Management Decision

Management styles and innovation

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Abstract

Purpose – Using a sample of about 323 Italian companies and 423 managers from July 2020–March 2021, the work tests hypotheses on reliability of The Open MOOd Questionnaire. Data collected are analyzed by a psychometric model and a latent trait is found. Results are verified and validated. Moreover, external robustness is assured by comparing the Rasch Analysis results with other statistical methods.
Design/methodology/approach – The purpose of this paper is to measure the level of openness of managers through the Open MOOd Questionnaire. Which aspects allow us to identify different management styles, and if the "openness" characterizes specific clusters of managers.
Findings – The study shows that the openness attitude in the professional activity of the managers is very high. The Open MOOd Questionnaire can be improved by considering some dichotomic items.
Practical implications – The study highlights the model proposed identifies the Open Manager's competencies, and identifies teaching methods for their development.
Originality/value – The authors propose a new model to study openness. Diagnostic tools of consolidated statistical methods show that the Open MOOd Questionnaire is an effective tool to evaluate the openness.

Keywords Openness, Innovation, Human resources analysis, Open manager, Partial credit model
Paper type Original article

1. Introduction

The wave of globalization has profoundly impacted organizations in many ways. On one hand, it has expanded the scope of business areas, creating new opportunities for companies and increasing the number and characteristics of competitors. On the other hand, the growing importance of digitalization has accelerated competitive processes, leading to an increased need for companies to invest in innovation. The Fourth Industrial Revolution (Schwab, 2016) represents a paradigm shift capable of significantly impacting economic and social systems. In this context, there is a pressing need for a profound rethinking of managerial culture to identify innovative variants of mainstream managerial models, thereby fostering leadership that is attuned to contemporary demands. Such a change is essential to enable today's business leaders to navigate challenges by rethinking management in entirely new ways and logics.

Since the emergence of Web 2.0 and Enterprise 2.0 (O'reilly, 2005; McAfee, 2009), value production through peer-to-peer relationships (Bauwens *et al.*, 2019) has gained prominence in economic culture. It has become evident how resources can be transmitted or made available through diffusion channels (of information, knowledge, social capital) with the help of catalytic elements such as entrepreneurial figures, technological hubs, and business networks (Burt, 1987). Additionally, one of the most intriguing perspectives in strategic and

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industrial development research in recent years has been the phenomenon known as Open Innovation (Chesbrough, 2003a). This approach acknowledges the possibility of developing innovation through connections and collaborations with research centers, professionals, and companies outside the organization, aiming to create mutually beneficial alliances. This model requires a significant cultural shift, going beyond traditional notions of ownership (Chesbrough, 2003b) as a criterion for competitive advantage. Embracing innovation from external sources (inbound) or exporting innovation outside (outbound) may represent the only opportunity for growth and market viability in these new scenarios.

In recent years, the concept of "openness" has also been applied to the enterprise as a whole, to employee relationships, and to management's interpretation of its role (Whitehurst, 2015; Bruttini, 2014b; Li, 2010). Thus, the Open Organization encompasses a complex set of practices, including organizational models, teamwork systems, and managerial behaviors that aim to provide a concrete response to the need for companies to adapt quickly and evolve based on market demands (customers and competition). It is a fragmented, multifaceted, and largely unstructured movement (Laloux *et al.*, 2015), identified by various "buzz words" such as heterarchy, agility, teal, and openness. Experiments with new organizational models that explore alternative ways of organizing work are underway worldwide. Key concepts that unite these experiences include speed, communication, teamwork, transparency, reduced hierarchy, increased participation, and well-being. Thus, the goal is not only to enhance organizational performance but also more able to respond to the needs of workers in the second two decades of the 21st century, the needs to see greater harmony between personal and professional identity. Since the mid of second decade of 2000s, research has been directed towards the development of a new managerial culture capable of addressing these perspectives (Open Leadership Manifesto, Bruttini, 2014a) and creating the cultural prerequisites for this shift to occur.

In 2020, thanks to significant funding from an Italian public fund aimed at promoting the training of managers enrolled in the fund, research began on the distinctive competencies that managers need to develop to foster innovation processes in their companies. Specifically, the fund focused on the Open Innovation model (West and Bogers, 2014; Enkel *et al.*, 2009; Bogers *et al.*, 2017; Dahlander *et al.*, 2021; West *et al.*, 2014; Chesbrough, 2006), believing it to be particularly suitable for Italian companies, many of which are characterized by small and medium sizes. With the resources provided by the fund and the involvement of research partners, a management model was designed to foster Open Innovation and a broader culture of organizational openness. To identify the characteristics of the Open Manager, a survey questionnaire was administered to 5,400 companies between 2020 and 2021, resulting in a novel dataset involving 323 companies and 413 managers. The primary objective of this study is to validate the developed model, measure the level of openness among surveyed managers, and identify different management styles.

