

Received 2 March 2024, accepted 26 March 2024, date of publication 29 March 2024, date of current version 12 April 2024.

Digital Object Identifier 10.1109/ACCESS.2024.3383141

RESEARCH ARTICLE

Development and Validation of a Multidimensional Perceived Media Convergence Scale: A Classical Test Theory and Item Response Theory Approach

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ABSTRACT Media convergence is considered an effective way to alleviate the decline of traditional media audiences. Although media convergence has nearly swept through the world's foremost traditional media, studies reflecting its effects on individuals at the micro level are lacking. Therefore, this study established a multidimensional perceived media convergence scale to measure the actual perception of media convergence from the audience's perspective. To achieve this, a comprehensive field survey was conducted in a county in southwestern China, yielding a sample of 966 participants. Study 1 used exploratory factor analysis and a multidimensional graded response model (MGRM) to optimize the item pool. Study 2 then tested the reliability and validity of the scale using confirmatory factor analysis and a MGRM. Moreover, the entire sample was tested and analyzed for the measurement accuracy of this scale. The final instrument contains 24 items in six dimensions: communication power, influence power, guiding power, credibility power, political propaganda power, and service power. This study demonstrated the robustness and scalability of the scale. Based on this scale, future research can provide a deep understanding of which groups of people perceive media convergence in what way and conduct causal inference or mechanism analysis in conjunction with the audience's behaviors.

INDEX TERMS Media convergence, convergence perception, multidimensional graded response model, scale development.

I. INTRODUCTION

With the widespread use of the Internet and online technologies, media convergence is considered a comprehensive transition process and a response by traditional media to the challenges posed by new media. As of July 2022, the number of new media Internet users worldwide was over 5 billion, representing 63.1% of the world's population [1].

The associate editor coordinating the review of this manuscript and approving it for publication was Lei Shu¹.

The emergence of new media has gradually enhanced the interactivity of social information transmission, which leads to a decline in the number of audiences and participation of traditional media [2]. This phenomenon forced the traditional media to gradually adapt to the changes of the new media environment through reform and gave birth to the convergence of traditional media and new media.

Media convergence is the strategic amalgamation of traditional media, encompassing television, radio, and newspapers, with emerging media channels like the Internet,

cell phones, and other intelligent terminals, operating within diversified transmission modes [3]. This intricate process involves the integration of previously distinct technologies, industries, and content formats into a cohesive and interconnected system [4]. By sharing resources, centralizing processing, and utilizing various platforms, media convergence facilitates the dissemination of different forms of information to audiences [5]. The impetus behind media convergence lies in technological advancements and consumer behavior shifts, fostering a seamless and integrated flow of information and entertainment across diverse media channels.

Regions increasingly are gradually engaging in the media convergence process, and China is an interesting case to learn from. Recognizing the declining power of state-owned traditional media to guide the ideology of the population, the Chinese government has elevated media convergence to a national strategy since 2014 [6]. Driven by national policies and the media market, the mainstream media have integrated communication channels, such as the Internet, mobile applications, and significant social media. In addition, the mainstream media organized and established national-, provincial-, municipal-, and county-level converged media centers. The government sees media convergence as an ideal way to transfer information from traditional media to the Internet. Hence, the authority of traditional media and the communication flow of new media can be combined to guide public opinion in the right direction [7]. The media has also become an important channel for the Chinese Communist Party and the government to reach and serve the masses, partly explaining the high level of citizen cohesion [8]. Particularly during the COVID-19 pandemic, converged media played a big role in communicating epidemic prevention measures and national policies owing to activity restrictions and the need to maintain distance [9]. With the completion of the construction of the converged media center, the focus of research in recent years has shifted from how to promote the development of media convergence to the actual impact of media convergence on the audience.

Media convergence has allowed the media to penetrate deeply into people's lives. However, does the public realize the impact of media convergence on themselves? The audience comprises individuals with different characteristics, and media convergence research largely ignores how individuals perceive media convergence. Media convergence has given the media new functions and attributes, particularly in China, where the government has pinned hopes on news dissemination, public service, and political advocacy [10]. The lack of individual measurements of audience perceptions of media convergence may lead to incomplete excavation and understanding of this emerging trend.

Therefore, this study aims to develop and verify a unique audience-perceived media convergence scale (PMCS), which measures individuals' actual perception of media convergence in the context of Chinese media convergence. The possible marginal contribution of this study mainly includes the following two aspects: From the perspective

of theory and management, the constructed scale will be helpful for further research on media convergence. Examples include assessing the effectiveness of measures to improve audience perceptions of media convergence and further exploring the impact of media convergence on audience social behavior. From the research methodology perspective, this study followed the scale development process [11] and combined exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and item response theory (IRT) methods for scale verification. Through the combination of linear and nonlinear measurement models, this study aims to leverage the strengths of each technique to complement and validate findings from the other. This integrative strategy enhances the overall reliability and validity of our analyses, ensuring a more comprehensive and accurate depiction of the underlying structures and dynamics in the data.

