties affect positively reciprocity

Network ties affect positively commitment

Network Appropriateness enables the relationships developed in a specific setting to be used in another setting (Nahapiet and Ghoshal, 1998; Hollenbeck 2015). Therefore, the trust commitment

and reciprocity that exists among the members' network will be maintained even at the organizational level.

Network appropriateness affects positively reciprocity

Network appropriateness affects positively trust

Network appropriateness affects positively commitment

Network configuration refers to hierarchy, density, and connectivity that influence the resource exchange (Inkpen and Tsang 2005). Network configuration impacts the nature of the relationship among members. Technically, it plays an important role in stimulating trust, socialization, and commitment.

Network configuration affects positively trust

Network configuration affects positively socialization

Network configuration affects positively reciprocity

Network configuration affects positively commitment

The relationship stability can be defined as maintained membership in a network. A highly unstable network is limiting the development of relational capital. Because

when an individual leaves, the tie disappears. Therefore all the relational aspects related to him such as trust, commitment, socialization and, reciprocity will disappear.

The relationship stability affects positively trust

The relationship stability affects positively

We can conclude the following proposition:

P1: the structural dimension affects positively the relational dimension

Cognitive dimension

The cognitive dimension refers to the third dimension of Social Capital: the resources generated from the shared visions, interpretations and systems of meaning, mainly codes and narratives shared values and other cultural elements among actors (Nahapiet and Ghoshal, 1998). In other words, members share a common understanding of the collective orientation and mission of the organization. The cognitive dimension separates networks or organizations from creating unique terms, acronyms, interpretation of numbers and concepts (Muniady et al., 2015). The cognitive dimension is the least studied of the three. Cognitive dimension includes

features such as shared organizational values and visions (Yim & Leem 2013; Krause Handfield et al, 2007; Lin, 2005; Tsai and Ghoshal, 1998); common fate (Yim & Leem 2013), common goals (Zhou 2018) shared code and languages (Nahapiet et Ghoshal 1998) Considering the concept of cooperatives we will add the solidarity as another variable.

Shared organizational values and visions represent the degree to which members have a common understanding and vision of the organization. Relationships developed with shared values can be expected to be stronger (Moran, 2005). Shared values and visions have been found to positively impact business relationships (Hofstede and Bond 1988; Tsai and Ghoshal 1998; Krause, Handfield et, al. 2007) which implicates that the relationships will be characterized by trust, commitment, reciprocity, and socialization.

Shared organizational values and visions affect positively trust.

Shared organizational values and visions affect positively commitment.

Shared organizational values and visions affect positively reciprocity.

Shared organizational values and visions affect positively socialization.

Solidarity reflects normative perceptions of one network member regarding the importance of their relationship with another network member (Kaufmann and Stern, 1988). Scholars demonstrated the importance of group solidarity when considering the high risk of collective action. Developing group solidarity among an organization increase the trust and commitment of a member

Solidarity affects positively trust;

Solidarity affects positively commitment;

Common goals describe how partners perceive the alignment of their own objectives and their partners' objectives (Angeles and Nath 2001; Lejeune and Yakova 2005; Simatupang and Sridharan 2005). A common understanding of collective orientation and missions contributes to build trust and to minimize opportunistic behavior (Pearson et al 2008). According to Peesama (2013) trust is highly correlated to commitment. Therefore common goals will impact also commitment.

Common goals affect positively trust.

Common goals affect positively commitment. Common fate is an extension of shared values and visions. When the partner knows that he shares a common destiny with the other actors. It will enhance their commitment, trust, and reciprocity.

Common fate affects positively trust

Common fate affects positively commitment

Common fate affects positively reciprocity

Shared code and language have a direct and important function in social relations. It is a vehicle of socialization between individuals. To the extent that people share a common language, this facilitates access to their relation capital stock.

Shared code language affects positively trust

Shared code language affects positively commitment

Shared code language affects positively reciprocity

Shared code language affects positively socialization

We suggested that the relation dimensions variables are positively impacted by the cognitive dimensions variables. Then we can state this proposition:

P2: the cognitive dimension affects positively the relational dimension

Social capital and collaboration

Collaboration is conceptualized as different firms or business entities committed in the relationship in order to share improved outcomes and benefits

(Claudine & Paul 2015). Olorunniw and Li (2010) see collaboration as a relationship between autonomous business entities based on openness and trust, where risks, rewards, and costs should be shared. Togar & Sridharan et al, (2002) refer to collaboration as two or more members aiming to satisfy the end customer needs through information sharing, joint decisions, and benefits sharing. Whipple et al., (2010) define collaboration as a long-term relationship enabling parties to enhance their performance. Hudnurkar et al (2014) have identified in the literature the factors influencing the success of collaboration. For example, the commitment of members to make efforts to develop a lasting relationship, trust, information sharing, process integration, and the extent to which Chain members will organize their processes, alignment of operations and fair sharing of costs/benefits Walter (2003), Fynes et al, (2005), Nyaga et al, (2010) Simptupang and Sridharan (2008) Fawcett et al (2011). Collaboration is based on different activities. Information sharing, dedicated investments (Badraoui 2018, Nyaga et al 2010, Abbad 2008), and resource sharing. It includes human and financial resources (Badraoui 2018, Zhang and Cao, 2018). Considering the discussion above, we retain the following collaboration elements for our conceptual model: Information

sharing, Resource sharing, Dedicated investments and Joint relationship efforts. Our decision is motivated by the fact that other factors such as trust and commitment are retained in the relational capital.

In our study, we will try to study the link between collaboration and the social capital dimensions.

Information sharing

Collaborative group members often interact, update each other, discuss openly, pass on all the necessary information internally (Badraoui 2018; Zhang and Cao 2018; Nyaga et al 2010; Abbad 2008), Rai et al (2006) identify three types information sharing that occurs between members operational, tactical and strategic. Information is often inconsistent between partners (Prajogo and Olhager, 2012). Cooperatives members have to share complete correct information to facilitate collaboration. Information sharing between partners is mainly a concern of trust. Partners maintaining a high trust relationship do not hesitate to share information (Beccerra and Gupta, 1999, Kwon and Suh 2005, Wu 2014). Ha et al (2011) argue that affective trust enables information sharing. In addition, commitment improves information sharing among partners (Yang et al 2008). As Moberg et al, (2002) reported the commitment to the relationship influence

information sharing. Also, reciprocity facilitate information sharing (Humphrey et al 2001)

We conclude the following proposition:

Trust affects positively information sharing

Commitment affects positively information sharing

Reciprocity affects positively information sharing

Resource sharing

Resource sharing refers to the exchange of both tangible and intangible resources among partners (min 2008). Resource sharing includes financial and non-financial resources. Socialization provides the potential for partners to access to their respective available resources by shaping the willingness of sharing them (Moran 2005) Prior research suggests that trust facilitates social and resource exchange (Putnam 1993, Tsai and Ghoshal 1998). Low levels of trust among partners prevent them from sharing idiosyncratic resources (Fawcett et al, 2008, 2010, McCarter and Northcraft, 2007).

Trust affects positively resource sharing

Socialization affects positively resource sharing

Dedicated investment

Dedicated investments refer to the investments made by a party of collaboration for their specific relationship (Cao and Zhan, 2011, Fawcett et al 2008, Crook et al 2008). These assets permits to the partners to attain higher outcomes and a sustainable competitive advantage (Nyaga et al 2010) Kwon and Suh (2004) show that trust is positively associated with asset specific investments. Dedicated investments require the partner's commitment to the relationship (Walker et al., 2013).

Trust affects positively dedicated investment

Commitment positively affects dedicated investment

Joint relationship efforts

Joint relationship efforts are activities such as planning, goal setting, performance measurement, and problem solving. This activity is crucial for collaboration success (Badraoui 2019, Fynes et al 2015, Nyaga et al 2010). Joint relationship efforts enable a member to gain a clear understanding of the demand in order to coordinate in a proper manner (Barratt, 2004). Accordingly, a strong sense of commitment guarantees joint relationship efforts for maintaining the relationship (Morgan and Hunt 1994) Wei et al 2012 argued that joint relationship efforts are

maintained because the partners offer reciprocal benefits to one another over time. Ha et al., (2011) suggests that trust in competency affects joint relationships effort.

Trust positively affects joint relationships effort

Commitment positively affects joint relationships effort

Reciprocity positively affects joint relationships effort.

We conclude from the discussion above that the elements of the relational capital are linked to the collaboration activities. Moreover, as we have suggested before both the structural dimension and the cognitive dimension impacts positively the relation dimension. Therefore we formulate the following proposition:

P3: the relational dimension affects positively collaboration

P3 a: the relational dimension plays a mediating role between the structural dimension and collaboration

P3 b: the relational dimension plays a mediating role between the cognitive dimension and collaboration

Collaboration and cooperatives' longevity

Researchers tend to view survival/business sustainability or longevity as a performance measure for a firm (Napolitano 2015). While the literature separates between performance and business survival. Business survival had great interest from leaders, competitors, communities and other stakeholders (Hannan and Freeman, 1989). Various variables were used to control the influence of commercial and industrial factors on organizational sustainability, such as controlling the effects of market size and growth on the probability of survival (Hannan and Freeman, 1989). Longevity is defined as how the company can (or must) adapt its behavior and practices to enable continued growth and prosperity Mignon (2008). Elliot (2018) defined sustainability as an equilibrium enabling to guarantee that the choices by members cannot be changed. Moreover, according to them, the concept is related to how cooperatives react and adapt to a changing environment. For cooperatives, this equilibrium exists when transactions remain optimal for cooperative members over long periods of time despite changes in the external environments (Elliot 2018). The formation of cooperatives has for the

main goal to fulfill its members' needs. Dissatisfied members dissolve the cooperative entirely or often choose other forms of governance such as bilateral or collective contracts (Binjman and Hendriske 2003, Fulton et Hueth 2009). Therefore, we could conclude that cooperatives' longevity depends on the satisfaction of its members. Satisfaction can be measured at the economic level and the relational level (Badraoui 2018, Zacharia et al., 2009). Satisfaction with the result includes the development of the product or the service proposed by the cooperative, enhanced outcomes, and fulfilled expectations. The relational satisfaction means members' satisfaction toward all the aspect of the relationship.

Johnson et al, (2004) and Wu and Chiu (2018) a successful collaboration creates a feeling of satisfaction among the partners. Wu (2008) concluded that information sharing influences the competitive advantage. Moreover, Min et al (2008) argue that information sharing, resource sharing, and joint relationships effort lead to better business performance. Scholars have agreed that collaborative activities (resource sharing; information sharing, joint relationships effort and dedicated investment) help to reduce costs and to identify environmental changes rapidly in

order to perform optimal responses (Horvath 2001).

Information sharing affects positively the economic satisfaction

Resource sharing affects positively the economic satisfaction

Dedicated investments affect positively the economic satisfaction

Joint effort relationships affect positively the economic satisfaction

The collaborative activities lead also to satisfaction with the relationship (Zacharia et al 2009). When partners invest in specific-assets, share reliable information, perform joint relationships effort such as collective planning and problem solving and exchange resources result in a high satisfaction with the relationship.

Information sharing affects positively the relational satisfaction

Resource sharing affects positively the relational satisfaction

Dedicated investments affect positively the relational satisfaction

Joint effort relationships affect positively the relational satisfaction

The relational capital of the cooperatives enhance their collaboration, which allow them to make investments , share

information and resources, and make dedicated investments in order improve the economic and relational outcomes (Sossay et al 2015). Ashnai et al, (2016) conducted a study where they show that trust, reciprocity, socialization, and commitment encourages collaborative activities and leads to positive outcomes.

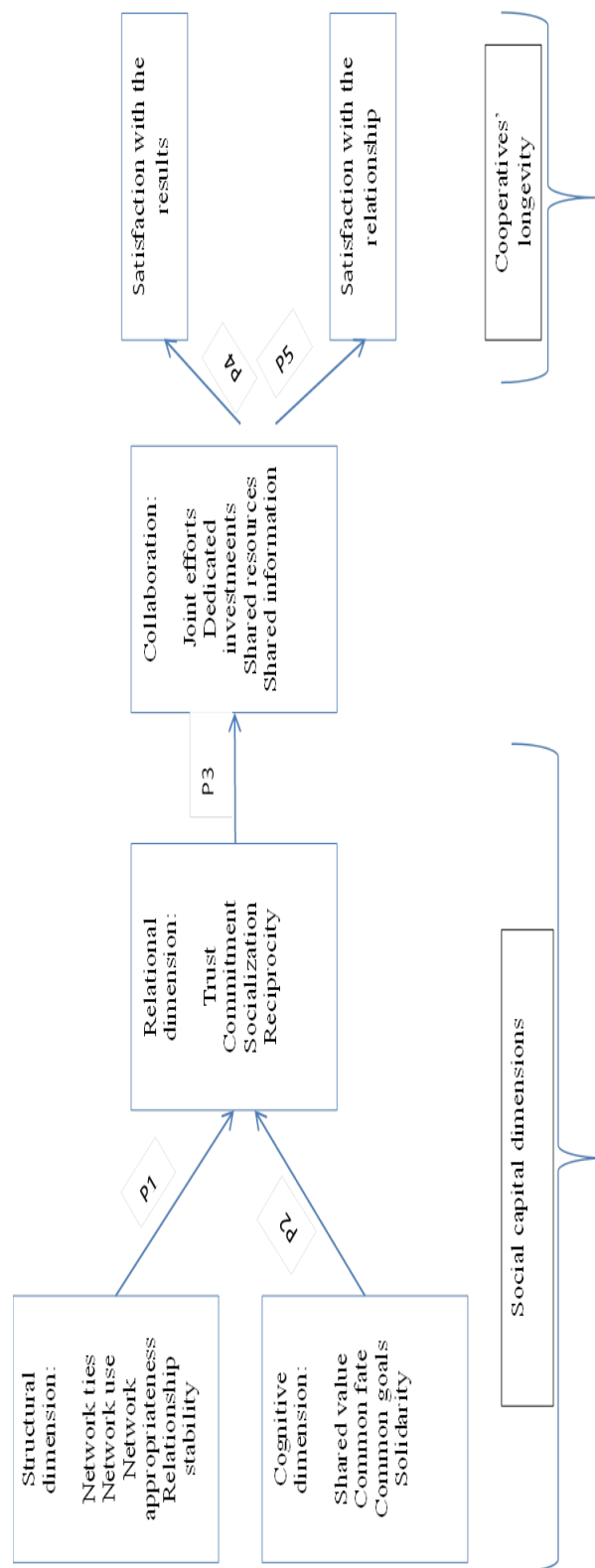
Based on this discussion we propose:

P3: a successful collaboration enables satisfaction with results

P3a: a successful collaboration mediate positively the relationship between the social capital dimensions and the satisfaction with the results

P4: a successful collaboration enables satisfaction with the relationship

P4a: a successful collaboration mediate positively the relationship between the social capital dimensions and the satisfaction with the results



Control variables

Heterogeneity among members is linked to factors such as divergence in farm size, distinct farm level strategies, and different farmer profiles. Heterogeneity may affect the organization by influencing the investment behavior, joint efforts relationship, member commitment (Hansmann 1996 (8), Fulton et al 2009 36, Gripsrud et al 2000 43). As consequence, it will impact the success of collaboration among partners. According to Valentinov (2004) the involvement of cooperatives' members is correlated positively with the level of their asymmetries.