The subsequent sections of this paper are structured as follows: First, the literature review and hypotheses section will summarize existing research on Open MOOd (Open Manager for Open Organization) competencies, outline the three hypotheses tested within the paper, and present the theoretical model. Second, the research methodology will describe the data collection process and provide a detailed explanation of the survey measures and statistical tools used for analysis. Third, the research findings will be presented, providing analysis and support for each of the hypotheses tested. Finally, the paper will present its theoretical contributions to Open MOOd, implications for practice, and areas for future research.

2. Literature review and hypotheses

2.1 Background

In the Innovation Process Promoter model, nine competencies were selected. First, adaptability (Maier and Brem, 2018), refers to flexibility and the ability to adapt to continuous change, as

reflected in the item "I can accept continuous changes in the business world," and the reverse item "Business today requires maximum consistency". Additionally, the desire to learn, characterized by a willingness to invest time in expanding knowledge and learning new things, even without external rewards, is expressed in the item "I take every opportunity to learn new things" (Maier and Brem, 2018). Furthermore, the ability to establish contacts is identified as essential for the Open Manager (Naqshbandi and Tabche, 2018). This involves a willingness to seek contact with both familiar and unfamiliar individuals, as well as actively maintaining professional and personal networks. This competence is reflected in the item "When faced with any critical task I always know someone who can be of help to me", and in every context I go to I immediately try to create relationships'. This is accompanied by action orientation (Maier and Brem, 2018), understood as a readiness to quickly turn a decision into a goal-oriented activity, expressed in the item "In the professional context, I act very quickly". Another selected competency is alliance building, understood as the propensity and ability to create strategic alliances (Lichtenthaler and Lichtenthaler, 2009) by overcoming barriers in non-knowledge, particularly between people in one's own organization and people in the external environment, translated in the item "I always manage to develop relationships with interlocutors who can have an impact on the business". Finally, persuasion is identified, encompassing tolerance for others' judgments, self-motivation, confidence in expected performance, and argumentative ability, as expressed in the item "In my work I know that I have to convince even my enemies".

For the Power Promoter cluster (Maier and Brem, 2018), four core competencies were chosen. First is learning facilitation, which involves encouraging learning processes within the team and supporting individual change processes, reflected in the item "I expect my collaborators to be able to change independently" (reverse item). Assertiveness and perseverance, the tendency to influence social situations and persist in achieving goals despite resistance, are expressed in the item "In the face of people's resistance, I act to overcome it". Self-confidence, positivity, and belief in one's abilities are identified as relevant for the Open Manager and are reflected in the item "I never lose confidence and the idea that I can do it". Visionariness, the ability to envision innovative solutions and connect markets and technological solutions in new ways, is expressed in the item "I often imagine doing things that others think are impossible".

In conclusion, to this macrocategory, we bring back the competencies identified from the Expertise for Innovation model: on the one hand we find knowledge of the company's business perspective, understood as an orientation to consider business dimensions, even when they are not directly related to one's role, expressed in the item "I am always careful to identify areas of potential business growth." On the other hand, on the other hand, we find excellent technical competence, i.e. a deep knowledge of technology and internal organizational processes, translated in the item "In order to do my job, I need to develop a deep knowledge of technology and organizational processes." Added to these is the assessment of organizational identification, that is, the process by which individuals tend to associate personal goals with corporate goals, experiencing as their own the successes and failures of the group to which they belong, expressed in the items "I feel that I have become attached to my colleagues in this company" and "I feel that I totally identify with my company".

2.2 Hypothesis development

The Open MOOd model proposed is built upon a set of items, with the Partial Credit Model applied to evaluate the trade-off between manager attitudes, or personality traits, and item difficulties. The primary objective is to ascertain whether our model can effectively measure the Open MOOd.

Therefore, we hypothesize:

H1. The Open MOOd Questionnaire Measures Open Management.

The second hypothesis concerns the ability to discern clusters of managers who tend to respond similarly to certain discriminating questions. This analysis aims to identify more significant questions and characterize the clusters synthetically, thus allowing us to delineate management styles as measured by the Open MOOd model.

H2. There are discriminant items that allow us to identify different management styles.

Further analysis of questionnaire question number 31 delves into a more subjective dimension of the survey. This question explores the Manager's "feeling of Openness," reflecting one's perception of being an open manager. Our hypothesis explores the potential connection between this "feeling" and the managerial clusters revealed by the Rasch technique. Additionally, the technique will help assess whether the attribute of Openness is associated with one or more managerial styles.

H3. Open management cuts across different managerial styles.