In the next section, this study introduces the relevant conceptual background of media convergence and explains the meaning of each initial dimension of perceived media convergence. Following the rigorous scale development process, we derive a measurement scale for PMCS. Specifically, this study verifies the structure and validity of the scale through a random survey of residents in a county of Guizhou Province in southwest China. Finally, we discuss the results and concludes the study.

II. CONCEPTUAL BACKGROUND

A. CONCEPT AND DEVELOPMENT OF MEDIA CONVERGENCE

One of the challenges of studying media convergence is that the concept is so broad and has multiple meanings [12]. The term convergence was first proposed by [13], and its definition has been expanded with the development of communication technology. Representatively, media convergence is defined as a phenomenon involving the interconnection of information and media content resulting from digitalization and computer networking [14]. Specifically, convergence was the merging of old media (traditional media, such as magazines, newspapers, television, and radio) with new media to produce and distribute content [15]. Nonetheless, media convergence was not just a simple combination of traditional media and digital technology but also a convergence of five categories: ownership, tactical, structural, information, and presentation [16]. From a macro-perspective, media convergence was the change in social formats. In other words, the reintegration of media from different dimensions uses digital technology as the original technological platform to form a globalized, rising network society, and the media organization would be a node in the network.

Convergence refers to a multidimensional process involving technological, economic, social, cultural, and policy dimensions [17], but not an endpoint. Reference [18] proposed a convergence continuum model, which roughly describes the five stages of the media convergence process: cross-promotion, cloning, cooperation, content sharing, and full convergence. Cross-promotion was the level of

cooperation between two media to introduce media content to each other. The competition was a stage where media entities cooperate and compete simultaneously based on cultural differences. Content sharing allowed two different media to share content by repackaging the collected information. Finally, full convergence meant that different media cooperated fully in content collection, production, and distribution to jointly plan, report, and produce news stories. Particularly in China, in the past 20 years, with the promotion of the government and information industry, traditional media and new media have gradually carried out joint content production and committed to developing the full convergence stage. However, unless research accepts the association among the ideological function, government policy, and convergence, any understanding of this topic in the Chinese context will be skewed or meaningless [10].

B. PERCEIVED MEDIA CONVERGENCE FROM THE AUDIENCES' PERSPECTIVES

Media effects occur at the micro level through the cognitive processes of individuals as they receive and process information [19]. Thousands of empirical studies have been conducted on the effects of media on children and adults [20]. In general, media effects are often described as cognitive, affective, or behavioral [21]. Cognitive effects reflect what people learn through media, how media content is constructed in people's brains, and how people's needs for information are met [22]. Affective effects include the formation of attitudes or positive or negative evaluations of something that produces an emotional response to media content in people [23]. Behavioral effects are observable behavioral changes produced by exposing people to media [24], [25]. However, in the context of media convergence, capturing the actual audience perception of media effects fully is difficult for traditional comparative analyses based on content and survey results. First, content analyses cannot encompass all communication channels that may affect audience perceptions, particularly the increasingly popular social media platforms [26]. Second, compared with the unidirectional output of traditional media, new media enable audiences to interact and share freely. Therefore, this study provides individual-level specific descriptions of media convergence perceptions to understand how media convergence affects audiences for a robust measurement system in media convergence.

As China develops its characteristic media convergence, the country also proposes core indicators to measure the dynamics, role, and effectiveness of news and public opinion production and dissemination. The construction of converged media follows the development guide of communication, guiding, influence, and credibility power, which is directly related to the survival and development of Chinese mainstream news media itself [27]. Moreover, they seem to be relatively independent, but complementary to each other. Communication power measures the ability of the communication subject to achieve effective communication,

intending to influence the public, reflecting the potential impact of the communication subject on society, individuals, and the formation of public opinion. Guiding power is the guidance of the communication subject through a variety of channels of public opinion; the correct guidance of public opinion can ensure that the communication subject does not deviate not only from the ideological fundamentals but also from the front to guide the formation of a positive public opinion of the audience toward the direction of the positive. Influence power refers to the ability of the communication subject and its published content to influence the audience's thoughts, behaviors, and attitudes, which is the key to obtaining good social benefits from integrated media. Credibility power is the key to the construction of converged media, the communication subject's ability to gain the audience's recognition and trust.