In addition, Feng et al (2011) and Nilsson et al (2012) stated that the increasing size of cooperatives may weaken the ties they have. This leads to organizational complexity. Moreover, the voice of an individual member drowns in the multitude of voices (Osterberg and Nilsson 2009). The large size of membership may generate less information sharing and may impact the relational dimension.

As consequence, it is necessary to add these two control variables to our conceptual model : heterogeneity and the size.

Conclusion and limitations

Cooperatives allow small farmers to seize an opportunity more quickly by leveraging the resources and knowledge of the other party. Cooperatives can facilitate access to new opportunities and reduce barriers to entry.

Implementing and managing a cooperative can be difficult because each partner has a different way of operating. Suspicion can arise, especially when it comes to competition or protected information. Cooperatives are not without risk. Their successes depend on their members. The problems faced by many cooperatives are probably due to new structural factors in the current environment (Nilson et al., 2009). Due to the origin of the researchers, the literature has focused on some particular factors and neglected others (Azadi et al 2010). We have noticed that factors are analyzed separately in previous studies. However, variables such as trust, commitment, homogeneity, communication, and member satisfaction are interconnected. This article aims to examine the impact of social capital on collaboration and identify its mediating role between the social capital and the cooperatives' longevity. This study suggests that it is likely insufficient to solely focus on one dimension of social capital. To meet this proposal, a research

model was designed taking into account the dimensions of social capital and the cooperatives' longevity. In addition, collaboration was considered as the mediator of the relationship between these variables.

We hope this article will stimulate new lines of thinking and streams of research that provide novel insights into the role of social capital as a force that may contribute to cooperatives' longevity. By examining cooperatives from this new social perspective, cooperatives' managers may be able to make better-informed decisions about their members and enable them to collaborate in an efficient way. In addition, by highlighting some of the possible research opportunities around the social capital dimensions in the cooperatives' are, we can draw the attention of researchers from other fields and expand the general interest in cooperatives. This could generate a richer, and a deeper understanding of cooperatives'. However, we should note some limitations to our study, even though the social capital dimensions' framework has a wide variety of uses in this domain. In some organizations', increased social interactions are more frequent but of lesser quality (Hollenbeck 2015). Besides, while it is good that cooperatives recognize the need to develop their social capital,

Whipple (2015) demonstrates that it is a necessary but not sufficient condition to enhance organizations' longevity. Finally, social capital is a complex construct for this reason we have to conduct an empirical research to test our theoretical findings.

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On Predicting Supply Chain Risks: Back Propagation Neural Networks Training Algorithm

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Abstract—Managing supply chain risks has received attention in recent years, with the goal of protecting supply chains from disruptions by predicting their occurrence and mitigating their adverse effects. At the same time, the resurgence of Artificial Intelligence (AI) has led to investigation of machine learning techniques and their applicability in supply chain risk management. However, most works focus on prediction performance and the importance of interpretability so that results can be understood by supply chain practitioners, helping them make decisions that can mitigate or prevent risks from occurring. In this work, we focus on the risk assessment of supply chain based on Back propagation (BP) neural network. The risk assessment procedure is discussed and after the risk factors of supply chain identification and analysis, the risk assessment model is built with BP neural network. Through training of the model using MATLAB, the model shows the preciseness and comprehensive practicability.

Keywords—supply chain risk, risk assessment, BP neural network.

I. INTRODUCTION

Supply chain management (SCM) is defined as a set of methods used to interconnect suppliers, manufacturers, warehouses and clients so that the merchandise is produced and distributed at the right quantities, to the right places at the right time with the objective of minimizing global system costs and maximizing the customer service levels [1]. There exist numerous quantitative methods for the SCM [2]. The majority of these methods can be regrouped into two classes: methods based on the discrete event simulation and the methods based on the mathematical programming techniques. SCM based on discrete event simulation generally deals with the tactical and operational level decisions such as inventory control, material handling, layout design, and vehicle routing/scheduling, while the mathematical programming techniques are mostly used for long-term strategic decision-making. In modern supply chain networks, in order to increase their competitive edge, the firms employ new strategies such as recentring their activities by outsourcing some part of their production, proposing increased diversity of products to capture the market share and so on. Even though efficient in a stable environment, these strategies augment the vulnerabilities of the firms in an uncertain environment, thus resulting in operational risks to take into account. The field of supply chain risk management (SCRM),

which emerged in the early 2000s has now become more than the overlap of directly related areas such as enterprise risk management and supply chain management [3]. As defined in [4], SCRM “encompasses the collaborative and coordinated efforts of all parties involved in a supply chain to identify, assess, mitigate and monitor risks with the aim to reduce vulnerability and increase robustness and reliance of supply chain, ensuring profitability and continuity”.

The wide range of decisions and actions that are involved in SCRM have led to an equally wide spectrum of solutions proposed by researchers. These can be broadly classified in three categories: (1) multiple-criteria decision analysis techniques; (2) mathematical modelling and optimization; and (3) Artificial Intelligence (AI) techniques [19].

AI techniques have received relatively little attention in relation to SCRM or supply chain research, in general. Recently, there has been an upsurge in AI due to the availability of increased computing power and large amounts of data, as well as the success of approaches within the broad area of machine learning. This has also led to SCRM researchers considering the potential of AI techniques in relation to tasks such as risk identification, prediction, assessment and response [5-6].

Since artificial neural network is a learning system which can develop the knowledge more than the designers’ original level of knowledge, it is well positioned to overcome the subjectivity of risk assessment in which subjectivity is inevitable.[7] In this paper, Back Propagation (BP) neural network, which is currently one of the most widely used and successful neural networks, is applied in supply chain risk assessment to effectively overcome the artificial nature of the assessment and to ensure the accuracy and objectivity of the risk assessment results [18].

II. SUPPLY CHAIN RISK ASSESSMENT PROCEDURES

1. The Procedures

In the main, risks are assessed by a function with “p” and “c” as parameters. Here “p” is the probability of risk event occurring and is decided by the possibility of a threat occurring and a weak point being attacked; and “c” is for the consequences of risk events occurring, or the value of the lost assets. Thus, the risk estimation process includes identification of risk factors and risk factor analysis in two stages.

2. Supply Chain Risk Identification

Risk identification refers to the process of identifying the different risk factors in the supply chain, which is made to identify and record the risk process thence all risk factors and their relationships are identified. In a supply chain, materials flow through a large number of production enterprises to customers, and business flow, logistics, and information flow is generated in the process. The supply chain process is associated with many processes including the transportation, storage, loading and unloading, Handling, packaging, distribution processing, distribution, information processing and many other processes, in which any one link will cause problems with supply chain risks. Therefore, many risk factors are affecting the normal operation of the supply chain. It is generally believed that the supply chain risks usually come from the natural environment and social environment in two aspects. [8] Through them, the risk factors caused by the natural environment are generally difficult to control and forecast. Therefore, we only consider the risk factors caused by the social environment in this paper. The risk factors caused by the social environment include the sole supplier risks, the information transmission risks, the logistics and distribution risks, the financial risks, market volatility risks, partner risks and profit distribution risks. For the sake of brevity, this paper takes the information risks, financial risks, logistics risks, time risks, and organizational risks as the supply-chain risk assessment factors.

3. Supply Chain Risk Analysis

On the basis of risk identification, risk analysis can further improve risk. Its goal is to collect enough information on the risks so as to determine the probability of the occurrence of various types of risk, as well as the consequences in case the risk events happen. Risks can be estimated with this information. In this paper, we take the risk ratings as the input vectors of the BP neural network, and the risk assessment value as the output of the neural network. After the network training with some samples which are evaluated successfully using traditional methods, the weight values of the network become correct through the adaptive learning process. Thus, the well-trained neural network can be used as an effective tool of risk assessment [9].

III. NEURAL MODELING AND SYNTHESIS

1. Neural networks

Neural networks, like powerful computational tools, have been typically applied to a wide range of tasks, such as function approximation, pattern recognition, identification of complex systems and times series prediction [10]. Neural network Modeling requires the step of model selection, which is an important phase in the design of a neural network.

There are different kinds and architectures of neural networks depending fundamentally on the manner how they learn. In this work, the multi-layer perception approach is used. Many researchers have focused on learning neural networks problems and several algorithms have been developed. Higher accuracy and faster convergence are a crucial issue in choosing the appropriate training algorithm.

The most popular technique for training multilayered is known as the back propagation (BP) algorithm [11]. The use of this algorithm is not always successful due to its sensitivity to learning parameters, initial state and perturbation [12]. There has been much work on the convergence of (BP) algorithm by using the gradient method [13]. Also, different versions of (BP) learning algorithms have been proposed, such as on-line algorithm for dealing with varying inputs [14] and the Levenberg-Marquardt-algorithm [15].

In this paper, training algorithm with one hidden layer have been presented. According to various studies [11], a single layer of hidden neurons is used to resolve most problems and is made the approximation of some functions thanks to its universal approximation capability.

Consider that the system model is describes by the following recurrent equation:

$$y(k+1) = F[y(k), y(k-1), \dots, y(k-n+1), u(k), u(k-1), \dots, u(k-m+1)] \quad (1)$$

Where u and y represent respectively the input and the output vector of the network, m is the order of u , F is assumed unknown nonlinear function.

$[y(k), y(k-1), \dots, y(k-n+1), u(k), u(k-1), \dots, u(k-m+1)]$ represents the input vector.

The neural model can be used therefore to provide the estimated output $y_m(k+1)$ of the process at time $k+1$ based on the input values and output values at time k .

Each neuron is connected to all of the next layer by connections whose weights are arbitrary real numbers. A neuron in the hidden layer or in the output layer combines its inputs into single value, that which it transforms afterwards to produce the output This transformation is called the activation function.

For multi-layer networks, the sigmoid activation function is defined as: $f(x) = \frac{1}{1+e^{-x}}$.

2. Direct Neural Network « DNM »

A simple (DNM), with a single output may be described in Fig. 1.

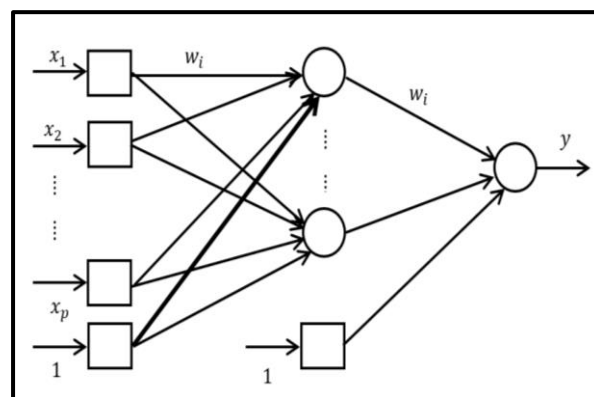


Fig 1: Feedforward Neural Network (FNN)

In this work we mean by the name the direct neural model the global neural model. To obtain the global model we use one neural network this is called the mono-network neural modeling.

2.1 Learning

Artificial neural networks (ANN) can be considered as a black box containing learned and memorized information. But at startup this box is empty, it contains neither information nor knowledge, learning is necessary. The learning process is a phase during which the behavior of the network is modified until the desired behavior is achieved. Learning of "ANN" consists of adapting its different parameters (weight) according to an iterative algorithm of adjustment or adaptation. The learning process takes into consideration all the examples provided at the entrance. Learning algorithms yield better results for multiple and varied input examples [16].

The learning procedure requires:

- A training set consisting of N examples, each one consisting of a vector applied to the input network and a vector of desired values of outputs. This training set must be rich enough that it covers the maximum possible area of operation for the network.
- Defining a cost function which measures the difference between network outputs and desired outputs present in the training set.
- An algorithm for minimizing the cost function.

$$E_r = \frac{1}{2} [y_p(k+1) - y_m(k+1)] \quad (2)$$

$y_p(k+1)$ and $y_m(k+1)$ respectively represent the output of the process and that of the model at k+1.

Most "neural network" learning algorithms are optimization algorithms: they seek to minimize, by nonlinear optimization methods, a cost function that is a measure of the gap between the network responses and the desired responses. This optimization is done iteratively, by modifying the weights as a function of the gradient of the cost function: the gradient is estimated by a method specific to neural networks, the so-called backpropagation method. The backpropagation algorithm is one of the most used supervised algorithms for learning multilayer perceptions (MLP). Generally, the learning is done over a relatively long period, and includes four stages of calculation:

Generally, learning requires a relatively long period, and includes four stages of calculation:

1. Initialization of synaptic weights of the network.
2. Presentation of the input vector and propagation of states.
3. Calculation of the error at the output of the network.
4. Calculation of the vector of correction.

For this type of network, we use the back-propagation algorithm as a learning algorithm.