3. Research design and model

The Open MOOd research, initiated by Fondirigenti, engaged 323 companies and 413 managers between July 2020 and March 2021. The primary objective was to delineate a new managerial archetype, the Open Manager, and to develop an assessment tool and specialized training model. The meta-objective aim of this research is to foster the evolution of a managerial culture that aligns more closely with ongoing cultural and technological shifts. In the initial phase, a survey questionnaire was distributed to approximately 5,400 companies, primarily sourced from the Italian public fund database. The selection of companies for the survey and the exploration of open management topics were facilitated through indicators enabling filtering of datasets from the Fondo Database, AIDA (Integrated Automation Customs Excise) database for large companies, and the Ministry of Economic Development Dataset for SMEs (MISE). Specifically, companies to receive the survey were identified based on the presence of keywords in notices, including:

(1) Internationalization;

(2) Organizational, process, and/or product innovation;

(3) Interventions for skill development related to data utilization and information as business resources;

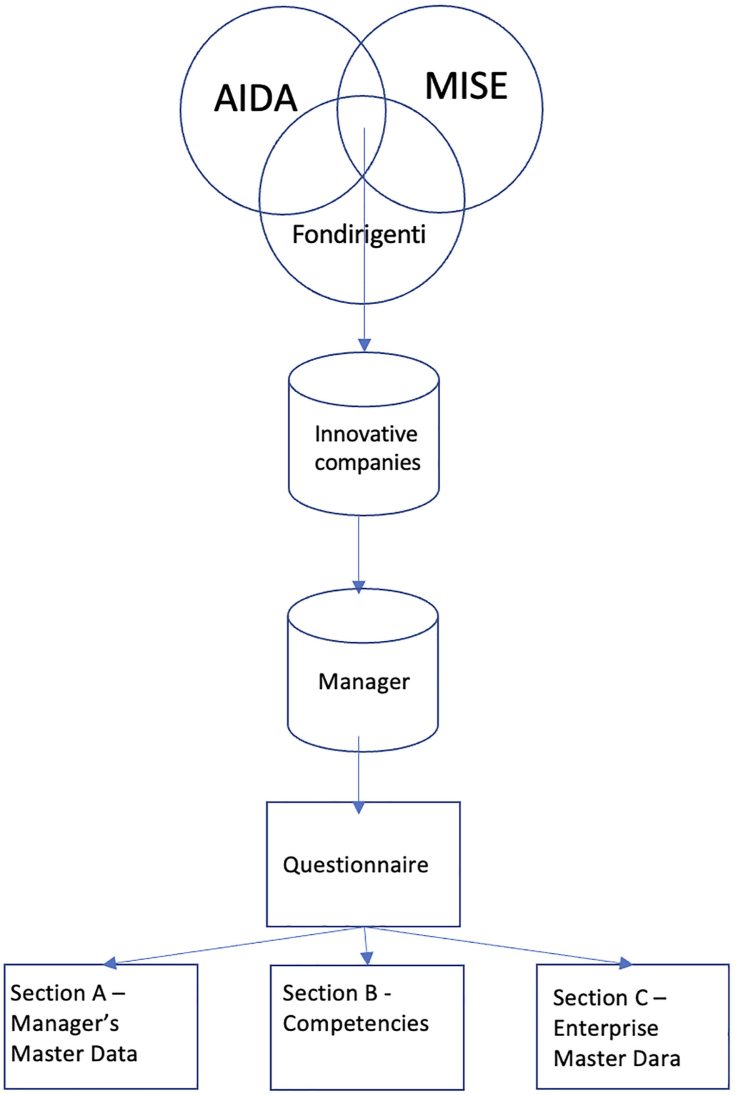
(4) Interventions for skill development in managing or initiating online commercialization processes;

(5) Interventions for skill development in managing or enhancing e-reputation or promoting products, services, projects, or events through digital channels.

A schematic overview of the research design and procedures is depicted in Figure 1.

In total, 1,336 email addresses were identified by Fondo for survey distribution. For data on large enterprises, the Confindustria Study Center extracted information from the AIDA database, focusing on corporations with 250 or more employees, engaged in specific NACE activities. Innovative SMEs were identified from the MISE Dataset, filtered by NACE sectors and registration dates (specifically, sectors 21, 28, 61, 62, 63, 70, and 72).

Furthermore, innovative SMEs extracted by the CSC (Confindustria Study Center) from the MISE Dataset were identified through the following criteria:



Source(s): Figure by authors

Figure 1.
Research design

(1) NACE sectors

- 21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
- 28 Manufacture of machinery and equipment n.e.c.
- 61 Telecommunications
- 62 Computer programming, consultancy, and related activities
- 63 Information service activities

- 70 Activities of head offices, management consultancy activities
- 72 Scientific research and development;

(2) Date of registration in the section of innovative SMEs;

(3) Date of registration in the Companies Register.

An additional consideration was taken into account in the analysis to ensure the representativeness of the sample across Italy.

Subsequently, 1,322 companies were identified from the MISE and AIDA lists to which the questionnaire was distributed. Based on these analyses, the questionnaire was sent to 2,740 email addresses, including 2,684 from their CRM and 57 direct emails.

In total, 213 completed surveys were returned, constituting the experimental sample group. A thorough review of existing literature was conducted to inform the questionnaire development. This process led to the identification of an initial set of managerial skills characteristic of the Open Manager, translated into observable behaviors to be investigated through the tailored questionnaire.

The questionnaire was initially administered online to 213 managers from innovative enterprises across various sectors, including machinery and equipment manufacturing, manufacture of basic pharmaceutical products and pharmaceutical preparations, information and communication services, software production, IT consulting, business and management consulting, and scientific research and development. These enterprises were evenly distributed across Italian regions. An additional control group of 170 managers supported the statistical analyses. Subsequently, five focus groups were conducted to validate the quantitative analyses. Transcribed interviews underwent linguistic and emotional analysis using software to identify lemmas, emotions, and values expressed by the participating managers.

