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RESEARCH PAPER

IMPACT OF OPEN INNOVATION ON INDIVIDUAL RESILIENCE: EXPLORING HIGHER EDUCATION STUDENTS' PERCEPTIONS AND EXPERIENCES

DR SAMAH CHEMLI HORCHANI
Management Department, Tunis El-Manar University, FSEGT
Laboratory of Innovation Strategy Entrepreneurship Finance and Economics (LISEFE)
Tunis, Tunisia
Email: samahchemli1@gmail.com

PROF. MAHMOUD ZOUAOUI
Management Department, High Business School, ESCT
Laboratory of Innovation Strategy Entrepreneurship Finance and Economics (LISEFE)
Tunis, Tunisia
Email: mahmoudzouaoui.esct@gmail.com

ABSTRACT

PURPOSE: The present study deals with the link between open innovation and resilience. It examines the mechanisms by which open innovation generates effects on different resilience forms. Open innovation, through its effect, is studied as a component affecting resilience, especially on an individual level.

DESIGN/METHODOLOGY/APPROACH: Data were collected from 250 higher education students using non-probabilistic convenience sampling. Factor analysis, followed by a structural equation modelling analysis with Smart PLS software, made it possible to study the link significance.

FINDINGS: Findings confirm that open innovation positively affects individual resilience through its two components, external technology acquisition and external technology exploitation. The results show that gender moderates the link between open innovation and individual resilience, but the age moderating effect is partially verified.

ORIGINALITY/VALUE OF THE PAPER: The originality of the paper is in providing further understanding of open innovation importance to ensure resilience at the individual level.

RESEARCH LIMITATIONS/IMPLICATIONS: These findings contribute to a better discernment of the studied concepts through a meticulous literature study.

PRACTICAL IMPLICATIONS: The results are a major support at the practical level through the programming of an individual or combined resilience likely to impact human development in the long term.

KEYWORDS: *External Technology Acquisition; External Technology Exploitation; Individual Resilience; High Education; Gender; Age*

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INTRODUCTION

The integration of innovation in people's life and business represents a key lever to ensure sustainability and continuity (Jordan *et al*., 2013). Open innovation as a reciprocal exchange of ideas and innovations among people combines with agile capabilities to resist vulnerabilities (Dey *et al*., 2017). Indeed, the new paradigm called "resilience" is then considered as a strategic response to environmental changes. Resilience is described as the ability to recover and adapt to suffering and change (Meredith *et al*., 2011). Personal resilience is seen as the opposite of vulnerability (Rutter, 2012). Resilience is not only conceived as the ability to recover from shocks, but also as an ability to make leaps and bounds, ensuring the use of challenges as opportunity openings (Manca *et al*., 2017). Rehman *et al*. (2021) used individual resilience as a mediating variable of the relationship between human resources' strategic management and organisational resilience to promote open innovation. Researchers argue that open innovation leads to resilience through cybernetic openness (Fraga-Lamas and Fernández-Caramés, 2020).

The investigation shows the variety of positions and the rarity, even the absence, of studies examining the linkage between open innovation and individual resilience. Addressing this gap in the literature is important. The present paper aims to outline the relationship between open innovation and individual resilience. In fact, recent studies affirm the digital effect on personal resilience (Al Halbusi, 2023) or the open innovation effect to recover from shocks (Trantopoulos *et al*., 2023). The present research reveals various facets of innovation and resilience in facing changes.

The empirical context of the study consists of students belonging to a higher institute of administration located in southern Tunisia. A structured questionnaire was sent online to the institute's student groups. Analyses are generated using SPSS 20 and Smart PLS4 software. The study provides clear design guidelines for building and applying interventions to increase individual resilience through open innovation and is organised as follows. The next section concentrates on the theoretical review and the definition of the studied concepts. Then the link between the variables is studied with hypothesis development. This is followed by a focus on research design and data analyses. Finally, we discuss our results and present their implications to theory and practice with limitations and further research directions.