2.2 The back propagation algorithm

In an "MLP", for each example presented to the network, an estimated output is calculated by propagating the calculation from one layer to another to the output layer, then an error will be computed and then backpropagated in the network to end, adjust each weight. The same procedure is repeated for all learning examples. This process is repeated until the outputs of the network are sufficiently close to the desired outputs.

Denote that $y(y_1, \dots, y_m)$ is the vector of desired outputs and the sigmoid function f , its derivative is: $f'(x) = f(x)(1 - f(x))$.

The input and output of a neuron v are respectively denoted by I_v and O_v .

$$\begin{cases} I_v = \sum_j W_{jv} O_j \\ O_v = f(I_v) \end{cases} \quad (3)$$

The error corresponding of an example p is given by:

$$E_p(w) = \sum_{i=1}^m \frac{1}{2} (S_i^p - Y_i^p)^2 \quad (4)$$

The back-propagation algorithm is an approximation of the gradient method. It is defined by:

$$W_{uv}(t+1) = W_{uv}(t) - \varepsilon(t) \frac{\partial E^p(w)}{\partial W_{uv}} \quad (5)$$

t denotes the numbers of iterations, $\varepsilon(t)$ is the step of gradient. This equation requires the calculation of W_{uv} .

Suppose that $d_v = \frac{\partial E^p}{\partial I_v}$, so we have:

$$W_{uv}(t+1) = W_{uv}(t) - \varepsilon(t) d_v O_u \quad (6)$$

This learning algorithm depends on several factors [17]:

The initialization of the network parameters: the choice of the initial values of the weights and the iteration step must be done in a way that ensures a fast and stable convergence.

The complexity of the learning base and the order of presentation of the examples.

The structure of the "Neural Networks" considered must be chosen in an appropriate way, especially the number of neurons of the hidden layer which must be optimal.

The main purpose of learning is to make a network capable of generalizing. It is dangerous to continue indefinitely the learning phase without control [16]. The learning capacity of a neural network is so strong that after a certain number of iterations, the synaptic weights are able to predict almost the data without error. At this stage, the neural network is no longer mistaken in its predictions, but there is a great risk that these predictions are just as good as the data on which learning was based. This is called learning by heart or over-learning. This phenomenon is then prevented by adding a phase to the modeling procedure called the generalization or validation phase.

2.3 Generalization

The concept of generalization for a neural network is used to accurately measure model performance for a given problem once learning is complete. The generalization is manifested by an input basis, unknown to the network, given to the model to test its ability to generalize; if error is minimal, we say that the process has learned otherwise, so we speak of over learning. It represents one of the features of neural networks because they are able to generalize from a test.

This phase is influenced mainly by three factors: the number and quality of the learning examples, the complexity of the learning algorithm used and the size of the network. [11]

IV. SIMULATION RESULTS

In this section, we present the simulation results. The application of the modeling approach is showed. We use this modeling approach for the neural identification of Supply Chain Risk. The neural modeling was done through a neural network with one hidden layer and one output. The activation function used in the example is the sigmoid function and the network generates the output $y_m(k+1)$.

4.1 Experiment Data

The database used in experiment, including the risk assessment value and the risk level of the risk factors, can be collected by expert evaluation. The sample data as neurons in the input layer and the output layer is listed in Table 1, where X1 is for information risk rating value, X2 is for the level of financial risk, X3 is the logistics risk rating value, X4 is the time risk rating, X5 is the value of organization risk rating.

4.2 BP neural network training

An artificial neural network models with BP training has been developed using MATLAB software for supply chain risk assessment, and the experiment dataset in Table 1 is used to train the network. The performance of the BP neural network training is indicated in Fig.2. Here the variable learning rate back propagation algorithm is used in the network training, which can adjust the learning rate in accordance with the error curve change.

The architecture of the neural network generating the database is illustrated in Fig. 2.

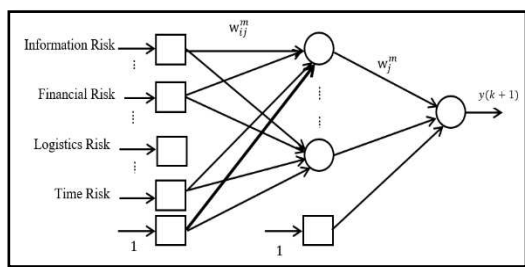


Fig 2: The architecture of the neural network generating the database.

TABLE I. DESCRIPTION AND MEASUREMENT UNIT OF THE METRICS OF THE PROPOSED PREDICTION SYSTEM

No	Parameters in the input layer					Sample results
	X_1	X_2	X_3	X_4	X_5	
1	0.4	0.3	0.4	0.5	0.3	0.2
2	0.3	0.5	0.8	0.4	0.2	0.41
3	0.4	0.3	0.2	0.3	0.4	0.36
4	0.6	0.5	0.2	0.7	0.5	0.59
5	0.3	0.2	0.4	0.5	0.4	0.35
6	0.2	0.2	0.2	0.3	0.4	0.28
7	0.5	0.4	0.3	0.6	0.4	0.46
8	0.8	0.7	0.6	0.8	0.7	0.77
9	0.2	0.3	0.3	0.4	0.2	0.26
10	0.4	0.5	0.6	0.4	0.35	0.48
11	0.7	0.6	0.8	0.5	0.73	0.74
12	0.4	0.3	0.2	0.3	0.5	0.38
13	0.87	0.7	0.63	0.6	0.8	0.80
14	0.3	0.2	0.4	0.4	0.5	0.34
15	0.6	0.5	0.7	0.5	0.6	0.62

4.3 BP neural network testing

After proper training, the network is simulated with other input parameters combinations and the network responses are compared with experimental response. The comparison of predicted values by using the developed model with experimental data was shown in Table II. It shows that predicted accuracy of the model is quite good and can be used in the supply chain risk assessment.

TABLE II. COMPARAISON BETWEEN SAMPLE RESULTS AND THE SIMULATION RESULTS

No	Sample results	Simulation results
11	0.74	0.7452
12	0.38	0.0390
13	0.80	0.801
14	0.34	0.342
15	0.62	0.625

A. Experiments and discussions

In this section, we present the simulation results. The sufficiency of the suggested algorithm is analyzed. We utilize this algorithm for the neural identification of a supply chain risk assessment.

The goal of our simulation is to find the adequate structure of the input-output neural model which describes the dynamics of the supply chain risk by using the approach presented in previous section.

The supply chain risk parameters used in simulations are illustrated in “Table. I”. This model, assumed that:

- The number of hidden neurons equal to 6 and a step iteration ϵ equal to 0.2. These values are determined with tacking into account a good approximation and a good generalization.
- The learning algorithm used is the back-propagation algorithm.
- The learning time is equal to 192.792545 seconds.
- The value of error is equal to .00001.

The results of training phase are of the model is given by this figure:

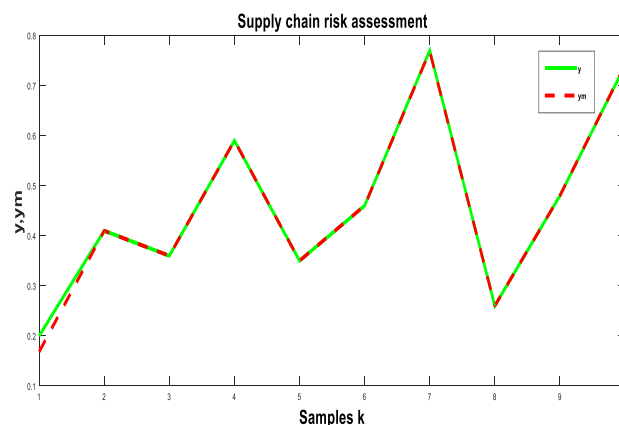


Fig 3: The evolution of the outputs

It can be shown that the suggested algorithm offers a good convergence characteristic in the training and validation phases.

“Fig. 3” illustrates the importance the PB algorithm. Indeed, we can see that the PB algorithm provides a good performance but with a slow convergence time. In the same way, the PB algorithm has a minimum convergence time with degradation of the performance of the model acquired. The resulting algorithm guarantees both rapid convergence and higher learning and generalization capabilities.

V. CONCLUSION

In this paper, an artificial neural network training algorithm has been designed and applied in Supply Chain Risk assessment. The proposed approach develops a BP algorithm based on artificial neural networks techniques to avoid subjectivity factors in the risk assessment process. The network simulation results shows that the model is accurate and practical.

An essential finding in this study is that the construction of the neural network is an empirical process and requires several trials to find the suitable parameters giving the best performances of the neural training. These parameters include weights initialization, number of hidden neurons, MSE (mean square error), numbers of iterations, etc. The learning pedagogy affects also the accuracy rate.

The limitation faced in this research is the collection of the database that’s need to be larger as the accuracy of the ANN training increases by increasing the number of selected samples per training class. Moreover, the correctness of the sample become difficult to testified.

Various research directions and challenges could be considered for future research. Firstly, the approach proposed in

this article can be applied to forecast supply chain performance in order to automate the whole logistics management processes.

Another direction of research concerns the application of other artificial neural approaches like fuzzy logic in supply chain risk estimation in order to compare the advantages and limitations of using each of them.

In additional, in this study we have consider only some risk variable. Future studies can take into account other risk variable and can also involve other external features that will lead to better risk assessment.

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The strategy of Tunisian Solar Plan: Maximum Power Point Tracking for PV using Incremental Conductance Algorithm

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Abstract—This research was aimed to present the version of the Tunisian Solar Plan, that focuses on the transition to a sober economy in energy and carbon, based on the improvement of energy efficiency aimed at better control of energy demand and recourse renewable energies aiming at the diversification of the energy mix for the production of electricity.

For this purpose, we will explore the performance of a maximum power point tracking system which implements Incremental Conductance (INC) algorithm. The INC method was designed to control the duty cycle of DC-DC Boost converter connected of the photovoltaic panel and to ensure the MPPT work at its maximum efficiency. The system performance of INC algorithm connected to the PV process are presented. From the simulation results, the INC technique shows a better performance and also has a lower oscillation.

Keywords— Energy, TSP, Transition, Economy, Strategy, PV, MPP, INC, DC-DC Boost converter.

I. INTRODUCTION

For more than two decades, Tunisia has focused on the rational use of energy and the development of renewable energies. Ambitious energy demand management programs have reduced the rate of growth of energy consumption and substantially lowered energy intensity. Thanks to these programs, to produce the same level of wealth, Tunisia today consumes 20% less energy than in 2000 [3].

The analysis of the evolution of the Tunisian energy system and the challenges it will face during the next two decades highlights the need to transform this system on the basis of two priority actions: the reinforcement of energy efficiency and the recourse renewable energies [1,2,4,18].

Tunisia has prepared the first version of its solar plan in 2009. The evaluation of achievements highlights the need to update the Tunisian Solar Plan (TSP) so that it is consistent with the Mediterranean Solar Plan and more ambitious in

terms of boosting energy efficiency and breakthrough renewable energy [5,6].

This version of the Tunisian Solar Plan is part of a transition to a low energy and carbon economy based on two major choices:

- Significant improvement in energy efficiency to better control energy demand.
- Substantial use of renewable energies to diversify the energy mix for electricity production.

In order to make the Tunisian Solar Plan succeed, the point of operation of the photovoltaic panel must coincide with the optimum power point. Hence, the use of a MPPT command is a necessity in order to extract the maximum power of the photovoltaic panel [12].

The PV system consists of many components such as PV modules, mounting structure and electrical connections and means of regulating and modifying the electrical output.

A DC-DC converter is needed for implementing MPPT. The DC-DC converter delivers the maximum power from PV module to load by adjusting the duty cycle and able to distribute a maximum power, when load is changes. Some common DC-DC converter topologies for implementing MPPT are Buck converter, Boost converter and Buck-Boost converter. The performance of Incremental Conductance (INC) algorithm outperformed the P&O algorithm when it implemented at Buck converter or Boost converter [15]. Another research had shown that implementing INC method on DC-DC Boost converter also able to find the maximum power point and had an efficient performance on some different weather condition [9,10].

This paper is organized as follows. The Tunisian strategy of the electric mix is presented in section 2. The long-term electricity mix and the objectives of the TSP are discussed at the end of the second section. Photovoltaic system characteristics are defined in section 3. Incremental conductance MPPT algorithm is presented at the end of the third section. To show the performance of the INC technique, some simulation results of PV energy process are discussed in section 4. Finally, conclusions are drawn in the final section.

II. THE TUNISIAN STRATEGY OF THE ELECTRIC MIX

1. Prospective electrical demand

The forecast of the electrical demand is defined on the basis of two scenarios of evolution of the electrical intensity:

- An electricity efficiency scenario, according to which it is considered that the electricity savings of electricity efficiency actions launched between 2008 and 2012 continue to produce electricity savings until 2020. Beyond 2020, it is considered that intensity will continue to fall with the same average annual rate forecast for 2013-2020, is -0.6% per annum. Under this trend scenario of electricity efficiency, final electricity demand would reach 20.8 TWh in 2020 and 34.9 TWh in 2030.
- A proactive scenario of electrical efficiency (retained by the strategy of the electric mix), which also integrates efficiency actions between the years 2008 and 2012 those launched between 2013 and 2020. Beyond 2020 we consider that the intensity will decline less strongly or -1.5% between 2020 and 2025 and -1% between 2025 and 2030 reflecting the constraints of access to deposits of energy savings increasingly difficult to mobilize. The average annual rate of the decline in intensity between 2013 and 2030 will be -2% in this case [1,2,5].

To achieve this goal of reducing electricity intensity, Tunisia will put in place an ambitious strategy in terms of energy efficiency based on a coherent mix of instruments regulatory, institutional and incentive [7,8].

Thus, in the case of this scenario, demand would evolve more moderately to reach 16.9 TWh in 2020 and 26.7 TWh in 2030, or 24% below demand in the trend scenario.

Figure 1 present the scenarios of the demand for electricity in Tunisia.