3.1 Measurements

The OPEN MOOd questionnaire aims to assess managerial style, propensity for change and innovation, as well as team and relationship orientation. Its purpose is to identify Open Manager competencies, validate them, and ascertain teaching methods for their development. Specifically, three macro-sections are identified:

(1) Section A - Manager's Master Data;

(2) Section B - Competencies;

(3) Section C - Enterprise Master Data.

The first section gathers information regarding the participant's educational and professional background, including qualifications, training, previous employment history, job title, functional area, activities performed, and frequency of activities outside the home base.

The second section forms the core of the questionnaire and assesses the manager's competencies, attitudes, and behaviors related to Openness and the Open Manager concept. It consists of 30 multiple-choice questions where participants rate their agreement level. Additionally, items 31 and 32 gauge the respondent's perception of their organization's readiness for Openness and Open Innovation, respectively, on a 10-point scale. Questions 33 and 34 explore specific aspects of Open Innovation programs and skills characterizing the Open Manager. Item 35 is a dichotomous question about the participant's willingness to participate in Open Management training initiatives.

The third section collects biographical data about the respondent's organization, including its production chain, number of employees, turnover class, level of internationalization, and territorial distribution.

The responses from these sections are analyzed to identify common factors among Open Managers, considering both the personal characteristics of the respondents and the organizational context. Additionally, reverse items are included to mitigate acquiescence bias, enhancing the authenticity of responses. This comprehensive approach aims to provide valuable insights into managerial competencies and organizational readiness for Openness, facilitating further statistical data analysis.

3.2 Statistical tools

Rasch techniques (Rasch, 1993, Bond *et al.*, 2020) are commonly employed in survey instrument development. The proposed model gathers data on managers' attitudes in open organization competencies, including aspects of openness that may be challenging to assess.

The simplest Rasch technique involves a binary outcome, where the model predicts the probability of a response aligning with the open manager figure. This probability is determined by the difference between the manager's propensity (B_n) to be open and the difficulty (D_i) of the item (i) in eliciting a positive response.

Using a logarithmic scale, the model can be expressed as.

$$\log(P_{ni}1/P_{ni}0) = B_n - D_i$$

Here, $P_{ni}1$ represents the probability of a correct response (success = 1) from manager n to item i, and $P_{ni}0$ represents the probability of an incorrect response (failure = 0). B_n denotes the measure of person n' s ability, while D_i indicates the measure of item i' s difficulty.

In our model, items are rated on a Likert scale with four categories.

The thresholds between these categories are allowed to vary across items, allowing for non-constant transitions between response categories. This version of the model, known as the Partial Credit Model, can be expressed as:

$$\log(P_{nij}/P_{ni}(j-1)) = B_n - D_i - F_{ij}$$

where F_{ij} represents the threshold between categories j and $(j-1)$ for item i. For further details, refer to Masters (2016) and Simonacci and Gallo (2017)

4. Results

4.1 Model validation

In this session, we employ the Partial Credit Model (PCM) to assess the latent trait of openness among Italian managers. The analysis was conducted using the Winstep software (Linacre, 2009), which facilitated the measurement of item and person fit. Additionally, meta-language analysis was performed using the eRm package in R (see Figure 2).

All results, including scores, frequencies, and diagnostics, are presented in Appendix. The infit and outfit statistics provide insight into the fit of items and managers' responses to the model. With average unstandardized infit and outfit values of 0.97 and 0.96 for item fit, and 1 and 0.96 for person fit, respectively, these statistics fall within the recommended range proposed by Linacre [0.6; 1.4]. Thus, the data indicate a good fit. Referring to the person-item map (Figure 3), the following conclusions can be drawn. Regarding the reliability index, which measures the consistency of test results across repeated trials, higher values indicate greater reproducibility. The analysis reveals an item reliability of 0.99 and a manager reliability of 0.99 as well, indicating excellent reproducibility characteristics of the instrument. The lower pane of the diagram displays 30 items labeled from "1" to "30," arranged by their position on the latent dimension, with filled dots.

Indicating item difficulty and circles representing thresholds. In the upper panel (Person Parameter Distribution), managers' abilities are depicted from least able (on the left) to most