THEORETICAL FRAMEWORK AND DEFINITIONS

Open Innovation

Chesbrough (2003) created and coined the term "open innovation". Open innovation consists of opening its perimeter to allow the circulation of valuable knowledge from the outside to the inside, giving rise to opportunities for co-innovation processes with partners. Openness therefore explains the innovation principles, essentially how to best manage one's assets in response to market demands and needs (Enkel *et al*., 2009). Authors claim that open innovation is a broad concept, encompassing different components; however, there are three types of open innovation depending on the direction of knowledge flow used by users. First, inside-out

movement, or exploitative technology, is the use of technical capabilities outside an individual's private confines. The reverse movement, outside-in, is called technological exploration that consists of making use of external technologies for one's own benefit (Van de Vrande *et al*., 2010). The third type of open innovation is 'coupled open innovation' characterised by a combination of knowledge input and output (West *et al*., 2014). Recent works corroborate that open innovation consists of cultivating a culture of innovation encouraging experimentation and risk-taking (Yun *et al*., 2020). Researchers divide open innovation into two components (Chesbrough, 2003). The external technology acquisition (ETA) dimension refers to the degree of access to external technologies and the acquisition of technological knowledge from partners. The external technology exploitation (ETE) dimension refers to the external transfer of one's technological knowledge to obtain monetary or non-monetary benefits.

Individual Resilience

Resilience is defined as the process and result of successfully adapting to harsh or challenging life experiences, specifically through mental/emotional/behavioural flexibility with adaptation to external and internal demands (Steinberg *et al*., 2023). The psychological literature defines resilience as the ability of a dynamic system to adapt successfully to failures disturbing its functionality, viability or development (Sarkar and Fletcher, 2014). Alongside adaptability, individual resilience is manifested through practicing self-awareness and self-care to manage emotions and maintain balance (Yuan, 2021). The literature reveals four types of individual resilience (Tol *et al*., 2013). The first is related to emotions. Emotional resilience includes the ability to regulate emotions during stress times. Resilient people are aware of their emotional reactions and tend to stay in touch with their inner world. The second type is social resilience, called community resilience. It includes the ability to recover from difficult situations in groups. The third resilience type is mental. It refers to a person's ability to adapt to change and uncertainty. People with this resilience are flexible and calm in times of crisis. They use their mental toughness to solve problems, move forward, and stay hopeful when facing setbacks. The fourth type is physical resilience that could be improved by making healthy lifestyle choices. Sufficient sleep, a nutritious diet, and regular physical activity are some ways of developing this resilience type. In summary, individual resilience is an essential capacity that helps individuals overcome challenges.

THE LINK BETWEEN OPEN INNOVATION-INDIVIDUAL RESILIENCE AND THE HYPOTHESIS DEVELOPMENT

The literature review reveals several manifestations of the link between open innovation and individual resilience. First, the open innovation effect is manifested through technological openness (Park, 2017). Resilience takes the form of information and communication skills expressing the network's resistance. Nemeth *et al*. (2011) discuss the concept of resilience in engineering as a new property that needs to be analysed in all technical and digital network

infrastructures. Second, open innovation is expressed through artistic thought (Robbins, 2018). Indeed, art promotes positive personal growth and the artistic process promotes the empowerment of individuality (Chambon, 2009). Therefore, art thinking is an essential skill in finding solutions to interpersonal conflicts while improving self-esteem and self-confidence. The interference between art and individual resilience constitutes a sphere ensuring human development as well as the meaning of thinking and doing (Wager *et al*., 2009). Third, open innovation is manifested through the application of laws and regulations. Rights as a tool for social education encourages students to actively work on their own growth and resilience (Herczog, 2012). Fourth, open innovation appeared through engagement in an entrepreneurial project (Ortiz-de-Urbina-Criado *et al*., 2018). Studies show that personality traits associated to individual resilience are positively and definitively related to project success (Owens *et al*., 2013). Additionally, open innovation is manifested through communication with others. Therefore, communication with others has a huge impact on building resilience in facing adversity (Hutchinson *et al*., 2007), and this forms the basis for the socialisation and empowerment of individuals.