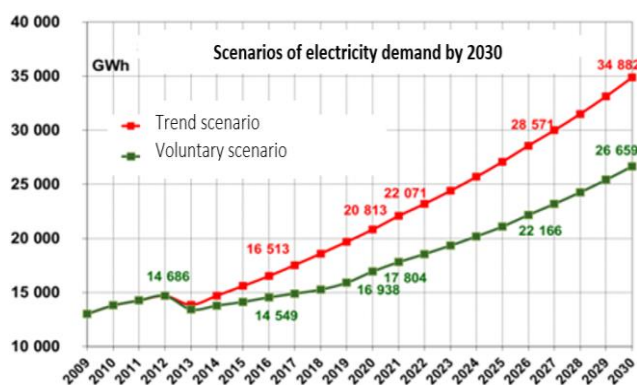


Figure 1. Scenarios of the demand for electricity in Tunisia (study electric mix, WI-ALCOR, ANME-GIZ).

2. The long-term electricity mix

2.1. Electricity generation targets by 2030

The Tunisian strategy plans to reduce the share of renewable energy in electricity production from around 2% in 2010 to

30% in 2030, compared to trend scenario at 5% renewable energy.

This share will be split between wind, solar photovoltaic and solar thermodynamic (CSP) as follows: 15% wind, 10% PV and 5% CSP.

Figure 2 present the scenario of the electric mix retention in Tunisia.

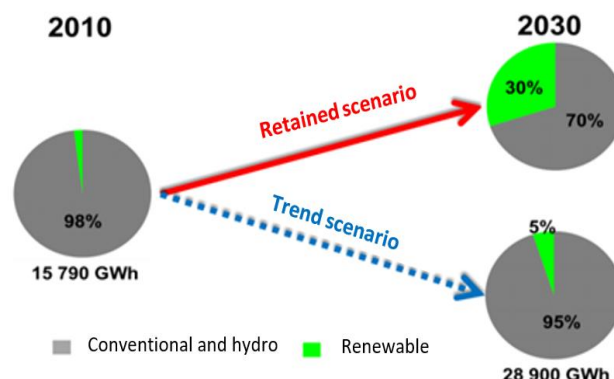


Figure 2. Scenario of the electric mix retention in Tunisia (study mix electric, WI-ALCOR, ANME-GIZ).

2.2. Objectives of the Tunisian Solar Plan

The TSP is the operational tool for implementing the Tunisian strategy for electricity mix with regard to the renewable electricity generation part. As such, he focuses solely on electricity generation connected to the grid and focuses more specifically on three sectors, namely: wind, grid-connected PV and thermodynamic solar energy (CSP) [3,4,7,18].

Thus, the quantitative objective of the TSP is to achieve a penetration rate of renewable energies in terms of electricity production of about 30% in 2030.

The prediction of installed electric capacity of renewable origin by die in Tunisia is presented in Figure 3.

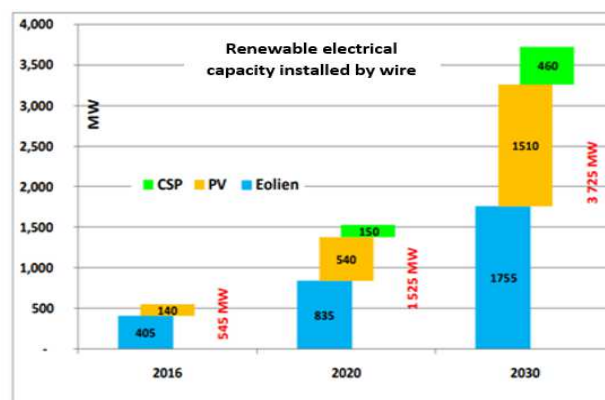


Figure 3. Prediction of installed electric capacity of renewable origin by die in Tunisia (study, WI-ALCOR, ANME-GIZ).

In accordance with the strategy of the mix, the TSP foresees a distribution of the renewable energy mix in 2030 between the main sectors as follows:

- 15% wind energy
- 10% solar PV
- 5% thermodynamic solar

In terms of installed capacity, the TSP plans to reach an installed capacity of renewable energies in 2030 of around 3725 MW compared to a total electricity capacity of approximately 10900 MW. It should be recalled that the renewable electric power at the end of 2012 is about 250 MW, mainly wind power (245 MW) and PV (5 MW) [6]. Lastly, the TSP also plans to promote the control of electricity demand by combining development of renewable energies and energy efficiency actions in its activities [8].

Now, we are interested in studying the different characteristics of the PV process in order to make the strategy of the Tunisian Solar Plan succeed.

III. PHOTOVOLTAIC SYSTEM CHARACTERISTICS

The photovoltaic power generation system considered in this paper, consists of a PV array and a DC-DC Boost converter. The electrical equivalent circuit of the PV cell is given by Figure 4.

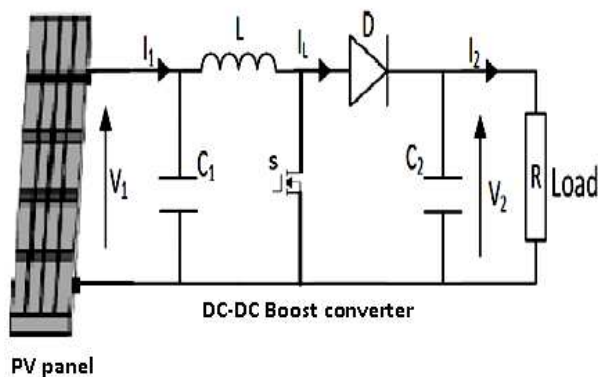


Figure 4. Configuration of the photovoltaic energy system.

1. Photovoltaic panel

A solar cell is a p-n semiconductor junction. When exposed to light, a DC current is generated. The generated current varies linearly with the solar irradiance [9,10,17].

The output current generated by the PV panel can be expressed by:

$$I_{pv} = I_{ph} - I_s \left[\exp \left(\frac{q(V + R_s I_{pv})}{n_s k T} \right) - 1 \right] - \frac{(V + R_s I_{pv})}{R_{sh}} \quad (1)$$

The photocurrent of the PV panel, varies with temperature and irradiation. It is described by the following equation:

$$I_{ph} = (I_{ph,n} + K_I \Delta T) \frac{G}{G_n} \quad (2)$$

$I_{ph,n}$ is the rated current generated by the photovoltaic panel under standard conditions of temperature and irradiation ($T=25^\circ\text{C}$ and $G=1000 \text{ W/m}^2$):

$$I_{ph,n} = \frac{(I_{ph} + K_I \Delta T)}{\exp \left(\frac{(V_{oc} + K_V \Delta T)}{V_t} \right) - 1} \quad (3)$$

with:

$$V_{oc} = n_s \frac{KT}{q} \text{Log} \left(\frac{I_{cc} + I_s}{I_s} \right) \quad (4)$$

where, I_s is a reverse saturation current, V_{oc} is the open circuit voltage, I_{cc} is the short circuit current.

The PV generator is strongly influenced by the variation in irradiation and temperature. In fact, in Figure 5, the PV generator is subjected to variations in irradiation, where it clearly appears the decrease in the power and the change of the maximum power point (MPP) during the decrease in irradiation.

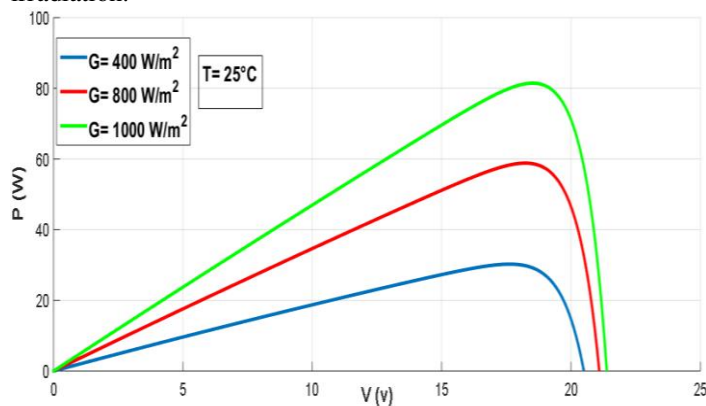


Figure 5. P-V curves with different values of irradiation.

In Figure 6, the PV generator is subjected to temperature variations under constant irradiation, here again the MPP changes.

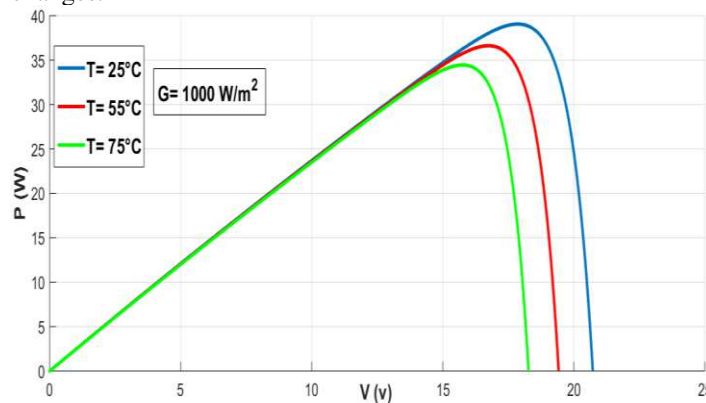


Figure 6. P-V curves with different values of temperature.

We must reconcile these behaviors with the load. During the source-load connection, it is therefore essential to take into account the variable nature of the power delivered by the PV generator, but also the characteristic of the load so that an operating point is possible. The operating point corresponds to the intersection of these two characteristics (Figure 7).

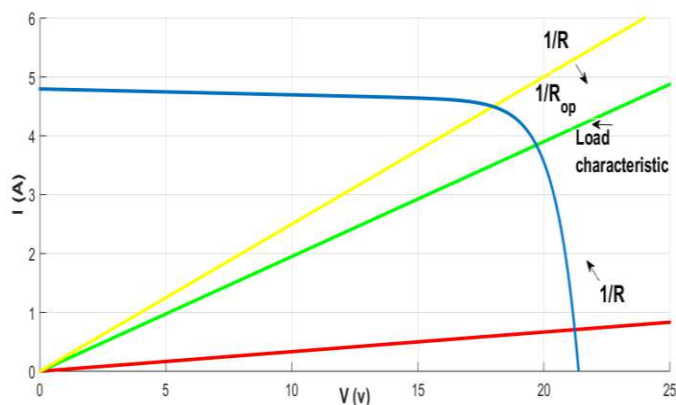


Figure 7. Influence of the load on the operating point.

The operation of the generator depends strongly on the characteristics of the load with which it is connected. In addition, for different values of R, the optimal adaptation occurs for a single operating point (R_{op}) named Maximum Power Point (MPP). Consequently, in order for the generator to operate most often at its maximum point, the solution commonly used is to introduce a DC-DC converter that acts as a load source adapter (Figure 4), in this case the generator delivers maximum power [13,15].

2. DC-DC Boost converter

The solar array is connected to a DC-DC Boost converter used to perform the following functions:

- Ensure the operation of the photovoltaic generator at the MPP. This function is generally required in grid-tied PV systems.
- Adequate the DC voltage and current signals at the generator output to a certain level according to the application.
- Non-inverted output voltage [11,12].

The dynamic model of the DC-DC Boost converter can be described by the following state equations:

$$\frac{di_L}{dt} = \frac{1}{L} (V_1 - V_2(1-\alpha)) \quad (5)$$

$$\frac{dV_2}{dt} = \frac{1}{C} (i_L(1-\alpha) - \frac{V_2}{R}) \quad (6)$$

Where i_L is the current on the inductance L and α is the duty ratio of the Pulse-Width-Modulation (PWM) signal.

3. Incremental Conductance MPPT Algorithm

The INC technique is considered as the most algorithms used in practice by the majority of authors to track the maximum power point.

INC was designed based on an observation of P-V characteristic curve. This algorithm was developed in 1993 and was intended to overcome some drawback of P&O algorithm. INC tries to improve the tracking time and to

produce more energy on a vast irradiation changes environment. The MPP can be calculated by using the relation between dI/dV and $-I/V$ [14,16].

If dP/dV is negative then MPPT lies on the right side of recent position and if the MPP is positive the MPPT is on left side. The equation of INC method is:

$$\frac{dP}{dV} = \frac{d(VI)}{dV} = I \frac{dV}{dV} + V \frac{dI}{dV} = I + V \frac{dI}{dV} \quad (7)$$

MPP is reached when $dP/dV=0$ and

$$\frac{dI}{dV} = -\frac{I}{V}$$

$$\frac{dP}{dV} > 0 \text{ then } V_p < V_{MPP}$$

$$\frac{dP}{dV} = 0 \text{ then } V_p = V_{MPP}$$

$$\frac{dP}{dV} < 0 \text{ then } V_p > V_{MPP}$$

In Figure 8, it is given a flowchart which describes the INC technique.

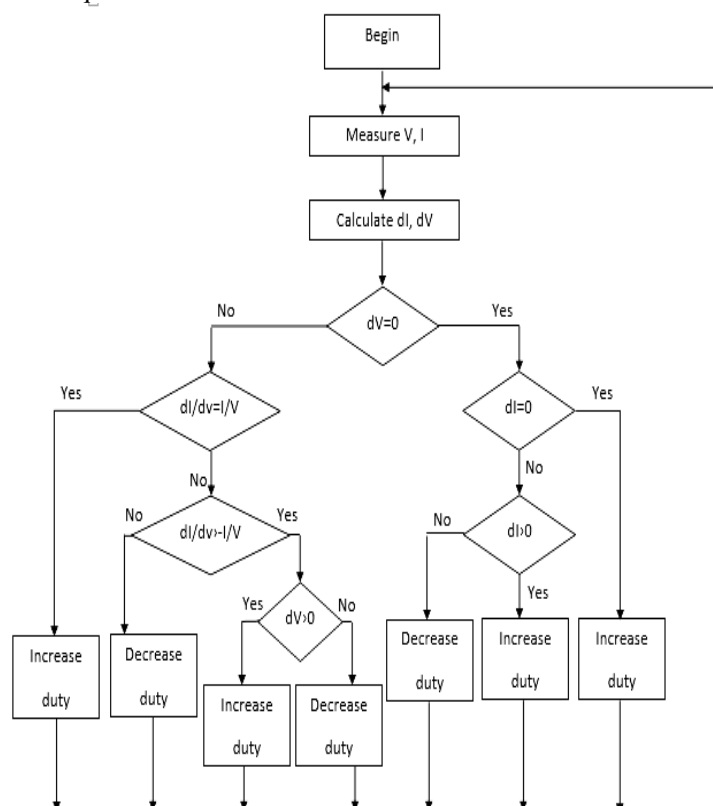


Figure 8. Flowchart of the INC algorithm.