Enhancing the power of political propaganda and public service is the inherent requirement and inevitable direction of the construction of integrated media [28]. UNESCO pointed out that "media are essential for transparency, accountability, and participation in governance." Policymakers may use information asymmetry to their advantage [29], and good information dissemination can be used as a means of voter coordination to improve the electoral system. Converged media will gradually become an "incremental" way to enhance political propaganda by publicizing national policies, interpreting current political events, and releasing public government information. In addition, the converged media centers have been positioned as a comprehensive service platform. Currently, most converged media centers set up convenient channels for the government and institutions to provide government services, recruitment, and communication services for their audiences. Media convergence broadens the channels for the public to do business and obtain information and enhances the public's recognition of the place, improving public service levels.

An important contribution of this study is that the study combines the functional positioning of existing converged media centers in measuring the media convergence perception by the audience. This study adds two more dimensions, that is, political propaganda power and service power, to the emerging four dimensions of communication, influence, credibility, and guiding power that have already been proposed. Although Chinese scholars have conducted much research on the four powers, most of them are from a theoretical perspective, and no relevant measurement research has been carried out at the individual level. Assessing the construction quality of converged media from the audience's point of view is complicated. On the one hand, many human and material resources should be organized for field research. On the other hand, the converged media center has just covered the whole country, and no unified and standardized measurement tool exists. This study examines the concept of perceived media convergence effect from the six dimensions mentioned above to provide a new perspective for media convergence research.

III. METHODS

This study combined CTT and IRT to examine the PMCS (Figure. 1). EFA and CFA are based on CTT, whereas Multidimensional Graded Response Model (MGRM) is based on IRT.

During instrument development or when no prior beliefs about the dimensionality or structure of an existing instrument, an EFA should be considered to investigate the factorial structure of the instrument [30]. Although sufficient prior theory exists, EFA with a promax rotation was conducted to clarify the main influence factors of latent variables to verify whether the dimensions of actual data met the predictions. This study employed multiple criteria to guide our factor extraction process [31]. These criteria encompassed parallel analysis, which aids in identifying the number of meaningful factors, adherence to the Kaiser-Guttman rule (wherein only factors with eigenvalues surpassing 1 are deemed crucial for extraction), and consideration of the theoretical implications associated with the identified factors [32]. Deciding upon the deletion of items, in general, is considered meaningful when the factor loading exceeds 0.40. This study took additional stringent measures to set the load threshold at 0.50 [33]. Items with loadings on a single factor and commonality less than 0.5 were omitted, including those with large cross-loadings.

After an instrument has been developed and validated, a basic understanding of the tool's dimensions and which indicators should be loaded into which factors is generally obtained. CFA was then applied to assess consistency between data and structures [34]. In CFA, rotation and uncertainty were not considered because the scale was fixed by setting the univariate loading of each factor or the variance of the factor to 1. In addition, cross-loadings between items and non-target factors are assumed to be precisely zero. During scale development, if a first-order CFA model determines the multidimensional structure of the data, then the usual next step would be to use a second-order CFA model to identify the possibility of further generalization [35]. The second-order measurement model implies a causal flow from the main construction to the first-order factors. This case also helps assess the structural relationship between the construct and the underlying sub-constructs [36]. Similar to EFA, the systematic fit assessment procedure is determined by meaningful satisfactory thresholds.

Unlike CTT, IRT analysis provides the relationship between an individual's item responses (item discrimination and item difficulty) and underlying latent traits [37]. Under the CTT framework, measurement precision is assumed to be constant across the scale score continuum. In IRT, however, the estimated conditional standard error is provided for each individual and can vary across the score continuum. One of the most commonly used models for polytomous data generated from Likert-type item responses is the GRM proposed by [38]. GRM simulates the probability of a given response category or higher by following the same order as the response options. In GRM, each response

category provides some information about the probability of a person choosing a particular response category. GRM creates $K - 1$ dichotomous term by cumulatively splitting response categories for an item with K -ordered response categories. Each of these artificial dichotomies has a unique difficulty parameter but shares the same discrimination parameter.

IRT is typically used to model unidimensional data. However, most measurement evaluations tend to measure two or more latent traits or dimensions, for which researchers have proposed different multidimensional item response theory (MIRT) models [39]. MIRT models explain the probability of a correct response to a given item as a function of a vector of latent traits instead of a single latent trait. These models are classified into two structures: between-item and within-item multidimensional modeling [40]. As each item of the scale in this study measures only one dimension, a between-item MIRT model is applied, which simultaneously accommodates data from multiple different dimensions, in much the same way as the related trait model in CFA. An important advantage of the MIRT model over several separate unidimensional IRT models is that the internal structure is explicitly considered, which allows for borrowing strength from other dimensions to aid in the estimation of item parameters, correlations, individual scores, and precision around scores [41]. Particularly when there are few items in each dimension and the sample size is not large, calculating the item discriminant parameters will be difficult, and the advantages of MIRT are prominent.