In the present work, we position ourselves in accordance with the study carried out by Hung and Chou (2013) stating that open innovation essentially has two dimensions: the acquisition and exploitation of technologies. We propose to investigate the effect of age and gender on the link between open innovation and resilience. Study of individual resilience at an advanced age has attracted the interest of researchers. Indeed, advancing age is a relevant context for seeing the effect of experience and resources on individual resilience (Hayman *et al*., 2017). Recent works claim that resilience comes from age through the acquisition of collective capacities shaping beliefs and adaptation (Kaye-Kauderer *et al*., 2021; Salam *et al.*, 2023). Other authors show the interaction between age and gender to develop individual resilience capacities, such as empathy, and the search for help from those around or from the outside (Sun and Stewart, 2007).

Therefore, the following hypothesis is posited:

H1: Open innovation significantly and positively impacts individual resilience.

This hypothesis is sub-divided into two sub-hypotheses according to the dimensions adopted.

H1.1: The acquisition of external technology positively impacts individual resilience.
H1.2: The exploitation of external technology positively impacts individual resilience.

H2: Age and gender moderate the link between open innovation and individual resilience.

The proposed conceptual model is presented in Figure 1.

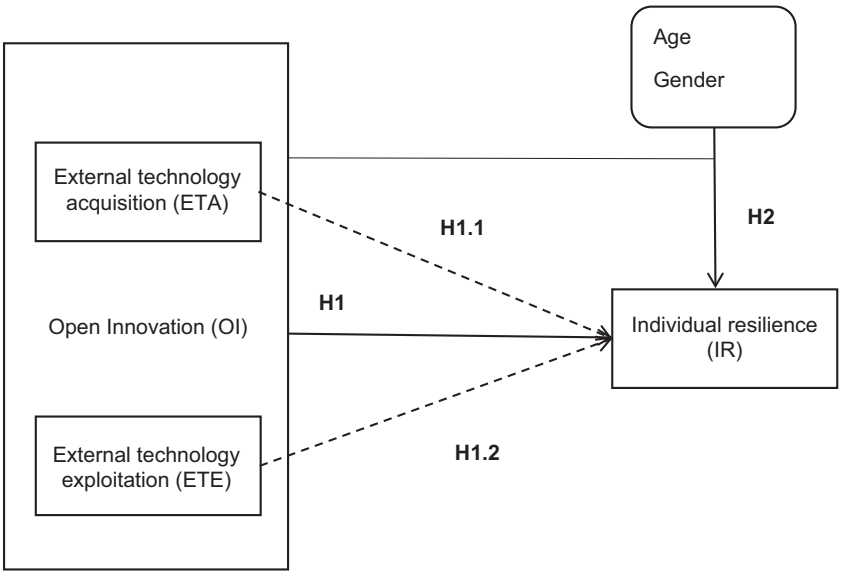

Figure 1: Proposed Model
Source: Constructed by authors

RESEARCH DESIGN AND DATA ANALYSES

Research Setting and Sampling

In our empirical study, we used a questionnaire as a data collection instrument. Our population is represented by students from a higher university institution specialising in business administration. The respondents are randomly selected students from different branches of this institution. Analysis of the survey data shows that among the 267 responses received, no questionnaire with missing responses was found. However, 17 questionnaires were found to be completed without proper engagement and were therefore removed from the dataset. The final base is composed of 250 responses ready for further statistical analysis. The sample specificity is described in Table 1.

MEASURES

The measurement scales developed for this study are based on scales formulated by preceding scholars; respondents answered questions with Likert-scale anchoring of 1 (strongly disagree) to 5 (strongly agree) (Lichtenthaler, 2009). We chose measurement scales of good methodological quality (reliability, validity, sensitivity). To measure open innovation, we adopt a two-dimensional measurement scale validated by Hung and Chou (2013). The first

Table 1: Sample Specificities

Criterion	Frequency	Percentage	Cumulative Percentage
Gender			
Male	51	20.4	20.4
Female	199	79.6	100.0
Age of the respondent			
Between18 and 25 years	194	77.6	77.6
Between 26 and 35 years	53	21.2	98.8
Greater than 36 years	3	1.2	100.0
Speciality			
Economic science	41	16.4	16.4
Management science	183	73.2	89.6
Computer science	26	10.4	100.0
Total	250	100	

Source: Constructed by authors

dimension, made up of five items, relates to external technology acquisition (Cronbach's α=0.88). The second dimension, composed of five items, relates to external technology exploitation (Cronbach's α=0.89). For individual resilience, we adopted the scale used and validated by Fisher *et al*. (2016), including ten items (Cronbach's α=0.82). The measurement scales used are presented in the Appendix.