If MPP lies on right side, $dI/dV < -I/V$ and then the photovoltaic voltage must be decreased to reach the MPP. INC method can be used for finding the MPP, improve the PV

efficiency, reduce power loss and system cost. Implementation INC on a microcontroller produced more stable performance when it compared to P&O. The oscillation around MPP area also can be suppressed in trade of with its implementation complexity [11,15].

IV. SIMULATION RESULTS

This section is reserved for presenting the main results. We use Matlab/Simulink program to simulate the behavior of the energy PV conversion system.

To explain the characteristic of the INC MPPT used, we apply a sudden change in temperature and irradiation.

The variation of the temperature and solar irradiation are given, respectively, by the following Figures 9 and 10.

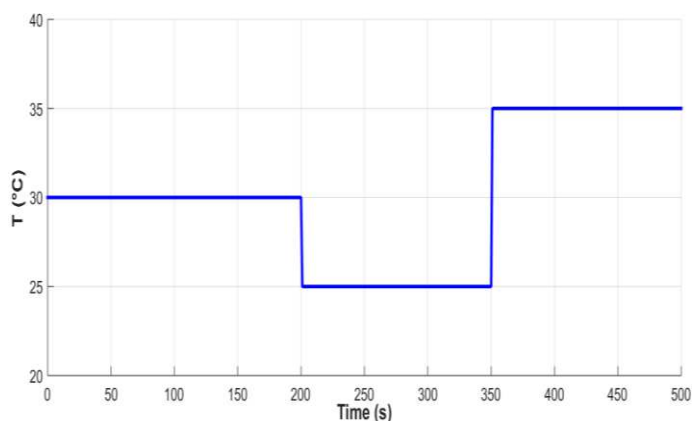


Figure 9. Variation of temperature.

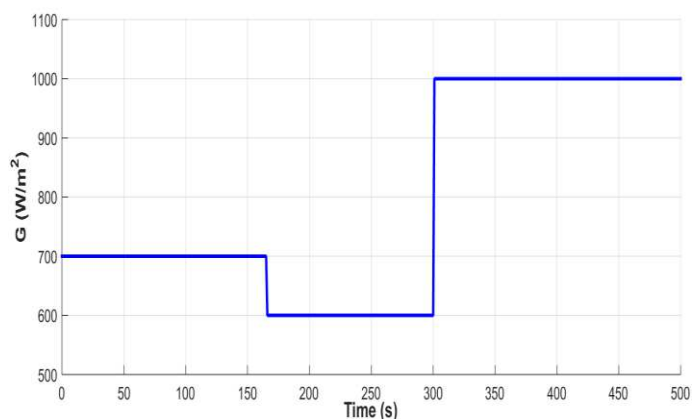


Figure 10. Variation of irradiation.

To check the performance of the photovoltaic panel, we can use the INC MPPT algorithm.

The Figures 11, 12, 13 and 14 illustrate, respectively, the evolution of the voltage, the error voltage, the evolution of the current and the error current according to the MPPT algorithm used.

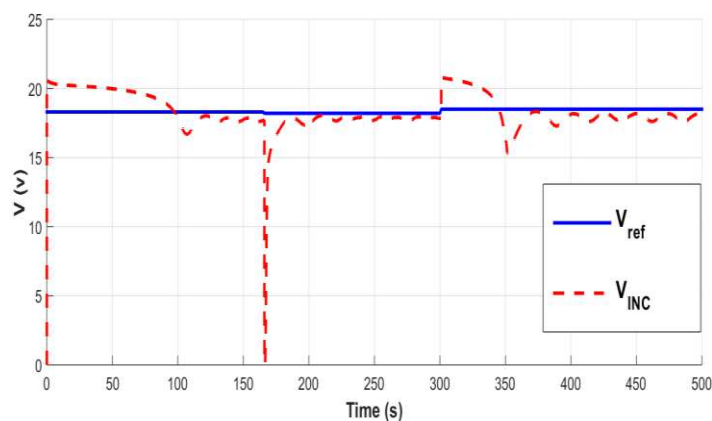


Figure 11. Evolution of the voltage based on INC technique.

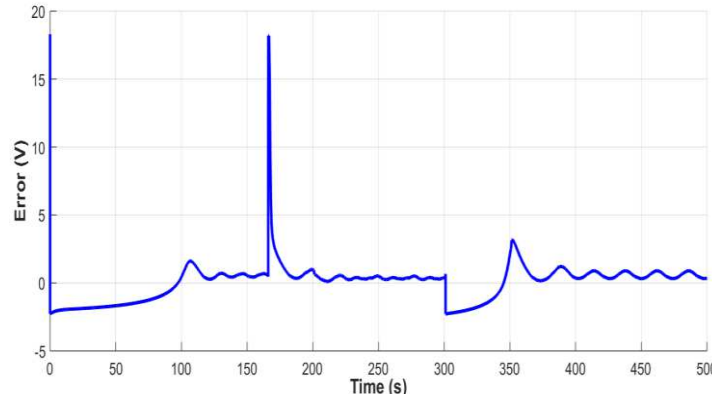


Figure 12. Evolution of the error voltage.

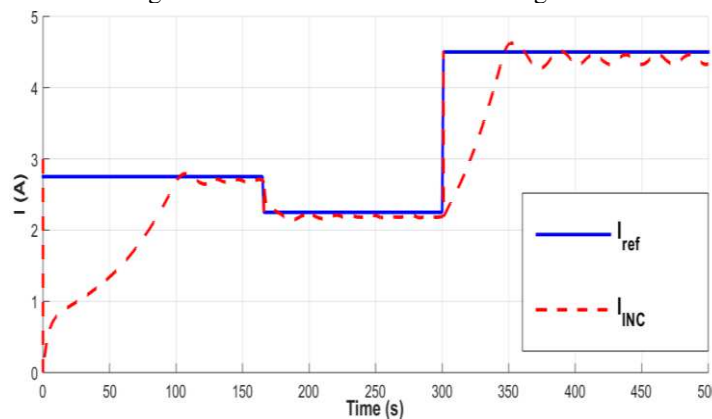


Figure 13. Evolution of the current based on INC technique.

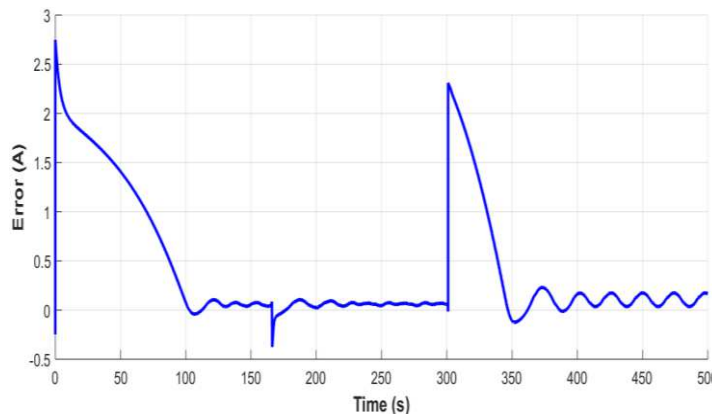


Figure 14. Evolution of the error current.

We can observe momentary peaks, which are resulted from sudden change in temperature and solar irradiation in Figures 11 and 13.

The power regulation response generated by using the INC MPPT algorithm is illustrated in Figure 15.

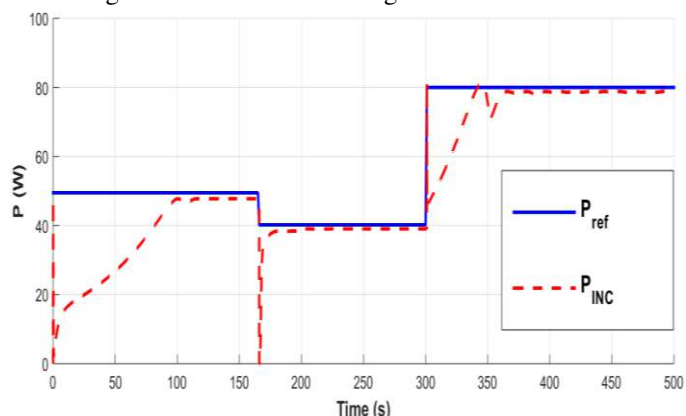


Figure 15. Evolution of PV power based on INC technique.

In Figure 15, we can see that the INC MPPT technique track the maximum power point.

Based on simulation results, it was observed that the INC technique were able to follow irradiation and temperature changes and retain the optimal point.

Incremental Conductance algorithm had proved able to detect irradiation and temperature changes and had successfully shifted the MPP by adjusting the PWM duty cycle. Duty cycle will be changed to follow changes in solar irradiation and temperature so that output voltage of DC-DC Boost converter remains on MPP point.

It is also clear that the generated solar power achieves rapidly the maximum value under the radiation conditions considered and maintains the real MPP after each temperature and irradiation variation, hence a good stabilization is obtained thanks to INC technique.

INC method also reduced the oscillation around MPP point. Using MPPT with INC method increases output power of system.

V. CONCLUSION

This research aimed to study the Tunisian Solar Plan which is not only an action plan, but also a strategic commitment, carrying original and innovative characteristics and ensuring the development of renewable electricity generation in Tunisia.

The electricity generation targets for 2030 in Tunisia have been studied and detailed.

The method discussed in this paper to extract maximum power from photovoltaic system is the Incremental Conductance. The simulation results show the performance of the proposed algorithm.

We can deduce that INC method can track the maximum power point with less chattering phenomenon.

In a future work, we can make a comparative study between the different MPPT commands used to extract the MPP from the photovoltaic panel, in order to realise the TSP program under the right conditions.

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Inbound open innovation in SMEs: towards a new conceptualization to explore openness behaviour and motivations in the Tunisian manufacturing sector

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Abstract— The objective of this paper is threefold by studying the degree of openness of SMEs under the aegis of the inbound dimension of Open Innovation model. In particular, it is intended to clarify the concept of the degree of openness, explore the behaviour of SMEs when approaching inbound practices and also explain the degree of openness of the innovation process through the effect of motivations. Then, in the light of a new conceptualization of the degree of openness and by referring to the dimensions of breadth and depth, it was possible to propose a configuration of 141 Tunisian manufacturing SMEs involved in innovative activities on the basis of classification analysis. The results categorize SMEs into four homogeneous groups that differ according to their degree of openness: *Closed, Supervisors, Engaged and Open*. In addition, findings show that the degree of adoption of inbound practices is stimulated by a range of internal incentives that can be linked either to the benefits of openness as such or to obstacles to innovation. The results of this paper have practical implications for both managers and political organisations involved in sustaining innovation.

Keywords— Inbound open innovation, degree of openness, openness behaviour, openness motivations, SMEs

I. INTRODUCTION

Innovation has long been regarded as the key element of business growth, development and survival. It is seen as a driver for strengthening their competitive position in the market and improving their competitiveness and performance. However, the question today is not to know the merits of innovation, nor to identify the related risks, but rather to explain the conditions for its success and the necessary mechanisms to stimulate it, particularly in the new economy based on knowledge. Regarding the way in which companies are organized to develop innovations, the debate is still ongoing and various approaches are trying to clarify this phenomenon. For years, innovation has remained an internal business process with a vision of protecting and hiding new ideas internally to ensure power and business advantage over competitors. Thus, innovation is traditionally considered as taking place mainly within a single company. This way of innovating reflects a limited interaction of companies with their environment. However, with the increasing availability and mobility of knowledge workers and the increasing importance of external sources and actors ([14]), more and more companies have redesigned their ways of innovating.

Recently, academics and professionals have agreed on an emerging trend towards new practices based on interaction, information sharing and collaboration to advance innovation ([43]-[44]). It is in this logic of openness that Professor Henri Chesbrough has introduced a new theoretical trend in innovation management, based on the Open innovation model.

Referring to [11], the Open Innovation model is defined as “*a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firm look to advance their technology.*” Indeed, the open innovation model has redefined the new boundaries of companies, making them more porous so that knowledge flows more freely between the company and its external environment [6]. Three dimensions were then proposed in the literature to reflect these movements of ideas and knowledge: the inbound dimension which aims at an innovation process from the outside to the inside to innovate, the outbound dimension which reflects a process from the inside to the outside to open new markets and the coupled dimension which corresponds to the combination of the first two dimensions ([4], [15]-[19])

Through the literature review, we have observed that the corpus of knowledge on open innovation in the context of SMEs is very recent and still poorly developed, which requires more investigation by researchers([21], [22], [33]-[43]). In this sense, this paper aims to take part in this research effort by studying open innovation in the specific context of SMEs. Moreover, there is a fairly broad consensus in the literature that these companies are more inclined to adopt the new innovation model through its inbound dimension because it does not require significant investment compared to other perspectives ([17], [30], [42]-[45]). This last observation led us to focus in this research on the analysis of the inbound dimension related to the open innovation paradigm in the specific context of SMEs.

To analyze this dimension, literature has introduced the concept of openness ([15], [26]-[27]) to designate a set of avenues that the company should pursue to remain innovative, moving from a closed innovation model to a more open model. Indeed, the authors pointed out that the adoption of the open innovation model is not a closed versus open dichotomous form, but rather is located on a continuum

ranging from a less open degree to a more open degree and with different degrees of openness ([14], [15], [16], [26], [27]). However, this idea of the degree of openness remains insufficiently studied in the literature. In fact, the openness of firms to open innovation practices has been widely associated in the literature with the practice of searching for external sources of information ([26]-[27]). Considered from this perspective, the conceptualization of openness seems very limited.