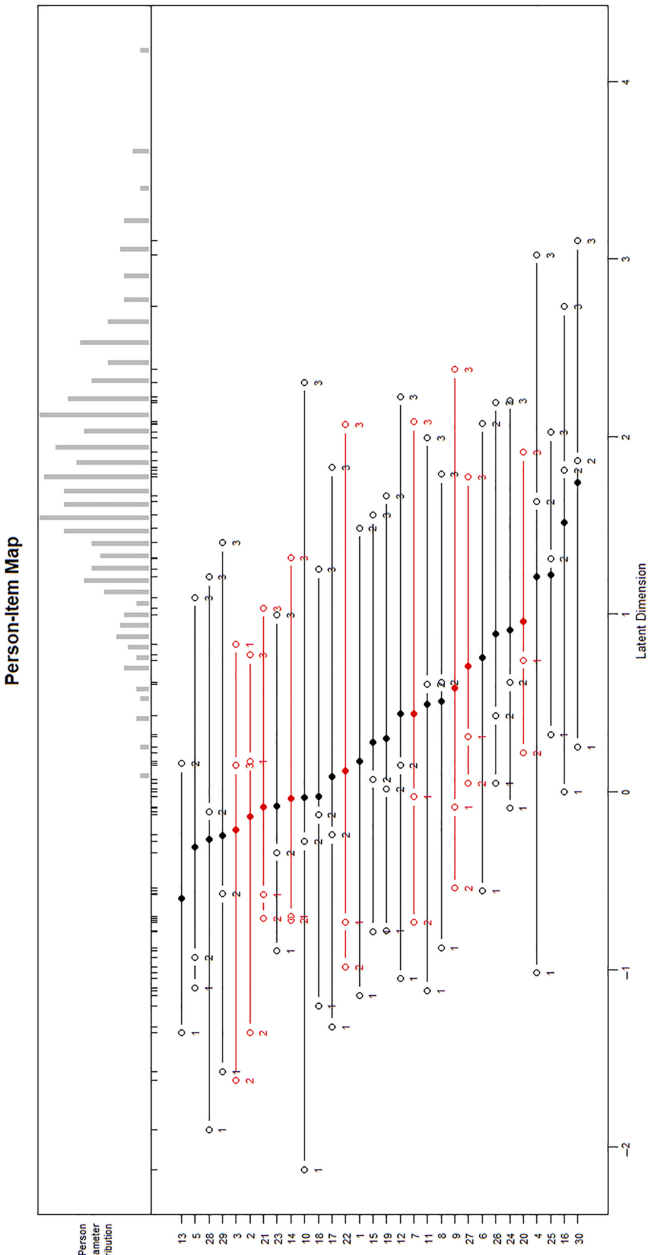


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Figure 2.
Person and item parameters (items 1–30)

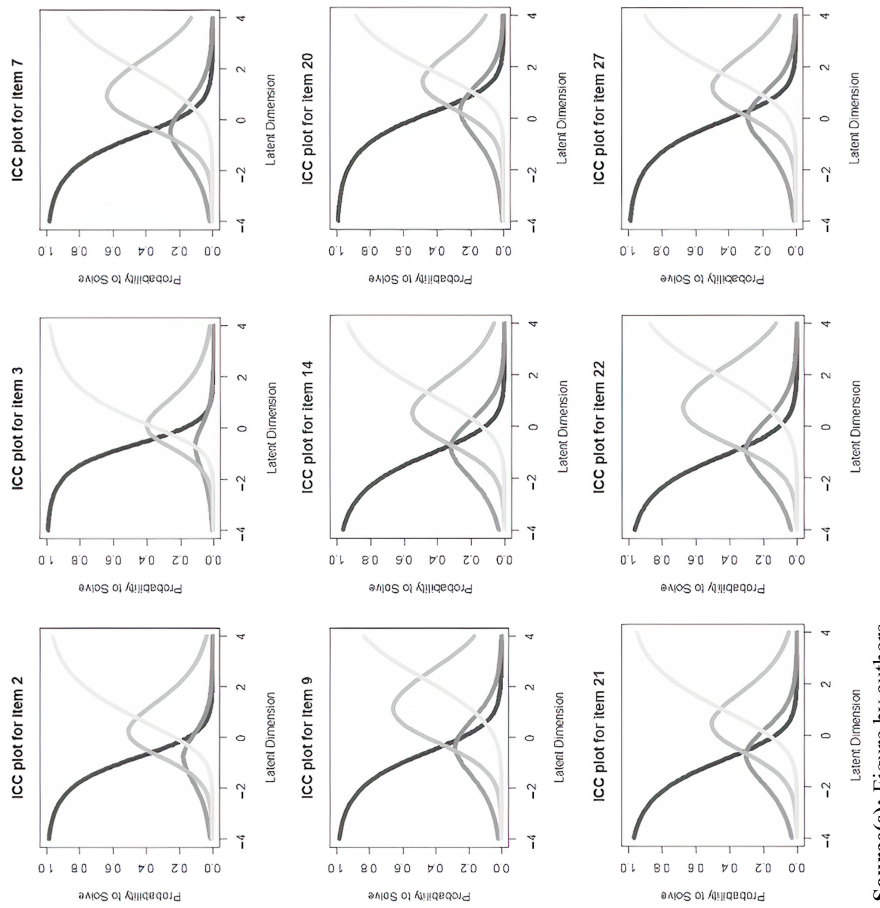

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Figure 3.
Characteristic curves of items 2, 3, 7, 9, 14, 20, 21, 22 e 27

able (on the right). Overall, managers exhibit higher abilities than the difficulty of the items, indicating a high propensity for open attitudes in their professional activities. However, certain items pose challenges even for highly capable managers, notably the reverse items: "I prefer employees who can impose themselves on others," "When making decisions, it is not always necessary to assess the impact on others," "It is not always appropriate to give oneself career development of one's employees as a priority," and "It is not always appropriate for subordinates to contribute to the making of important decisions" (items 4, 25, 16, 30).