DATA ANALYSIS AND RESULTS

The quantitative analysis of the data was carried out using the SPSS 20 and SPL4 statistical tools. This analysis is developed in the following four steps. The first is a descriptive statistical analysis of the sample. The second is an exploratory factor analysis (EFA) for verification of psychometric properties inherent to the measurement scales. This step will allow the purification of the measurement scales of all studied variables. Therefore, the purification goes through a first analysis stage of the scale's internal coherence/homogeneity. The third is a confirmatory factor analysis (CFA) to assert the validity and, moreover, the reliability of the constructs. The fourth and final step is to statistically test the link between the variables using the structural equation method (SEM). For greater clarity and precision, this study included participants' gender and age as moderator variables. Indeed, many researchers and policy-makers consider resilience from a gender perspective to sustain women's rights and gender equality (Smyth and Sweetman, 2015). Traditionally, studies conducted on individual resilience generally deal with early childhood and adolescence to see the effect of exposure to

difficulties such as poverty, parental relationships or community violence (Ong *et al*., 2009; Stern *et al*., 2023).

RELIABILITY AND VALIDITY MEASURE

Psychometric properties of the measurement model were analysed to check the relationship between each latent variable and its indicators. The principal component factor analysis of the external technology acquisition dimension shows the one-dimensional nature of the scale with five items retained. This factor explains 84.089% of the total variance. The contributions of the items to the ETA dimension are all significant. The value of Cronbach's alpha is 0.940, therefore close to 1; this reflects good internal consistency of the items (Hair *et al*., 1997). The factor analysis of the 'external technology exploitation' dimension makes it possible to detect a single factor explaining 88.200% of the total variance. Following the deletion of item OI-10 'We seldom co-exploit technology with external organizations', Cronbach's alpha becomes equal to 0.940, which explains good internal consistency. For the dependent variable, the principal component factor analysis of the ten retained items shows the scale's one-dimensional nature. This factor explains 79.450% of the total variance and the value of Cronbach's alpha is 0.970, which indicates strong internal consistency. Bartlett's sphericity test (sig=0.000) was verified for the studied variables (Durand, 2005). Convergent validity is examined by calculating the composite reliability index (Composite reliability: CR), the Cronbach's alpha index and the average shared index (Average Variance Extracted: AVE). The acceptability thresholds required for the measurement criteria are set out in Table 2.

Table 2: Measurement Model Evaluation, Reliability and Convergent Validity

Construct	Indicator	Loading	T-value	Cronbach's Alpha	Rho	CR	AVE
ETA				**0.953**	**0.953**	**0.964**	**0.841**
	OI1	0.919	81.308	0.940			
	OI2	0.931	141.810	0.937			
	OI3	0.925	111.128	0.939			
	OI4	0.923	80.496	0.940			
	OI5	0.886	57.592	0.949			
ETE				**0.958**	**0.956**	**0.968**	**0.882**
	OI6	0.926	86.507	0.948			
	OI7	0.948	127.065	0.936			
	OI8	0.940	127.279	0.940			
	OI9	0.942	100.455	0.939			

(continued)

Table 2: Measurement Model Evaluation, Reliability and Convergent Validity *(continued)*

Construct	Indicator	Loading	T-value	Cronbach's Alpha	Rho	CR	AVE
IR				**0.972**	**0.972**	**0.975**	**0.794**
	IR1	0.808	27.278	0.971			
	IR2	0.904	54.203	0.967			
	IR3	0.896	65.035	0.968			
	IR4	0.896	61.647	0.968			
	IR5	0.935	129.106	0.966			
	IR6	0.934	131.931	0.966			
	IR7	0.925	69.564	0.966			
	IR8	0.895	49.490	0.968			
	IR9	0.929	94.737	0.966			
	IR10	0.777	27.278	0.972			
Goodness-of-fit							
R^2	R^2IR=0.930						
GOF	0.874						