All these considerations lead us to focus, in this research, on studying the degree of openness of innovative SMEs under the aegis of the inbound dimension of the open innovation model. In order to achieve this general objective, three specific objectives will be pursued to address the identified gaps in the literature. First, our research attempts to contribute to the clarification of the concept of the degree of openness, which is considered very little explored in the literature on the open innovation model. This gap is all the more pronounced in the context of SMEs. Second, our research aims to explore the behaviour of SMEs in adopting open innovation practices. This means identifying innovative SME configurations that differ according to their degree of openness. Finally, and to go further in analyzing the degree of openness of SMEs and understanding their behaviour when adopting inbound practices, we propose in this article to answer in part the question: *why do some SMEs succeed in opening their innovation process more than others?* More specifically, we choose to explain the behavioral difference of SMEs in terms of their degree of openness through a motive-based approach. To achieve all these objectives, we opted for a quantitative approach and conducted an empirical study among Tunisian SMEs operating in the manufacturing sector.

The remainder of the paper is structured in four main parts. In Part II, we will conduct a literature review, focusing in particular on inbound open innovation and the degree of openness, in order to set out a roadmap for a new conceptualization of the degree of openness. Next, we will present, in Part III, the conceptual framework for studying the behaviour and determinants of the degree of openness. Then, we will present the empirical study in Part IV, detailing respectively the research methodology, the measurement of variables and the results of the various empirical analyses. At the end of this document and through Part V, we will discuss the results obtained and present through the conclusion a reminder of the strengths of this work, also highlighting the limitations of this study, as well as recommendations for the orientation of future research in our field of research.

II. LITERATURE REVIEW

A. *Inbound Open Innovation in SMEs*

Since this paper focuses on open inbound innovation in the specific context of SMEs, we specify the inbound opening practices in the first instance, and the advantages of integrating SMEs to an inbound open innovation approach in the second instance.

1) *Inbound Open Innovation Practices*: The inbound dimension of the open innovation model consists of the acquisition, assimilation and internal incorporation of new ideas, knowledge and technologies developed in the company's external environment. In this way, inbound open innovation is a way for companies to renovate and enrich their internal knowledge base through opportunities to access new, complementary and unique resources ([19]) in order to stimulate innovation processes.

To innovate through this approach of resource internalization, the literature predicts that companies embrace several practices. References [26] and [27] linked the inbound dimension to the strategy of searching for external information sources. Indeed, the authors suggest that companies should rely on the knowledge and expertise of a wide range of external actors and information sources ([26]-[27]). This research practice is carried out through various external sources of information used by companies to support their innovative activities: customers, suppliers, research laboratories, etc. reference [42], for their part, use the terminology "exploration" to refer to the inbound dimension. The authors present five practices related to this dimension: customer involvement, external networking, external participation, the acquisition of technical and scientific services from other organizations (R&D outsourcing) and the acquisition or use of intellectual property rights held by other organizations (inward licensing of IP).

In the continuity of research exploring inbound practices adopted by SMEs, [15] introduced a theoretical model to present the forms of openness according to which the inbound or outbound process is related. The authors linked the inbound dimension to two major practices: Sourcing and acquiring. This implies that the inbound dimension is associated with the exploration and integration of external resources to develop the knowledge base and internal resources that are available in the external environment ([15], [26], [27], [32]-[42]).

The review of the current state of the literature on the open innovation paradigm in the context of SMEs has enabled us to propose a categorization of forms of openness according to inbound logic. Thus, we can classify inbound activities into three main practices of internalizing external resources. These are practices of internalization through the use of external information sources, collaboration and acquisition. Table I illustrates some empirical work on the adoption of the innovation model through inbound practices. It should be noted that the analysis focused more specifically on the SMEs context.

By examining the empirical literature relating to the inbound dimension, we can see that this way of approaching the open innovation model has attracted the attention of researchers who have reported the positive impact of this dimension on innovation in the context of SMEs. Reference [41] has already carried out a systematic literature review to structure the field of open innovation in SMEs. The authors note an emerging trend towards a practical application of open innovation by SMEs. In order to better understand the

adequacy of the open innovation paradigm with the specific context of SMEs, it is necessary to present the advantages of integrating into an open innovation approach.

TABLE I
 INBOUND OPEN INNOVATION PRACTICES IN SMEs

Inbound Open Innovation Practices	Activities related to Inbound practices	Some Empirical studies
Internalization practices by external search of information	Suppliers of materials and equipment, customers, competitors, research laboratories; public and private research centers; professional conferences and congresses; fairs; professional networks, etc.	[16], [23], [26], [27], [30], [32], [36], [39]
Internalization practices by collaboration	Client involvement; External participation; Vertical collaboration; Horizontal collaboration; Collaboration with end-user; Scientific collaboration; Domestic collaboration; International collaboration	[16], [26], [30], [32], [34], [40], [42]
Internalization practices by acquiring	Acquisition of technical and scientific services from other organizations; Acquisition of intellectual property rights owned by other organizations; Acquisition of equipment and other preparations.	[4], [16], [30], [32], [34], [42]

2) *Benefits of adopting an inbound open innovation approach by SMEs:* The literature explicitly relates the interactive nature of the innovation process in the context of SMEs. Several authors affirm the importance of the conjunction of the firm's internal resources with external resources to ensure the successful development of innovations in SMEs, given their specific characteristics in terms of insufficient resources ([7], [21], [25]-[41]). Previously, [9] and [39] demonstrated that due to scarcity of resources and capacity, SMEs profit from open innovation activities and use these practices more intensively than large companies. By cooperating with other companies, SMEs can have access to inter-firm resources with low costs that help to overcome technological, financial or human capital obstacles [17].

Collaboration with customer firms is an essential practice to compensate for the lack of internal resources and then transform ideas and inventions into commercially viable innovative products ([17]-[32]). Partnering up with third parties can help SMEs to complement limited qualitative and quantitative resources and share risks associated with the development and commercialization of new products or services ([41]). Therefore, establishment of partnerships promotes the development of new products, marketing in new

markets, as well as economies of scale and cost advantages ([46]).

Compared to large companies, being generally more flexible, less bureaucratic and faster in decision-making and in responding to market changes, open innovation is a feasible innovation strategy for SMEs ([1]-[17]). It is due to these specific characteristics that they could benefit even better from the concept than large companies ([7]; [9], [38]). Moreover, the speed at which new ideas are transformed into marketable products is crucial to differentiate from competitors and remain competitive in the global marketplace. On this basis, the integration of open innovation practices by establishing cooperation with universities and other companies helps SMEs to meet this challenge and create innovative products in an open way ([46]). Reference [37] adds that in a highly competitive and rapidly changing environment making innovation today more difficult, costly and risky, SMEs should adopt the new open innovation approach to overcome these challenges and reduce the cost and risk of innovation.

As we can see from the most recent systematic literature reviews (SLR) on open innovation in SMEs ([21]; [25]-[41]), the majority of the articles are in favor of open innovation for SMEs. A growing number of studies on such companies demonstrate the relevance of an open innovation approach to improving overall innovation performance ([21]). The proximity of SMEs to the external resource landscape is therefore a key factor in the success of an effective and efficient innovation strategy, not only to overcome the obstacles inherent in the process but also to be inspired for new ideas from external actors. Therefore, it could be seen that SMEs were certainly taking advantage of the opportunities offered by the new open innovation model.

B. Efforts to Conceptualize the Degree of Openness

1) *The Degree of Openness in the Literature:* The literature on open innovation considers the notion of openness in many ways and it has been established in recent years that open innovation should be considered not from a dichotomous perspective between open and closed processes, but rather along a continuum with varying degrees of adoption of the foundations of open innovation ([14]; [15]-[28]). This observation will generate a particular enthusiasm on the part of researchers who have tried to explore the modalities of opening up companies.

Two previous studies are particularly relevant to improve our understanding of the concept of openness: these are the works of [26], [27] and [15]. It should be noted that these studies are widely cited in research papers on open innovation.

Based on the work of Katila and Ahuja, [26] and [27] present the concept of openness while emphasizing two dimensions, which are external search breadth and external search depth. From this perspective, openness is carried out from various channels and sources of information, such as customers, suppliers, competitors and research institutions, with certain intensity.

Referring to [27], external search breadth refers to the degree to which the company explores new information and knowledge. This reflects the number of external sources or search channels that firms rely upon in their innovation process. External search depth is defined in terms of the extent to which company draw deeply from the different external sources or search channels. This way of conceptualizing the degree of openness through the breadth and depth in the use of external information sources is proposed by the authors as a new theoretical contribution. Moreover, [27] argued that firms who are more open to external sources are more likely to have a higher level of innovation performance.

Even if the conceptualization of openness has been very well defined by [27], their operationalization is still considered very specific to the inbound process of open innovation ([42]). On the other hand, and despite the debate that this conceptualization has generated among some authors ([42]; [15]; [22]), it remains widely used in studies referring to the new open innovation paradigm and most recommended in studies conducted in the context of SMEs ([30]).

On the other hand, [15] propose, in their seminal article "How Open is Innovation?" different forms of openness. Presented as a theoretical model, their proposal seems to be most relevant in the literature on open innovation because it is the first to include the question of forms of openness in the particular context of SMEs. Through an extensive literature search, the authors categorized the papers in the database by distinguishing inbound and outbound innovation as a starting point. Then, they divide inbound and outbound innovation to pecuniary versus non-pecuniary transactions. In doing so, the authors distinguish four forms of openness. Acquiring and Sourcing are practices related to the inbound dimension. Sourcing refers to how firms can use external sources of innovation with non-pecuniary transaction. Companies can therefore analyze the external environment to explore ideas and technologies available externally and integrate them into internal innovation processes ([15]).

Acquiring is the inbound practice with a pecuniary transaction. This type of openness refers to the acquisition of inputs available on the market to strengthen the innovation process. Following this reasoning, openness can be understood as how firms license-in and acquire external expertise or technology to stimulate the internal innovation process ([15]).

Reference [15] distinguishes in addition between two outbound practices: the first refers to selling by referring to how firms commercialize their inventions and technologies through selling or licensing-out of internally developed resources; and the second refers to revealing, which refers to how internal resources are revealed to the external environment without immediate financial rewards, in search of indirect benefits. Finally, the authors suggested that the different dimensions of the open innovation model could be considered in a continuum covering various degrees of openness.

2) *Towards a new conceptualization of the degree of openness*: The literature presents the concept of openness in reference to the open innovation model to focus on a set of open practices that organizations could adopt to stimulate the innovation process. However, this question of opening up companies has been relatively unexplored. Very few studies have focused on the detailed analysis of SME openness. Moreover, we have found in the literature that when the authors referred to openness, it was difficult to appreciate in what form and to what degree. Studies on openness include either an identification of the forms of openness or an operationalization of the degree of openness with reference to a single form. To the best of our knowledge, we never find a study that considers openness in reference to both form and degree.

With regard first of all to forms of openness, Dahlander and Gann's (2010) pioneering study is undoubtedly instructive. An examination of their model shows that although the four forms of openness are well defined in the study, their degree of application remains ambiguous. Consequently, the contributions developed by Dahlander and Gann (2010) remain, in our view, incomplete since they do not shed enough light on the degree to which companies are approaching the different forms provided in their study.

Turning then to the degree of openness in the literature on open innovation, we make two main findings from the conceptualization point of view. First, the degree of openness has been amply linked in the literature to the strategy of searching and using a wide range of external information sources with reference to the pioneering work of Laursen and Salter (2004; 2006). Second, we find that empirical research on the open innovation model focuses largely on the conceptual effort of Laursen and Salter (2004; 2006) to study the degree of openness of organizations. As a result, the notion of the degree of openness was not satisfactorily defined in the literature as it is commonly represented by reference to the use of a wide range of external information sources. Indeed, considered from this angle, the openness of companies seems very limited because it is only applied to the practice of external search of information.

In this paper, we wish to enrich the concept of the degree of openness. In fact, this notion merited further attention in order to provide a better explanation of the adoption of openness practices by the particular class of SMEs. As a result, we will build on the work on conceptualizing openness provided by Laursen and Salter (2004; 2006) and adopt an integrated approach to include the majority of forms of openness related to the inbound process. In fact, our theoretical reflection is based on both the forms of internalization of external resources and their degree of adoption. In this research work, we then choose to combine two research postures, i. e. the forms, referring to [15] and the degree of openness, referring to [27].

By extending to the work of [27], we believe that understanding the degree of openness of organizations also requires the integration of other practices for internalizing external resources. As a result, we extend the same

conceptualization of the degree of openness predicted by [27] through the dimensions of breadth and depth to include the majority of the forms of openness predicted in the literature. Therefore, our conceptualization is founded on three inbound open innovation practices. This involves the internalization of resources available outside organizational boundaries through search activities and the use of external information sources, collaborative relationships with other external actors and the acquisition of technologies and knowledge to fortify the internal expertise base. These practices that served our proposition of conceptualizing the degree of openness have a well-founded recognition in the literature on open innovation.

For this reason, we have chosen to include our proposal in a globalizing vision by presenting the degree of openness as a combined set of these three main inbound practices that the firm could adopt when managing its innovation process.

In order to identify this theoretical contribution, we present Fig.1 to visualize our approach considering the degree of openness of SMEs to the inbound practices of the new open innovation model. Therefore, we assume that the more the company uses all these practices, the more open its innovation strategy will be.