As mentioned earlier, these reverse items, designed to counteract acquiescent behavior, require careful consideration from respondents. To identify areas for improvement in managers' attitudes, it may be beneficial to focus on items immediately preceding the reverse ones, as they may elicit different evaluations. Items 24, 26, 6, 27 represent aspects for managers to develop an open profile, including the ability to achieve seemingly impossible tasks, manage relationships with adversaries, act swiftly in professional contexts, and foster identification with their company. Conversely, items 13, 5, 28, 29, 3, 2, 21, 23, 14, 10, and 18 are deemed simpler and represent areas where managers excel, such as clarifying team priorities, providing visibility opportunities for employees, acquiring deep knowledge of technologies and organizational processes, enabling self-management in work contexts, embracing continuous learning, admitting mistakes, instilling confidence in employees, maintaining unwavering self-confidence, identifying business growth areas, cultivating impactful relationships, and adeptly networking in various contexts.

The person-item map also highlights certain items (3, 2, 21, 14, 22, 7, 9, 27 and 20) marked in red, indicating they possess unordered thresholds, suggesting redundant response categories. For items with unordered thresholds, the "Partially disagree" category may not be distinct, necessitating its merger with adjacent categories or potential elimination.

4.2 Transversality of profiles

The Rasch analysis results were utilized to evaluate hypotheses regarding manager characteristics as previously identified in Bruttini *et al.* (2022). One of the key items considered was: "In relation to the characteristics of the Open Manager, within your company, how close do you feel to this figure?" This item was scored from 1 to 10. Notably, responses from 7 to 10, accounting for over 81% of the total, corresponded to groups of managers with increasing mean measure, indicating a direct relationship (refer to Table 1). These findings suggest that self-assessments align closely with measures estimated using the Partial Credit Model (PCM). A comparison was undertaken with the findings of the analysis conducted by Bruttini *et al.* (2022) using the identical dataset. Their analysis

Table 1. Measure and self-assessment

Manager count	Measure (mean)	Code
4	1.10	1
2	1.33	2
4	1.22	3
4	0.91	4
17	1.22	5
39	1.22	6
87	1.34	7
138	1.43	8
63	1.78	9
25	1.95	10
383	1.46	**

Source(s): Table by authors

delineated six discrete groups of managers exhibiting similar behaviors, predicated on their responses to questionnaire items. By juxtaposing the distribution of item responses within each group against the aggregate dataset, the study elucidated the varying levels of openness characterizing each managerial group. The results of the Rasch Analysis remain congruent with those derived from an alternate methodological approach, with one notable exception observed in group 3. This deviation warrants further explanation.

5. Conclusion

The research makes significant contributions to human resources analysis and literature. Firstly, it enhances our understanding of how and why HR analysis correlates with improved organizational performance. Secondly, it underscores the importance of access to HR technology for identifying effective HR models. Finally, empirical evidence, supported by Rasch Analysis, validates Evidence-Based Management (EBM) and its positive impact on organizational performance.

The Rasch model demonstrates potential as a performance assessment tool, enabling targeted interventions for managers to develop specific competencies and foster innovation within their companies. In summary, the key findings are as follows:

(1) The instrument demonstrates good reproducibility in repeated trials (H1);

(2) The items used exhibit a good fit, as evidenced by the infit statistics falling within the expected range (H1).

(3) The person-item map reveals that, on average, managers exhibit a high propensity for open attitudes in their professional activities, which aligns with their self-assessment. Reverse items were more challenging for respondents, while some items were deemed overly simplistic and could potentially be removed in future administrations. Items 6, 24, 26, and 27 encapsulate areas warranting intervention.

(4) Regarding items with unordered thresholds (2, 3, 7, 9, 14, 20, 21, 22, 27), future administrations of the questionnaire may benefit from eliminating the "Partially disagree" category or even making these items dichotomous based on item characteristic curves.

(5) The results of the Rasch Analysis align with managers' perceptions of their own openness and with results obtained from hierarchical cluster analysis on the same dataset (H2);

(6) Validation of the results from Bruttini *et al.*, (2022) using Rasch methodology, as shown in Table 2, indicates a distribution of the latent component "openness" across different clusters of managers (H3).

Manager count	Group	Measure (mean)	Average
76	1	1.40	7.4
79	2	1.43	7.2
69	3	0.95	7.5
67	4	1.68	7.8
73	5	2.15	8.3
19	6	0.29	6.3
383		1.46	

Note(s): Group: 1 guardians, traditionalist, defender; 2 open leaders; 3 selfish people; 4 regulators; 5 explorers; 6 opponents

Source(s): Table by authors

Table 2.