This study referred to the classical scale development procedures proposed by Rossiter [42], which were adopted by DeVellis and Thorpe [43] to develop an accurate and reliable PMCS. The creation of a robust scale involves three key stages: item development, scale development, and scale validation (Figure. 1). In the initial item development stage, the primary focus is on proposing the initial scale and assessing the clarity and content validity of the scale questions. The second stage, scale development, entails the extraction of potential factors and the reduction of scale items. This process involves employing EFA and a MGRM to assess the scale structure and eliminate redundant items. The last stage is scale validation, which tests the dimension, reliability and validity of the simplified scale in the second stage. This validation process utilizes CFA and a MGRM to ensure the rationality and robustness of the refined scale. In the second and third stages, the MGRM also served as a supplementary tool to provide specific information about the items in each dimension, enhancing the robustness and effectiveness of PMCS [44].

IV. ITEM DEVELOPMENT

A. CONSTRUCT SPECIFICATION AND ITEM GENERATION

The initial stage included specifying structural dimensions and generating an item pool for the PMCS. Inductive and deductive approaches were adopted to construct the perceived media convergence concept [45]. Converged media centers

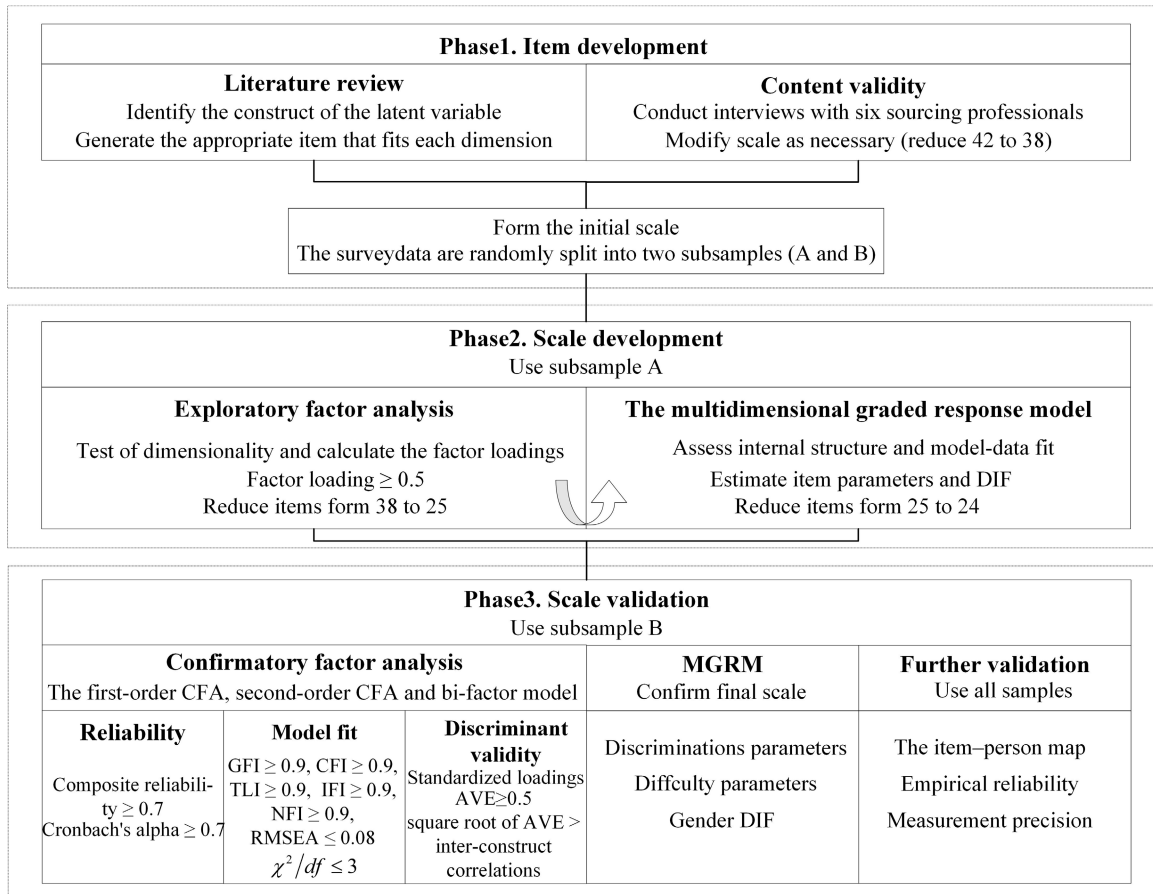


FIGURE 1. The scale development framework.

are unique to China and have just emerged in recent years, except for referring to media converged effects literature. Hence, we sort out many studies on communication, psychology, and other associated fields to grasp the perceived media convergence concept in a detailed and comprehensive way. The PMCS constructs into six dimensions based on [46]: communication, influence, credibility, guiding, service, and political propaganda power.