ETA: External technology acquisition; ETE: External technology exploitation; IR: Individual resilience; CR: Composite reliability; AVE: Average variance extracted

Source: Constructed by authors

The obtained composite reliability indices (CR) vary between 0.953 and 0.975, and the AVE (shared mean variance) vary between 0.794 and 0.882; this exceeds for the former the required threshold of 0.7 (Chin, 1998), and for the latter (AVE) the threshold is 0.5 (Fornell and Larcker, 1981) for all variables. Consequently, the convergent validity of our model is thus ensured.

The discriminant validity is tested using Fornell-Larcker criteria comparing the square root of the mean variance extracted relative to each latent variable with its correlations with the other latent variables (Hair *et al*., 2016). Moreover, cross-loading of various items is used.

The discriminant validity of the measurement instrument is confirmed by Table 3.

As can be seen from Table 3, the results show that the square root of the AVE for each construct is greater than the correlations between built about it. We could therefore conclude that the discriminant validity is ensured.

Table 3: Discriminant Validity					
	ETA	**ETE**	**IR**	**Gender**	**Age**
Fornell-Larcker criterion					
ETA	**0.917**				
ETE	0.912	**0.939**			
IR	0.905	0.930	**0.891**		
Gender	-0.213	-0.201	-0.166	**1.000**	
Age	0.209	0.172	0.196	-0.636	**1.000**
Cross-loading evaluation					
OI-1	**0.919**	0.836	0.846	-0.194	0.182
OI-2	**0.931**	0.811	0.825	-0.211	0.181
OI-3	**0.925**	0.787	0.835	-0.229	0.203
OI-4	**0.923**	0.872	0.891	-0.208	0.221
OI-5	**0.886**	0.874	0.848	-0.138	0.171
OI-6	0.846	**0.926**	0.804	-0.151	0.178
OI-7	0.877	**0.948**	0.887	-0.211	0.155
OI-8	0.846	**0.940**	0.871	-0.188	0.164
OI-9	0.858	**0.942**	0.804	-0.205	0.150
IR-1	0.775	0.778	**0.898**	-0.160	0.120
IR-2	0.846	0.839	**0.904**	-0.084	0.149
IR-3	0.799	0.822	**0.894**	-0.159	0.205
IR-4	0.812	0.817	**0.896**	-0.047	0.208
IR-5	0.860	0.876	**0.896**	-0.106	0.168
IR-6	0.881	0.900	**0.934**	-0.140	0.155
IR-7	0.871	0.895	**0.925**	-0.208	0.220
IR-8	0.812	0.844	**0.895**	-0.196	0.237
IR-9	0.857	0.890	**0.929**	-0.204	0.187
IR-10	0.724	0.793	**0.977**	-0.174	0.083
Gender	-0.213	-0.201	-0.166	**1000**	-0.636
Age	0.209	0.172	0.196	-0.636	**1000**

Source: Constructed by authors

EVALUATION OF THE STRUCTURAL MODEL

According to the previous analyses and through the same software, the model's psychometric specificity is satisfactory. We can currently estimate the structural relationships between the constructs and therefore the verification of our research hypotheses. The correlation between the constructs is estimated by examining the standardised correlation coefficients (path-coefficients) and the statistical values T-values.