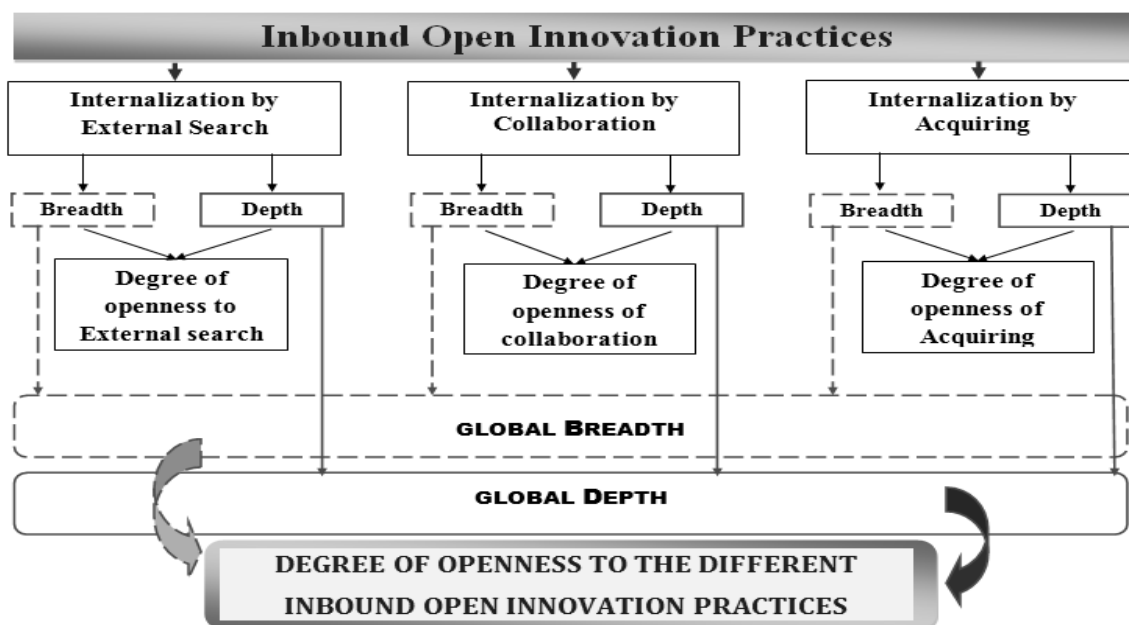


Fig. 1 The conceptualization of the degree of openness to inbound open innovation practices

Fig. 1 illustrates how to consider the degree of openness in this research. This new conceptualization is our first conceptual contribution to the literature on open innovation. We thus propose to define the degree of openness as a multidimensional approach driven by organizations that try to inject dynamism into their innovation process and whose purpose is to adopt various innovative organizational modalities that are situated on a continuum, thus breaking the close versus open cleavage.

Now that we have clarified our way of conceptualizing the notion of the degree of openness by adopting a globalizing approach, we now present our conceptual framework for the analysis of the degree of openness in the specific context of SMEs.

III. CONCEPTUAL FRAMEWORK FOR THE ANALYSIS OF OPENNESS: BEHAVIOUR AND DETERMINANTS

A. Behaviour of SMEs

Based on the above developments, we agree with the idea that openness behaviour should be placed in a continuum from a less open degree to a more open degree ([14]; [15],

[22]). Empirically, this way of considering the degree of openness has been examined in the literature on inbound practices by a pioneering study carried out by [23].

The authors proposed a classification of company profiles based on the dimensions of breadth and depth related to the degree of openness, but without differentiating between large companies and SMEs. In addition, the authors have approached the concept of openness by referring only to the practice of searching for external sources of information. In this study, an approach similar to that recommended in the classification analysis by [23] is adopted to show that SMEs are also a class of companies that can have different degrees of openness as large companies. Indeed, we will use the same openness criteria (breadth and depth) to categorize SMEs according to their degree of openness, but by applying them to the three inbound practices serving our conceptualization of openness.

This means splitting the openness of SMEs, as defined in this research, into four classes, according to the overall degree of breadth and depth. On theoretical level, Figure 2 shows the configuration to be empirically validated in this study.

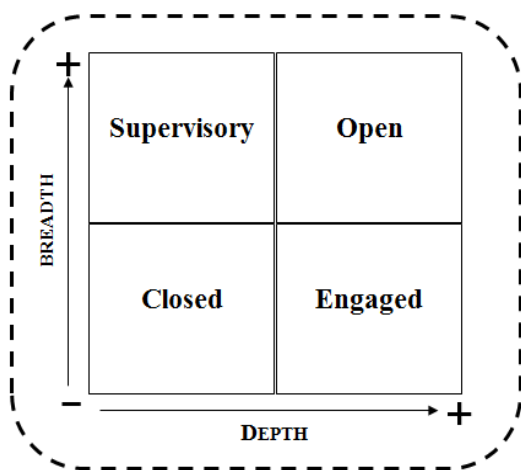


Fig 2. Theoretical classes of SMEs by degree of openness

B. Motivations of Degree of Openness

To go further in analyzing the degree of openness of SMEs and to understand their behaviour when adopting practices linked to the open innovation model by its inbound dimension, we propose in this paper another question to be explored, namely: Why do some SMEs succeed in opening up their innovation processes more than others? This amounts to joining a little-explored field of research that aims to study the determinants of open innovation in order to succeed in this approach ([24], [34], [36]). In this paper, we propose to study the factors that stimulate the degree of openness of SMEs. In this context, we have identified some work that attempts to identify incentives for the adoption of an open innovation strategy. These incentives can be linked either to the benefits of openness as such or to obstacles to innovation.

Reference [13] identifies that the main motivations for the use of external technologies are the quest for growth in terms of new product development and revenue and also the reduction of time-to-market. Despite the proliferation of the benefits of open innovation that could motivate companies to open their organizational boundaries, little empirical work has been done to analyze these sources of motivation. In this context, [42] explored the adoption of the open innovation model in the context of SMEs through the examination of motivations. The authors suggest that market considerations and knowledge creation are key motivations for fostering more open practices in the conduct of innovation activities. Other motivations in terms of expected revenues are also noted in the literature on innovation collaborations and open innovation. Thus, acquiring missing knowledge and complementary resources, sharing risks, expanding social networks, reducing costs and generating revenue are key incentives for companies to adopt open practices [42]. We therefore strongly believe that the presence of serious motivations in the company to strengthen and advance its internal innovation process can be the basis for its proactive behaviour when managing innovation activities. Thus, we can formulate the following research hypothesis.

Hypothesis 1: The different sources of motivation influence the behaviour of SMEs in terms of the degree of openness.

On the other hand, in the innovation literature, several studies have focused on the effects of different barriers on the innovation process of firms. The literature distinguishes between internal and external barriers. Internal barriers include financial resources, technical resources, human resources and factors related to the culture and structure of the company ([10]). External barriers are those related to market forces, supply, demand and the government environment. Research on innovation management has addressed the negative impact of these different obstacles on the innovation process of companies. Nevertheless, in the literature on the open innovation model, the vision is reversed such that obstacles to innovation are considered as factors that stimulate the openness of innovation processes, particularly in the specific context of SMEs. The argument for this consideration is motivated by the fact that SMEs had specific characteristics in terms of resource endowment and the adoption of the open innovation model is seen by them as a strategy to palliate deficiencies in internal resources and skills. Thus, inbound practices often serve to mitigate existing barriers by allowing firms to approach a much broader range of resources than can be obtained internally ([38]). This could therefore accelerate the innovation process by reducing the related costs and risks. Moreover, some empirical studies ([23], [30]-[47]). have been conducted around this question and all show that companies facing these obstacles to innovation could open their innovation processes in order to circumvent the effect of these obstacles. Reference [23] studied the impact of internal barriers on the adoption of the open innovation model by firms. In particular, the authors showed that barriers related to the lack of knowledge and information and barriers related to the overvaluation of innovation risks have led companies to opt for strategies to open up their innovation processes in order to face and overcome these obstacles inhibiting the development of innovations. The study conducted by [30] contains a series of the most notable barriers to innovation in the SME context that have encouraged companies to adopt inbound openness practices. The authors presented four categories of barriers: Labour shortages, lack of information (technological information, market information), lack of infrastructure and lack of financial resources (financing difficulties due to a high risk of technological uncertainty or due to marketing and innovation costs). In a related vein, [47] demonstrated in an empirical study the positive effect of internal barriers to innovation on the opening of SMEs' organizational boundaries by focusing on the categorization of innovation barriers presented by [30].

The opening of innovation activities can then be considered as the result of a deliberate search for an alternative solution to the internal presence of all the resources essential to innovation ([38]). All these findings allow us to suggest that the existence of such internal barriers to innovation can act as motivating factors for SMEs to open

up their innovation activities according to the open innovation model. Therefore, we aim to test the following research hypothesis:

Hypothesis 2: The presence of internal barriers to innovation influences the behaviour of SMEs in terms of the degree of openness.

IV. EMPIRICAL STUDY

A. Methodology and Variable Measurement

To study the openness behaviour of SMEs and identify its determinants, we used a quantitative analysis and focused on the questionnaire as a measurement instrument. For this, we conducted a field survey of 141 manufacturing companies distributed across the different industrial sectors in Tunisia (see Table II).

TABLE II
 THE SAMPLE BY ACTIVITY SECTOR

Activity sector	Numbers	Proportion
Food	24	17,0
Mechanical and Metallurgical	11	7,8
Construction Materials, Ceramics and Glass Industries	6	4,3
Electrical and Electronics Industries	7	5,0
Leather and Footwear Industries	13	9,2
Textile and Clothing Industries	46	32,6
Chemical Industries	7	5,0
Various industries	27	19,1
Total	141	100,0

For the operationalization of the dependent variable "degree of openness", we have been inspired by the measurement of [27] which consists in presenting the degree of openness through the dimensions of the breadth and depth of external information sources. We have generalized this same operationalization method for the other two inbound practices (collaboration and the practice of acquiring external resources). To do this, we have chosen 20 items from the literature review, distributed among the three inbound practices already identified.

External sources of information and knowledge was measured through twelve items referring to search from suppliers of materials and equipment, customers, competitors, consultants, research laboratories; universities and educational institutes; public research centers; private research institutes, professional conferences and congresses and meetings; fairs and exhibitions; professional networks; Internet. Collaboration was measured through five items referring to collaborate with five partners: Customers; Supplier of equipment, materials, components, or software; Competitors or other companies in the same sector of activity; End users and user community; Academic world (laboratories and research organizations, universities, etc.). With regard to acquiring practice, it was measured using the following three items: Recruiting employees who had qualifications that did not previously exist in your company,

Acquiring existing knowledge or patents from other companies and acquiring of sophisticated equipment essential to the innovation process. In the questionnaire, companies were asked to characterize their degree of use (Breadth) and importance (depth) of the various sources of openness in the conduct of their innovation process. Each source (item) is measured using a 5-point Likert ordinal scale.

Concerning independent variables, motivations were measured based on the study of [42]. Therefore, motivations are expressed first of all in terms of innovation processes (improving product development, integrating new technologies), in terms of knowledge (creating knowledge; bringing expertise to the organization), in terms of costs (sharing costs, profitability, etc.), in terms of capacities (offsetting lack of capacity) and in terms of markets (monitoring market development, responding to customer demands, new markets, increasing growth, etc.). In addition, factors related to the company's external environment can be considered as sources of motivation that can encourage an SME to establish a collaborative relationship during their innovation process. The items concern the evolution of the sector of activity, market instability, intensive competition, government incentives and the geographical proximity of the partners. SMEs are then asked about their level of appreciation of the various sources of motivation for adopting inbound opening practices, using a 5 point Likert scale ranging from (1) "Not at all important" to (5) "Very important".

With regard to the operationalization of innovation barriers and based on the work on open innovation ([23], [30], [47]), we have selected a group of eight barriers referring respectively to the lack of internal capacity and skills, difficulty in recruiting qualified people, difficulty in training workers on time required, high costs and funding difficulty, lack of diffusion of market and technology information; insufficient opportunities for cooperation with other companies and insufficient opportunities for cooperation with universities, public research centers and training institutions. Thus, SMEs were asked about obstacles that have slowed down or caused difficulties in improving and/or developing new products or processes. Each obstacle attribute is measured using a 5-point ordinal scale ranging from (1) "no delay" to (5) "was made impossible".

We also introduce two control variables, commonly used in empirical work ([26], [27], [23], [5]-[17]). This refers to the size and age of the SME. The size of the SME was measured by the number of employees of the company; the age was measured by the number of years of activity during the year in which the survey was conducted.

B. Results

For all variables, we first performed principal component analyses with "Varimax" rotation on the measurement scales using the Kaiser-Meyer-Olkin criterion (KMO) and the Bartlett Sphericity Test. Then, we performed a reliability analysis based on the Cronbach alpha study (α). In summary, we present the results obtained in Table III. Examination of

this table demonstrates that for all variables, the results of the factor analyses are all acceptable with regard to the significance of the KMO and *Bartlett sphericity* indices and also the importance of the variances explained. The reliability of the measurement scales has also been validated through the *Cronbach alpha* indices which range from 0.775 to 0.984.

1) *Classification analysis: State on SMEs' openness degree*: Hierarchical classification analysis supported by non-hierarchical classification (K-means) validates the coexistence of four business configurations based on the criteria of the breadth and depth of inbound opening practices. The results of the classification are presented in Table IV. Based on the means of the dimensions of the degree of openness, we considered the following four profiles respectively: *closed* SMEs, *Supervisory* SMEs, *Engaged* SMEs and *Open* SMEs. To provide more robustness to the results obtained, we conducted the Kruskal-Wallis test to assess the significance of the differences between the variables used in the classification analysis. The test result is summarized in Table V. By observing the table above, we can affirm the significance of the difference between both breadth and depth variables. Thus, the class with the highest degree of openness in terms of its two dimensions is the class with the highest average rank. We can then confirm that the open SME class has the highest average rankings on both

dimensions of openness, which corresponds to the class with the highest degree of openness. The class of closed SMEs, by contrast, has the lowest average ranking on both dimensions, which shows that it is the one with the lowest degree of openness.

The different groups of companies obtained from the classification analysis are as follows: The first configuration of openness is associated with companies that are qualified as "closed". This profile represents 31.9% of the survey sample. SMEs in this class have a very low degree of both dimensions of global openness, which shows that this group is characterized by a great reluctance to adopt inbound practices while defending the principles of closed innovation.