The item pool was generated through communication with five professionals from county-level converged media (CLCM) centers and the refinement of theoretical research. The five professionals have worked in CLCM centers for more than three years and are very familiar with the research topic. They cited the work contents of CLCM and the services they can provide for the audience, which were helpful to complement the insights summarized from previous theoretical studies. Each expertise was interviewed for approximately 1–2 h, and the interviews were voice recorded. After the interviews, three research team members with specialists in qualitative research executed the content analysis of the interview texts, which resulted in the initial applicability items. A total of 42 items remained for subsequent analysis by screening the text, removing duplication and redundancy, and extracting keywords and phrases, combined with the existing theoretical research.

B. CONTENT VALIDITY

The content validity of the items was assessed qualitatively and quantitatively before entering the item reduction phase of scale development. A panel of six communication and sociology scholars was invited to assess the clarity of items, considering content, structure, and wording, with the intention of making adjustments or removing redundant items. Following a comprehensive qualitative evaluation by the expert panel, four items unanimously identified as having poor clarity were removed. As a result of this refinement process, the initial version of the PMCS was reduced from 42 to 38 items. Then, experts rated items on a five-point Likert scale based on the relevance of each item to the topic, with 1 = not relevant and 5 = very relevant [47]. The content effectiveness index (CVI) was calculated for each entry, which is the proportion of experts that rated the item with a score of 3 or 4 [48]. A CVI greater than 0.78 was considered acceptable [37], and all items met this criterion. Therefore, 38 items were retained after the process.

C. SAMPLE AND PROCEDURE

The questionnaire survey in this study adopted two forms: an online survey and an offline paper survey. The offline field survey team consists of six Ph.D. students with extensive experience in the on-site survey. All six Ph.D. students

TABLE 1. Descriptive statistics of expert ratings.

	N	mean	sd	min	max
expert1	38	3.632	0.852	2	5
expert2	38	3.579	0.758	2	5
expert3	38	3.526	0.951	1	5
expert4	38	3.421	0.758	2	5
expert5	38	3.211	0.935	1	5
expert6	38	3.211	0.905	1	5

can fluently speak both Mandarin Chinese and the local Guizhou dialect. They went to distribute questionnaires in Guizhou Province of China, including Shuangshan Town, Muge Village, Xiaoba Village, and Pulu Village, where many people use CLCM, are the targeted sampling population of this study. Participants were informed that these data were for research purposes only and that care was taken not to expose participants to any risk or burden.

The questionnaire consisted of two parts. The first part was related to the 38 items generated in the prior step. A five-point Likert-type scale was used, where “1” represents “entirely disagree” and “5” represents “entirely agree.” The socio-demographic characteristic information of interviewees was captured in the second part. In addition, there was an additional question about whether respondents have used CLCM before, which is essential for the following data analysis.

In July 2021, 966 questionnaires were received, of which 428 were online and 538 were filled in the offline paper. During the sample cleaning process, We initially removed a total of 153 incomplete or identical data entries. Subsequently, we addressed potential response biases stemming from carelessness or insufficient effort (C/IE). Following a methodology inspired by Merino-Soto et al. [49], we employed Mahalanobis distance (D^2) and identified the longest sequence of equal responses (longstring) to detect instances of C/IE. The longstring method flagged 23 cases, while D^2 pinpointed 37 cases. For the refined “clean” database, responses from these 60 participants were omitted, resulting in a final dataset comprising 753 data entries. The demographic results showed that the gender ratio of participants was 38.2% (female) to 62.8% (male). Considering the no specific age requirement for the respondents in this study, the age range of the respondents was relatively wide ranging from 16 to 90 years old, and 53.1% of the respondents were over 40. Respondents with junior high school education and below accounted for 63.8% of the sample, whereas those with a bachelor’s degree only accounted for 14.5%.

In the subsequent scale verification analysis, the survey data underwent random division into two subsamples, each consisting of an equal volume of data. Subsample A comprises 376 observations, while subsample B includes 377 observations. Specifically, subsample was designated for the EFA, whereas subsample B was allocated for the CFA validation. This division facilitates the use of the second subsample as a retention sample for evaluating the fitness of each item [50].