The most significant clusters identified include the "Explorers" (group 5), characterized by openness to continuous changes in the business world, willingness to admit mistakes, quick decision-making, and a questioning attitude towards one's opinions. This profile highlights adaptability and learning as essential traits for navigating dynamic environments.

The second notable profile is the "Regulator" (group 4), where openness is emphasized through preferences for employees who assert themselves, consistency in business operations, and the ability to develop impactful relationships. Despite the term "regulator," this cluster may represent individuals who view their managerial role through an entrepreneurial lens, actively seeking opportunities externally while empowering employees for self-management internally. Overall, this study provides a reliable tool for assessing managerial competencies associated with openness in work organizations, revealing six distinct managerial styles with varying degrees of this factor. Future studies can delve deeper into manager characteristics and their potential influence on item functioning. By analyzing data from the first section of the questionnaire, researchers can compare groups of subjects with different personal attributes. This allows for investigating whether and how personal characteristics affect item performance. The typical approach involves conducting a combined analysis, rather than separate analyses, to examine item functioning. This entails holding all other variables constant while investigating the interaction of different groups with each item individually.

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Appendix

Entry number	Data code	Score value	Data count	%	Average ability	S.E. MEAN	Outfit MNSQ	PTMEA CORR.	ITEM
27	1	1	42	11	1.38	0.08	1.2	−0.12	30
	2	2	154	40	1.47	0.05	1.2	−0.15	
	3	3	140	37	1.62	0.05	1.3	0.04	
	4	4	47	12	2.07	0.10	1.0	0.29	
29	1	1	32	8	1.40	0.08	1.3	−0.09	16
	2	2	148	39	1.49	0.05	1.3	−0.12	
	3	3	138	36	1.54	0.05	1.4	−0.06	
	4	4	65	17	2.01	0.09	1.0	0.31	
28	1	1	12	3	1.71	0.16	1.7	0.03	4
	2	2	150	39	1.56*	0.05	1.4	−0.04	
	3	3	164	43	1.56*	0.05	1.5	−0.04	
	4	4	57	15	1.73	0.08	1.2	0.10	
30	1	1	30	8	1.42	0.10	1.4	−0.08	25
	2	2	95	25	1.49	0.06	1.3	−0.10	
	3	3	137	36	1.47*	0.05	1.2	−0.14	
	4	4	121	32	1.85	0.06	1.1	0.28	
22	1	1	14	4	1.26	0.11	1.2	−0.10	24
	2	2	64	17	1.28	0.07	1.0	−0.22	
	3	3	178	46	1.53	0.04	1.0	−0.08	
	4	4	127	33	1.86	0.06	1.0	0.31	
23	1	1	14	4	1.17	0.12	1.2	−0.13	26
	2	2	55	14	1.29	0.07	1.1	−0.20	
	3	3	183	48	1.52	0.04	1.0	−0.11	
	4	4	131	34	1.86	0.06	1.0	0.32	
18	1	1	21	5	1.43	0.13	1.5	−0.06	20
	2	2	41	11	1.26*	0.10	1.1	−0.18	
	3	3	166	43	1.51	0.05	1.1	−0.11	
	4	4	155	40	1.78	0.05	1.1	0.26	
10	1	1	5	1	0.88	0.15	0.9	−0.13	11
	2	2	62	16	1.20	0.07	1.0	−0.28	
	3	3	170	44	1.45	0.04	0.7	−0.20	
	4	4	146	38	1.95	0.05	0.9	0.45	
11	1	1	4	1	0.95	0.14	0.9	−0.11	12
	2	2	46	12	1.26	0.07	1.0	−0.19	
	3	3	198	52	1.49	0.04	1.0	−0.17	
	4	4	135	35	1.87	0.06	1.0	0.33	
8	1	1	6	2	1.10	0.28	1.2	−0.10	9
	2	2	26	7	1.09*	0.11	0.9	−0.22	
	3	3	222	58	1.47	0.04	0.9	−0.22	
	4	4	129	34	1.92	0.05	0.9	0.38	
7	1	1	6	2	1.35	0.45	2.0	−0.05	8
	2	2	58	15	1.31*	0.07	1.1	−0.19	
	3	3	156	41	1.46	0.04	0.9	−0.18	
	4	4	163	43	1.82	0.05	1.0	0.32	

(*continued*)