Table 4: Evaluation of the Structural Model

		Path	β-Standardise Estimate	t-value	Bootstrap (Standard deviation)	Validation of Hypotheses
H1	H1.1	ETA→IR	0.518***	6.090	0.085	Confirmed
	H1.2	ETE→IR	0.321**	2.921	0.110	Confirmed
		Gender →IR	0.132*	2.524	0.052	Confirmed
		Gender*ETA→IR	-0.249*	2.529	0.098	Confirmed
		Gender*ETE→IR	0.424**	3.082	0.138	Confirmed
		Age→IR	0.051*	2.228	0.023	Confirmed
		Age*ETA→IR	-0.106n.s	1.495	0.071	Invalidated
		Age*ETE→IR	0.173*	2.000	0.087	Confirmed

Note: ***p < 0.001;**p < 0.01; *p < 0.05; n.s: no significant
Source: Constructed by authors

Findings confirm that open innovation positively affects individual resilience through its two components ETA (β=0.518; t=0.518) and ETE (β=0.321; t=2.921). Additionally, the results show that age has an effect on individual resilience. The study of its moderating effect shows that age does not moderate the relationship between the external technologies acquisition and its link with individual resilience (t=1.495 and P=0.135 not significant). However, age moderates the link between the exploitation of technology and its effect on individual resilience (t=2.000 and P=0.048<0.05). This can be explained by the acquisition of experience leading to a better use of technologies. In this sense, researchers argue that maintaining daily abilities with adapting to source restrictions is more relevant for resilience in old age (Hayman *et al*., 2017).

For the gender moderation results presented in Table 4, we obtain t=3.082>1.96 and P=0.002<0.05. We deduce that gender has a moderating effect on the relationship between the external exploitation of technology and positively influences individual resilience. For t=2.529>1.96 and P=0.011<0.05, which implies this gender score. There is a gender moderating effect on the relationship between acquisition of external technologies and individual resilience. To summarise, the hypothesis of moderation by gender is verified while that by age is partially verified.

The study shows a negative loading (β=-0.249, t=2.529) of the gender variable on the link between the acquisition of external technologies and individual resilience. In fact, our sample is mainly composed of women (79.6%) that can explain the lack of openness to the outside for social and cultural reasons. On the other hand, the effect is significant and positive (β=0.424, t=3.082) concerning the use of technology to strengthen individual resilience. The result is in agreement with the contribution of Saeed *et al*. (2023) confirming that women's personal attributes and institutional conditions influence innovation openness.

The obtained result is confirmed by several researchers who have approached the acquisition of external technologies and individual resilience in several different ways (Morgan

and Hunt, 1994; Gbongli, 2023). These different concepts have been widely developed in the economic field and the field of marketing. Therefore, it is necessary to take into account the link between the acquisition of external technologies and individual resilience. This link could be changed by one or more socio-demographic variables such as gender, which is a cultural factor; it could play the moderating role.

DISCUSSION AND CONCLUSIONS

The relational duality of open innovation and individual resilience allows the redevelopment of human characteristics and capacities that is reflected in both society and the workplace. The literature review shows that open innovation increases opportunities (Horchani and Zouaoui, 2021; Horchani *et al*., 2022). They collaborate with others, build their professional networks and create new opportunities. The openness entails exposure to risk. However, by taking risks and succeeding in new ventures, individuals build their confidence and self-esteem. Through the development of new skills and mindsets, individuals become more resilient and adaptable. The study results show that open innovation is positively linked to individual resilience. Indeed, this innovation promotes individual resilience through the encouragement of collaborations. Individuals tap into diverse perspectives and ideas to find new solutions and build relationships. Likewise, open innovation fosters continuous learning. Through exposure to new knowledge and experiences, individuals acquire new skills and expand their capabilities. Open innovation promotes entrepreneurship by fostering a culture of experimentation and risk-taking, creating an environment that encourages persistence and determination. In addition, our study confirms the impact of gender diversity on the link between open innovation and individual resilience. This shows the importance of creating the social and cultural conditions conducive to women so that they can use the opportunities offered by openness to their personal development.

The results show that age does not control the relationship between technology acquisition and individual resilience. This can be explained by the availability and dependence on technology at all ages, hence the independence of its effect on individual resilience from the age variable (Calleja, 2019). However, for the exploitation dimension, the results show that age controls its effect on individual resilience. This can be explained by the degree of maturity that is accompanied by a better use of technologies for the acquisition of knowledge, the achievement of objectives and resistance to shocks. This result confirms the recent contribution of Zhao *et al*. (2023) showing that the technological capabilities of individuals develop with age.