V. STUDY 1: SCALE DEVELOPMENT

The primary aims of Study 1 were to (1) investigate the validity and reliability of the PMCS by evaluating whether the measurement items are consistent with the expected structure and (2) select the items within each dimension through EFA and IRT to form a short reliable scale.

A. EXPLORATORY FACTOR ANALYSIS

EFA with principal axis factoring (PAF) was conducted to explore the latent factor structure with subsample A. The Kaiser-Meyer-Olkin measure was 0.95, exceeding the recommended cut-off value of 0.6 [51], and Bartlett’s test of sphericity was significant ($\chi^2 = 8572.98$, $p < 0.001$). This result indicates that the relationship between the PMCS items was strong enough to conduct factor analyses, and the EFA is an appropriate method to deal with the data [52]. An exploratory analysis yielded six eigenvalues greater than one. As the ratio of the first to the second eigenvalue is enormous, a solid general factor and five further factors are evident. During parallel analysis, seven eigenvalues of the actual dataset were identified as exceeding their counterparts in the simulated dataset. This result advocates for the retention of seven factors. It is imperative to underscore that, notwithstanding the influence of statistical considerations, the determination of the final number of factors necessitates meticulous contemplation of theoretical and practical implications. Therefore, a solution comprising six factors was derived, considering Kaiser’s criterion, which entails retaining factors with eigenvalues surpassing one, in conjunction with parallel analysis and the overarching criterion of factor interpretability.

For a comprehensive review of the scale and the creation of a more concise scale project, 13 items were removed due to factor load thresholds and commonality below 0.5, aligning with established literature practices [53]. After deleting these items, Cronbach’s alpha coefficients of the PMCS ranged from 0.83 to 0.89, and the total reliability Omega coefficient of the scale was 0.95, demonstrating high internal consistency of obtained scores and reliable results. A final six-factor model was formed, with the remaining 25 items accounting for approximately 61% of the total variance.

B. ITEM RESPONSE THEORY

1) ASSESSING INTERNAL STRUCTURE AND MODEL-DATA FIT Using subsample A, CFA showed an approximate model fit of the six-dimensional model, $\chi^2 = 439.022$, $p < 0.001$, $\chi^2/df = 1.85$, SRMR = 0.035, and all absolute residual correlations were lower than 0.2. The dimensionality and local independence assumptions of IRT were deemed tenable. Additionally, this study focused on the item residuals to assess model-data fit. The absolute value of the residual of the individual item less than 2.5 usually indicated that the model data fit well [54], and all the items of the PMCS met this criterion.

TABLE 2. Exploratory factor analysis of the PMCS.

Dimension	Item	Com	Factor loadings					
			Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
CR	CR1 I think CLCM has a fair point of view.	0.51	0.70	-0.04	-0.08	-0.10	0.13	0.06
	CR2 I think CLCM reports the complete story.	0.52	0.75	-0.10	0.10	0.00	0.00	-0.06
	CR3 I think CLCM reports real news.	0.55	0.74	0.03	0.02	0.03	-0.04	-0.04
	CR4 I think CLCM is professional in terms of content.	0.54	0.69	0.04	-0.01	-0.02	0.06	0.01
	CR5 I think CLCM is credible.	0.54	0.75	0.03	-0.06	0.08	-0.16	0.06
IN	IN1 CLCM helps me to improve my job skills.	0.67	-0.05	0.87	-0.03	-0.02	-0.04	0.05
	IN2 I can learn about agriculture through CLCM.	0.59	-0.07	0.84	-0.06	-0.03	-0.03	0.08
	IN3 CLCM raises my democratic awareness.	0.61	0.01	0.68	0.12	-0.04	0.03	0.01
	IN4 CLCM fills me with positive energy.	0.63	0.10	0.65	0.07	0.01	0.09	-0.05
	IN5 I can get the information I need through CLCM.	0.54	0.06	0.59	0.07	0.02	0.10	-0.06
GU	GU1 I recommend CLCM's channel to others.	0.75	0.03	-0.03	0.88	-0.07	0.04	0.02
	GU2 I share CLCM's content with others.	0.66	0.01	0.07	0.78	0.04	-0.05	-0.03
	GU3 I discuss and evaluate CLCM's content with others.	0.61	-0.06	0.08	0.71	0.06	-0.02	0.03
CO	CO1 I acquaintance the news in the county through CLCM.	0.57	0.04	0.06	0.02	0.72	-0.05	0.01
	CO2 I keep abreast of the latest news through CLCM.	0.69	-0.05	-0.14	-0.03	0.89	0.04	0.04
	CO3 CLCM's channels are very convenient and quick to use.	0.64	0.02	0.07	0.04	0.66	0.11	-0.03
SE	SE1 I get job postings through CLCM.	0.65	0.00	-0.04	0.14	0.04	0.66	0.07
	SE2 I have mastered the functions of all channels of CLCM.	0.65	-0.05	-0.04	-0.03	0.03	0.81	0.08
	SE3 I communicate with others through CLCM's channel.	0.68	-0.04	0.00	-0.05	-0.01	0.88	0.00
	SE4 I think the charges for CLCM are reasonable.	0.58	0.04	0.03	-0.01	-0.03	0.71	0.04
	SE5 CLCM makes my life more convenient.	0.57	0.05	0.16	-0.04	0.06	0.66	-0.10
PO	PO1 I learn about state policy through CLCM.	0.59	0.08	-0.15	0.17	-0.02	0.04	0.69
	PO2 CLCM provides detailed explanations of political issues.	0.62	-0.04	0.04	0.09	-0.01	0.06	0.69
	PO3 I know more publicly government information through CLCM.	0.64	-0.07	0.04	-0.07	0.01	0.06	0.80
	PO4 CLCM makes me more aware of national politics.	0.56	0.09	0.15	-0.13	0.04	-0.09	0.71
Eigenvalues of actual factors		15.14	2.31	2.02	1.65	1.35	1.11	
Eigenvalues of simulated factors		0.77	0.69	0.63	0.58	0.53	0.49	
Cronbach's alpha		0.84	0.88	0.85	0.83	0.89	0.85	
Variance explained		0.11	0.12	0.09	0.07	0.13	0.09	