The second configuration is associated with the profile of the "supervisors". They represent 15.6% of the total sample. This class of companies differs from the "closed" in particular in terms of the breadth of the practices of internalizing the resources needed to advance their innovation process. In fact, "supervisors" are characterized by a high degree of breadth and a low to medium degree of depth. Thus, they are seeking to engage in a well-planned way to avoid surprises dedicated to the complexity of managing the open innovation model. That is why they opt for an improvement of their network by scanning their environment to capture and choose the best partners before being engaged in deep relationships.

TABLE III
 FACTORIAL ANALYSIS AND RELIABILITY ANALYSIS

Variables Analyzed	Extracted factors	KMO Indices	Total Var. Exp.	Cronbach's Alpha
Openness to different sources of information (A)	[OPESI]	0,500 (0,000)*	83,094	0,775
Breadth of external information sources	[BREIS]	0,682 (0,000)*	80,860	0,967
Depth of external information sources	[DEEIS]	0,684 (0,000)*	63,715	0,973
Openness to the collaboration practice (B)	[OPCOLL]	0,500 (0,000)*	86,569	0,853
Breadth of collaboration	[BRCOLL]	0,875 (0,000)*	90,672	0,978
Depth of collaboration	[DECOLL]	0,862 (0,000)*	84,047	0,952
Openness to Acquisition Practice (C)	[OPACQ]	0,500 (0,000)*	87,946	0,788
Breadth of acquisition	[BRACQ]	0,736 (0,000)*	78,816	0,844
Depth of acquisition	[DEACQ]	0,715 (0,000)*	81,868	0,875
Global Breadth	[GBR]	0,767 (0,000)*	94,011	0,976
Global Depth	[GDE]	0,784 (0,000)*	90,546	0,977
Global openness (A+B+C)	[OPEN]	0,780 (0,000)*	93,727	0,984
Motivations of inbound open innovation	-	0,826 (0,000)*	90,173	-
Internal Motivations	INMTV	-	49,041	0,942
External Motivations	EXMTV	-	41,131	0,814
Obstacles to innovation	-	0,854 (0,000)*	94,455	-
Internal Obstacles	INOBS	-	57,951	0,942
External Obstacles	EXOBS	-	36,503	0,911

* *Test de sphéricité de Bartlett (Sig)*

TABLE IV
 CLASSIFICATION RESULT BY DEGREE OF OPENNESS

	Class 1	Class 2	Class 3	Class 4
Number of SMEs	45 (31,9 %)	22 (15,6%)	53 (37,6%)	21 (14,9%)
Mean of Global Breadth	-1,158	1,257	-0,085	1,382
Mean of Global Depth	-1,213	-0,211	0,493	1,576
Denomination of classes	Closed SMEs	Supervisory SMEs	Engaged SMEs	Open SMEs

TABLE V
 INCIDENCE OF DEGREE OF OPENNESS DIMENSIONS IN SMES CLASSES

Degree of Openness Dimensions	Class 1 Closed	Class 2 Supervisors	Class 3 Engaged	Class 4 Open	Kruskal Wallis Test χ^2 (ddl=3)
Breadth	23,00	115,00	72,00	125,24	124,728 (0,000)
Depth	23,00	58,73	93,08	131,00	124,916 (0,000)

The third configuration is represented by the profile of the "Engaged". This category, which represents 37.6% of total companies, has a medium to high degree of depth and a medium degree of breadth. In this group, companies are involved in an acceptable way in the adoption of the open innovation model by opting for a strategy based on strengthening business relationships with a limited number of partners.

The fourth configuration of openness includes companies with the "open" profile and represents 14.9% of the survey sample. It is the most involved in the adoption of the open innovation model. This class has higher averages than the other groups with a high degree of breadth and depth. These companies perceive the open innovation model as very interesting for innovation management.

2) *Motivations as Determinants of the Degree of Openness*: To verify our hypotheses regarding the influence of motivations on companies' degree of openness, we rely on a multiple regression analysis. The regression model is as follows:

$$OPEN_i = \alpha_0 + \alpha_1 INMTV_i + \alpha_2 EXMTV_i + \alpha_3 INOBS_i + \alpha_4 EXOBS_i + \alpha_5 SIZE_i + \alpha_6 AGE_i + \epsilon_i$$

The results on the impacts of independent variables on the degree of openness of SMEs are presented in Table VI, which shows the linear regression coefficients corresponding to the direct effects between the variables.

TABLE VI
 RESULT OF REGRESSION ANALYSIS EXPLAINING DEGREE OF OPENNESS (N=141)

Regression model of the degree of openness			
	Coefficient $s\beta$	t of Student	Sig
Constant	- 0,399***	- 2,824	0,005
INMTV	0,685***	12,114	0,000
EXMTV	0,094 ^(NS)	1,963	0,052
INOBS	0,294***	6,458	0,000
EXOBS	- 0,091 ^(NS)	-1,941	0,054
AGE	0,078 ^(NS)	1,589	0,114
SIZE	0,126**	2,578	0,011
R ²	0,739		
F	63,230 0,000		

*** : significant at the 1% level; ** : significant at the 5% level; (NS) : not significant

The results shown in table VI attest to the overall significance of the model explaining the degree of openness, with an F statistic of (63,230) and a significance of less than

1% (p = 0.000). The analysis also demonstrates the importance of the model which explains about 74% of the variation in the degree of openness in SMEs (R² = 0,739).

In sum, the explicative power R² is important, the F statistic and its signification are also important. Thus, we can conclude that our model is statistically significant and explains the degree of openness in the SME context. We now proceed to test the research hypotheses associated with this model.

The results show a positive and statistically significant relationship between internal sources of motivation and the degree of openness of the innovation process. Thus, we find that the coefficient that associates the variable "INMTV" with the variable to be explained "OPEN" is positive ($\beta = 0,685$) and statistically significant at the 5% level (t = 12,114; p = 0.000 < 5%). In contrast, the table shows that external motivations have no significant effect on the degree of openness being the low values of student t and the significance of this (t = 1,963; p = 0.052 > 5%). As a result, the first hypothesis is partially validated. This implies that the motivations for adopting open innovation positively influence the degree of openness of the innovation process only when they are related to internal incentives. This result confirms the work of [42], which examined the adoption of an open innovation approach in SMEs by presenting a set of internal incentives for the implementation of open practices, such as the creation of new knowledge, access to additional resources and cost sharing.

Turning now to the impact of internal barriers to innovation on the degree of openness of firms, the results shown in table VI demonstrate a positive link between the variable "INOBS" and the degree of openness of the innovation process with a coefficient β in the order of (0,294). The t-statistics, which allows the significance of the coefficients to be tested, reveals that this relationship is significant at the 5% threshold (t = 6,458; p = 0,000). As a result, the internal obstacles encountered by the company positively affect their degree of openness to the external environment. This last result corroborates the conclusions of previous empirical studies such as those conducted by [23], [30] and [47], which showed that certain barriers to innovation encourage companies to opt for strategies to open their organizational borders in order to face and overcome these obstacles inhibiting the development of innovations. On the other hand, the empirical results of the regression model show a statistically insignificant relationship between external barriers to innovation and the degree of openness of the innovation process (t = -1,941; p = 0,054 > 5%). Therefore, our statistical results confirm the positive relationship between internal barriers to innovation and the degree of

openness to inbound practices and invalidate the relationship with external barriers, confirming also partially our second hypothesis.

In addition, the firm's particularities were taken into account in the formulation of our empirical model explaining the degree of openness of SMEs, particularly the size and age of the company. First of all, with regard to the size of SME, the analysis reveals a positive and significant relationship at the 5% level ($\beta = 0,126$; $t = 2,578$; $p = 0,011$). This result stipulates that the size of the company favors the degree of openness of the innovation process in SMEs. This result is already highlighted by several research studies such as [31], [42] and [23] as well as [40]. With regard to the age of the firm, the coefficients shown in the table do not support a positive relationship with a satisfactory level of significance that was well above 10% ($t = 1,589$; $p = 0,114$). This finding contradicts the result found by [40] that approved a positive and significant association between the variables. As a result, the age of the enterprise cannot be considered as an explanatory factor for the adoption of open innovation in Tunisian manufacturing companies, particularly SMEs.

V. DISCUSSION AND CONCLUSION

The objective of this paper is threefold by studying the degree of openness of SMEs under the aegis of the inbound dimension of the open innovation model. In particular, it is intended to clarify the concept of the degree of openness, explore the behaviour of SMEs when approaching inbound practices of open innovation and also explain the degree of openness of the innovation process through the effect of motivations.

Based on relevant literature, we first of all proposed an innovative conceptualization of the degree of openness while expanding Laursen and Salter's unique conceptual effort [27], through the breadth and depth dimensions, to include the majority of inbound practices. These practices concern the search for external information, the collaboration of the SME with external actors and the acquiring of external resources. This new conceptualization constitutes the first contribution assigned to this research paper.

In the light of this new conceptualization of the degree of openness and by referring to the dimensions of breadth and depth, it was possible to propose a configuration of SMEs pertaining to the Tunisian manufacturing sector on the basis of a classification analysis. The results categorize 141 innovative SMEs into four homogeneous groups that differ according to their overall degree of openness. These are respectively the "Closed", "Supervisors", "Engaged" and "Open" groups.

The results of the classification analysis corroborate to a certain extent those proposed by [23]. Thus, the authors proposed four groups of companies based on a classification analysis that differ according to their degree of openness. These are Scouts, Professionals, Explorers and Isolationists. Comparing the SME classes in our study with those in the study of [23], it can be said that the "Closed" SMEs class corresponds to that of "Isolationists" and the "Open" SME

class to that of "Professionals". In addition, it can be stated that the "Supervisory" SME class is very similar to the "Explorers" class. However, it was not possible to determine the existence of the "Engaged" SMEs class in the classification work of [23]. This may be due to the way in which firms' openness to inbound practices has been used in this study and in that of [23]. It should be noted that these authors considered openness only in reference to the use of external information sources, which was not the case in this study since a new conceptualization of openness was used through the internalization of three aforementioned inbound opening practices.

In the Tunisian context, we can see from the results of this empirical study that a significant proportion of manufacturing SMEs, almost 1/3, are involved in the closed model in the management of innovation. The other classes of SMEs resulting from the typology, i.e. 2/3, have moved towards open innovation, but with different degrees of openness. These SMEs then move away from the closed model by focusing on opening up their borders in order to access a much broader range of knowledge and ideas than can be obtained internally.

In addition, the analysis shows a high proportion of size in favour of supervisory and engaged SMEs (75 companies) compared to open SMEs (21 companies). This disproportion between SME classes shows that the adoption of the open innovation model in the Tunisian context is not as marked by total openness towards inbound opening practices.

This study is in line with the research on the open innovation model and confirms the conclusions of the literature that the degree of openness of the innovation process is defined from a continuum perspective ranging from a less open degree to a very open degree, while passing through various other degrees. Thus, we can confirm the configuration approach through the results of the classification analysis, which verified that, besides a closed approach and a purely open innovation behaviour, it seems that other opening strategies for SMEs engaged in the open innovation model can be exploited.

Exploring the way in which SMEs actually deploy the innovation process through a multidimensional conceptualization of the degree of openness is an interesting contribution to the development of theoretical and empirical knowledge about the open innovation model in the context of SMEs.

In order to better understand the behaviour of SMEs when adopting inbound openness practices, we have deepened the analysis by proposing another research question that aims to explain why some SMEs opt for a more open innovation process than others by studying the impact of the sources of motivation on the degree of openness of the innovation process.

In terms of results achieved, the degree of adoption of inbound practices is stimulated by a range of internal incentives, such as creating new knowledge, accessing additional resources, creating new value for customers and sharing costs and risks.

In addition, barriers to innovation need to be reconsidered. Widely regarded as factors inhibiting the development of innovations, today they must change their posture by acting as a source of motivation, thus encouraging companies to opt for inbound opening practices in order to face up to them.

The results of this paper have practical implications for both managers and political organisations involved in sustaining innovation. Indeed, based on the results of the classification, managers could determine the extent to which their approach to innovation is open. They could position their company in the most appropriate configuration and, therefore, envisage the imperatives necessary to stimulate a more open innovation management approach given the benefits of inbound open innovation.

In addition, to stimulate open innovation within their company, managers must be aware of the main advantages of opening organizational boundaries to explore and use new resources in the external environment (ideas, information, knowledge, technologies, etc.) and incorporate it with the internal base to stimulate the innovation process. Innovation project managers must pay more attention to the various obstacles to innovation by considering them, not as an obstacle to the development of innovations but rather as a motivation for openness. In fact, open innovation should be considered as a solution to overcome innovation barriers. Being aware of both the benefits of open innovation and the obstacles to innovation allows managers to make good decisions in innovation management.

On the other hand, and given that the results have shown that the adoption of the open innovation model in the Tunisian context is not as marked by a high level of openness towards inbound openness practices, public institutions supporting innovation should more valorize the role of different openness practices in their programmes promoting innovation in SMEs. In terms of results, they must make efforts to encourage more adoption of these open practices, in particular by strengthening links between actors in the economic and academic spheres.

Despite his contributions, this work contains some limitations that can be sources of research perspectives. At first, in this paper, one dimension linked to the model of open innovation was considered. Although the inbound dimension remains the most favoured by SMEs, it does not, however, reflect all the alternatives linked to the new model of open innovation. In this framework, future studies should explore these dimensions in the context of SMEs, such as the study of the combined effects of inbound and outbound dimensions on innovation in SMEs. In addition, this paper did not take into account the risks related to openness degrees, particularly in terms of costs related to the resources required to manage the open process. Thus, given the scarcity of resources, a more open approach consumes resource investments. It is therefore considered relevant for future studies to propose analytical frameworks highlighting the extent to which an open approach is considered interesting in terms of costs and benefits. It's like studying the moments when you had to stop openness. As a result, it is relevant to adopt a process analysis

approach to the conduct of innovation from a longitudinal perspective.

Finally, to understand open innovation in the context of SMEs, we recommend to analyze the determinants of openness with greater depth while emphasizing both internal and external factors and to study the impact of the openness degree on innovation performance in SMEs.

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