On a theoretical level, the investigation revealed the challenges of implementing open innovation and building resilience. Indeed, open innovation involves launching into the unknown and taking risks, which can be discouraging for individuals (West and Gallagher, 2006). Moreover, keeping up with innovation can be exhausting and leave individuals feeling burnt out (Gassmann *et al*., 2010). The weakness of collaborations associated with limited budgets, and a lack of time impede the ability to innovate and develop resilience

(Cichosz *et al*., 2020). Another challenge is breaking out of old habits and embracing new ways of thinking and working (Talke and Heidenreich, 2014).

On a practical level, the study revealed the foundations for building individual resilience in open innovation. Through this work, we recommend cultivating a growth mindset by embracing challenges as opportunities for growth and learning. Individuals must build a support network by surrounding themselves with people providing encouragement, support and guidance. It would be essential to practice self-care by taking time for self-reflection, self-care and stress-management to maintain balance. In addition, learning new skills helps to stay relevant, adaptable and resilient. From the results found, we suggest the importance of programme development, allowing the acquisition of technological benefits for strengthening the individual resilience of people aged between 18 and 35 years.

As with all research, there are some limitations that should be noted. First, the gender differences in individual resilience deserve further investigation, in view of their potential implications for mental health prevention and promotion. Second, this work focuses on the effect of open innovation on individual resilience. Therefore, future research should include resilience at the organisational level. Further investigation could focus on divergent institutions in different locations. Finally, scholars could extend research on the link between open innovation and resilience by integrating other intermediate variables such as agility, governance or even ambiguity.

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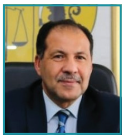
BIOGRAPHY

Dr Samah Chemli Horchani has a PhD in Management Sciences and is assistant professor at the Higher Institute of Business Administration in Gafsa, Tunisia. She is an academic researcher and a member of the Innovation Strategy Entrepreneurship Finance and Economy laboratory (LISEFE), Management Department, Faculty of Economics and Management of Tunis (Tunis El-Manar University), Tunisia. She has contributed to research in topics related to entrepreneurship and innovation management, such as entrepreneurial orientation, leadership, ambidextrous innovation, open innovation, intellectual capital, agility, and resilience.



Prof. Mahmoud Zouaoui is a Full Professor at the Tunis Business School (University of Manouba). He is a member of the Innovation Strategy Entrepreneurship Finance and Economy (LISEFE) laboratory, Management Department, Faculty of Economics and Management of Tunis FSEGT, Tunis El-Manar University, Tunisia. He is appointed as chief of staff to the Minister of Higher Education and has contributed to research on entrepreneurship, innovation, and strategic management.

APPENDIX
Measurement Scales Used

Open Innovation Measurement Scale	
Dimensions	**Items**
External technology acquisition	OI-1 We often acquire technological knowledge from outside for our use. OI-2 We regularly search for external ideas that may create value for us. OI-3 We have a sound system to search for and acquire external technology and intellectual property. OI-4 We proactively reach out to external parties for better technological knowledge or products. OI-5 We tend to build greater ties with external parties and rely on their innovation.
External technology exploitation	OI-6 We are proactive in managing outward knowledge flow. OI-7 We make it a formal practice to sell technological knowledge and intellectual property in the market. OI-8 We have a dedicated unit (i.e., gatekeepers, promoters) to commercialise knowledge assets (e.g., selling, cross-licensing patents, or spin-off). OI-9 We welcome others to purchase and use our technological knowledge or intellectual property. OI-10 We seldom co-exploit technology with external organisations (R).
Individual Resilience Measurement Scale	
Dimension	**Items**
Uni-dimensional	IR-1 I am able to adapt when changes occur. IR-2 I can deal with whatever comes my way. IR-3 I try to see the humorous side of problems. IR-4 Coping with stress can make me stronger. IR-5 I tend to bounce back after illness, injury, or other hardships. IR-6 I can achieve my goals, even if there are obstacles. IR-7 I stay focused under pressure. IR-8 I am not easily discouraged by failure. IR-9 I think of self as a strong person. IR-10 I am able to handle unpleasant or painful feelings
R: Reverse coded	