2) ESTIMATED ITEM PARAMETERS AND DIF

A MGRM [55] was fit to the 376-person estimation subsample A. Discrimination a_i and threshold b_j parameters are the most commonly used parameters in the IRT model. Items with high discrimination values are better indicators of an underlying trait than those with low values [37]. In this study, discrimination parameters of all items ranged from 1.98 (CR1) to 3.52 (CO3), which means items tended to have varying degrees of association with different latent traits. Threshold parameter b_j is defined as the location point on the θ scale at which the probability is 50% that the result will be in some higher category than j [56]. Thresholds are well distributed, with all items having some positive and negative thresholds, but no disordinal or reversal b_j was found, indicating that the items are spread over the continuum of the scales.

This study investigated gender differential item functioning (DIF) for each item in PMCS. The invariance of intercepts (uniform bias) parameters was verified through the likelihood ratio test. This analysis, rooted in the quest for fairness and equity across gender groups, serves to pinpoint potential biases in test items that may disproportionately affect one gender. DIF occurs because of a conditional dependency between group membership of participants (e.g., male versus female) and item performance after controlling for the latent trait [57]. Items exhibiting statistically DIF, indicated by a significant Chi-square statistic with a threshold of 0.05,

TABLE 3. MGRM parameter estimates of the PMCS.

Item	a	Threshold				DIF gender	
		b_1	b_2	b_3	b_4	χ^2	p
CR1	1.98	-3.19	-1.62	-0.09	1.42	0.14	0.71
CR2	2.10	-2.98	-1.54	0.02	1.30	0.80	0.37
CR3	2.31	-2.91	-1.49	-0.12	1.19	0.82	0.36
CR4	2.35	-2.77	-1.46	-0.13	1.01	0.14	0.71
CR5	2.23	-3.09	-1.69	-0.37	0.84	0.34	0.56
IN1	2.59	-2.19	-0.84	0.08	1.32	2.68	0.10
IN2	2.10	-2.11	-1.00	0.09	1.42	0.66	0.42
IN3	2.52	-1.91	-0.98	0.14	1.18	0.00	0.96
IN4	2.95	-2.11	-0.95	0.08	1.08	0.10	0.75
IN5	2.41	-2.11	-1.05	0.28	1.32	0.14	0.71
GU1	3.47	-2.00	-0.89	0.21	1.13	0.23	0.63
GU2	2.90	-1.86	-1.06	0.18	1.26	0.74	0.39
GU3	2.62	-1.86	-1.00	0.12	1.24	0.02	0.89
CO1	2.23	-2.31	-1.03	0.14	1.27	0.51	0.47
CO2	2.48	-2.39	-1.03	0.16	1.33	0.01	0.93
CO3	3.52	-2.05	-0.76	0.34	1.28	2.45	0.12
SE1	2.94	-1.67	-0.74	0.31	1.28	0.39	0.53
SE2	2.80	-1.76	-0.72	0.34	1.32	0.06	0.81
SE3	2.76	-1.70	-0.68	0.28	1.21	1.37	0.24
SE4	2.42	-1.99	-0.83	0.29	1.41	2.44	0.12
SE5	2.38	-1.57	-0.57	0.52	1.51	5.53	0.02
PO1	2.51	-2.55	-1.41	0.06	1.15	0.53	0.47
PO2	2.94	-2.30	-1.13	0.14	1.21	1.73	0.19
PO3	2.53	-2.27	-1.34	-0.16	0.92	1.35	0.25
PO4	2.06	-2.46	-1.46	-0.31	0.77	1.717	0.19

were duly identified and reported. The results indicated that in different groups only item SE5 showed significant DIF. After deleting item SE5, the final abbreviated 24-item scale was formed, which conformed to the initial design of the scale.