Table A1. Rasch analysis results

Entry number	Data code	Score value	Data count	%	Average ability	S.E. MEAN	Outfit MNSQ	PTMEA CORR.	ITEM
9	1	1	1	0	0.17		0.5	−0.12	10
	2	2	33	9	1.00	0.07	0.7	−0.29	
	3	3	215	56	1.48	0.04	0.9	−0.20	
	4	4	134	35	1.92	0.05	0.9	0.39	
24	1	1	12	3	1.21	0.13	1.2	−0.11	27
	2	2	35	9	1.18*	0.08	0.9	−0.21	
	3	3	164	43	1.43	0.04	0.9	−0.22	
	4	4	172	45	1.85	0.05	1.0	0.38	
6	1	1	5	1	1.32	0.28	1.4	−0.05	7
	2	2	20	5	0.98*	0.12	0.8	−0.23	
	3	3	203	53	1.45	0.04	0.9	−0.24	
	4	4	155	40	1.86	0.05	0.9	0.36	
5	2	2	24	6	1.16	0.12	1.0	−0.18	6
	3	3	203	53	1.50	0.04	1.2	−0.15	
	4	4	156	41	1.77	0.05	1.0	0.24	
20	1	1	2	1	1.16	0.58	1.2	−0.05	22
	2	2	16	4	0.94*	0.12	0.7	−0.22	
	3	3	206	54	1.40	0.04	0.8	−0.32	
	4	4	159	42	1.90	0.05	0.9	0.42	
15	1	1	2	1	0.14	0.32	0.5	−0.17	17
	2	2	29	8	1.06	0.08	0.8	−0.24	
	3	3	178	46	1.43	0.04	0.9	−0.23	
	4	4	174	45	1.86	0.05	0.9	0.39	
17	1	1	4	1	1.29	0.16	1.3	−0.05	19
	2	2	34	9	1.07*	0.08	0.9	−0.26	
	3	3	161	42	1.47	0.04	1.0	−0.16	
	4	4	184	48	1.79	0.05	1.0	0.31	
14	1	1	4	1	0.86	0.26	1.0	−0.12	15
	2	2	34	9	1.00	0.08	0.8	−0.30	
	3	3	152	40	1.41	0.04	0.9	−0.24	
	4	4	193	50	1.85	0.04	0.9	0.42	
16	1	1	2	1	0.00	0.17	0.5	−0.19	18
	2	2	25	7	0.94	0.08	0.8	−0.28	
	3	3	133	35	1.37	0.04	0.9	−0.25	
	4	4	223	58	1.81	0.04	0.9	0.41	
26	1	1	1	0	0.58		0.8	−0.08	29
	2	2	18	5	1.12	0.07	0.9	−0.17	
	3	3	149	39	1.29	0.04	0.8	−0.39	
	4	4	215	56	1.84	0.04	0.9	0.46	
25	1	1	1	0	1.83		2.0	0.02	28
	2	2	25	7	1.19*	0.10	1.0	−0.17	
	3	3	130	34	1.36*	0.04	0.9	−0.27	
	4	4	227	59	1.77*	0.04	1.0	0.34	
1	2	2	11	3	1.00	0.20	0.9	−0.16	1
	3	3	160	42	1.32	0.04	0.8	−0.37	
	4	4	212	55	1.82	0.04	0.9	0.42	

Table A1. (*continued*)

Entry number	Data code	Score value	Data count	%	Average ability	S.E. MEAN	Outfit MNSQ	PTMEA CORR.	ITEM
13	1	1	2	1	1.39	0.35	1.5	−0.02	14
	2	2	15	4	0.81*	0.13	0.7	−0.25	
	3	3	143	37	1.34*	0.04	0.9	−0.30	
	4	4	223	58	1.80	0.04	0.9	0.40	
21	1	1	2	1	0.24	0.41	0.6	−0.16	23
	2	2	18	5	0.99	0.09	0.9	−0.21	
	3	3	116	30	1.30	0.05	0.8	−0.30	
	4	4	247	64	1.78	0.04	0.9	0.41	
19	1	1	2	1	0.20	0.38	0.6	−0.16	21
	2	2	13	3	0.70	0.09	0.6	−0.27	
	3	3	121	32	1.34	0.05	0.9	−0.27	
	4	4	247	64	1.77	0.04	0.9	0.39	
4	1	1	1	0	0.97		1.0	−0.05	5
	2	2	11	3	0.92*	0.17	0.9	−0.18	
	3	3	127	33	1.32	0.05	0.9	−0.31	
	4	4	244	64	1.76	0.04	1.0	0.37	
2	1	1	2	1	0.17	0.17	0.6	−0.17	2
	2	2	6	2	0.54	0.20	0.6	−0.21	
	3	3	104	27	1.32	0.05	0.9	−0.26	
	4	4	271	71	1.73	0.04	1.0	0.34	
3	1	1	2	1	0.46	0.12	0.7	−0.13	3
	2	2	3	1	0.25*	0.24	0.4	−0.19	
	3	3	66	17	1.28	0.07	0.9	−0.22	
	4	4	312	81	1.67	0.03	1.0	0.28	
12	2	2	4	1	0.92	0.42	1.0	−0.11	13
	3	3	67	17	1.23	0.07	0.9	−0.26	
	4	4	312	81	1.67	0.03	1.0	0.29	

Note(s): Entry Number – is the item sequence number; Data Code – is the response code in the data file; Score Value – is the value assigned to the data code; Data Count – is the frequency of the data code in the data file; DATA % – is the percent of scored data codes; Average Ability – is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category; S.E. MEAN – is the standard error of the mean (average) measure of the sample of persons who responded in this category; Outfit MNSQ – is the ratio of observed variance to expected variance for observed responses in this category. PTMEA CORR – refers to Point Measure Correlation in the context of Rasch analysis

Source(s): Table by authors

Table A1.

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