C. CONCLUSIONS OF STUDY 1

The results from Study 1 indicated that the items used in this study to measure perceived media convergence can be identified as six dimensions: communication, influence, guiding, credibility, political propaganda, and service power. Furthermore, a total of 14 items were deleted from EFA and MGRM analysis to obtain a streamlined scale with an acceptable fit. Therefore, based on a literature review, expert judging, and exploratory study, the first-phase results provide a preliminary reliable, valid, 24-item scale as a basis for the follow-up analysis.

VI. STUDY 2: SCALE VALIDATION

The objective of Study 2 was to investigate whether the findings from Study 1 would generalize to a new sample (subsample B) and verify the reliability and validity of the scale.

A. CONFIRMATORY FACTOR ANALYSIS

1) THE FIRST-ORDER CFA

The results of the CFA with subsample B ($N = 377$) confirmed the results from Study 1. The goodness of fit for the six-factor model was primarily evaluated using the rotated component matrix from EFA as an input with the maximum likelihood solution. A measurement model was built, and frequently used goodness of fit indices were examined. Construct reliability of the developed scale was evaluated using Cronbach's alpha and composite reliability (CR). CR reflects the internal consistency between all the items measuring that specific construct. All the values of CR and Cronbach's alpha were above the common threshold of 0.70, indicating good internal consistency and reliability.

The chi-square test results indicated a poor model fit, with a large chi-square statistic ($\chi^2 = 432.156$, $df = 237$, $p < 0.001$). For large samples, the chi square test of model fit may erroneously reject a valid model. Thus, the χ^2/df ratio was recommended to sufficiently evaluate model fit and values ($\chi^2/df = 1.82$) less than three suggested a moderate model fit [58]. Various commonly employed goodness-of-fit indices, such as Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), and Incremental Fit Index (IFI), were assessed to validate the scale structure. Generally, it is recommended that CFI, GFI, TLI, and IFI exceeding 0.90, along with an RMSEA below 0.08, indicate an acceptable fit. As a result of CFA, most indicators were higher than 0.95 (CFI = 0.961 \geq 0.95, GFI = 0.914 \geq 0.9, TLI = 0.955 \geq 0.95, IFI = 0.961 \geq 0.95), and RMSEA was less than 0.05 (RMSEA = 0.047 \leq 0.05), indicating that the model was found to be a good fit with the observed data. A quantifiable way to describe convergent validity is to consider each scale item as a different method of measuring structure and determine whether all items converge. Therefore, the item factor loadings were examined, and all the standardized loadings were above 0.6 (Figure. 2).

Moreover, AVE is considered a consistent measure to evaluate convergent validity. As suggested by [59], the AVE value of all six factors exceeded the cut-off value of 0.5, and the CR was greater than AVE. The normed fit index (NFI=0.918 \geq 0.9) also indicated the good convergent validity of the scale [60].

2) THE SECOND-ORDER CFA

The PMCS scores are assumed to be fully represented by a hierarchical factorial structure to test the construct validity of the measuring instrument. The first-order six factors could be greatly explained by a single broader dimension of perceived media convergence. Moreover, the first-order CFA results showed that in addition to the credibility dimension, other dimensions had a high degree of correlation. For these reasons, the second-order factor analysis was performed to examine whether all the factors fitted the general concept of "perceived media convergence."

All goodness-of-fit statistics of the second-order six factors model were acceptable with the following values: $\chi^2/df = 1.85$, CFI = 0.959 \geq 0.9, GFI = 0.910 \geq 0.9, RMSEA = 0.048 \leq 0.05, TLI = 0.953 \geq 0.9, IFI = 0.958 \geq 0.9. Although this solution did not improve the first-order model fit, the appropriateness of the hierarchical structure of the model, with a single second-order factor and six first-order factors, was assessed based on the factor loadings. The magnitude of factor loadings showed that the first-order factors loaded significantly on the second-order factor, and the standardized factor loadings were greater than 0.6 for all the items (Figure. 3). Moreover, service and political propaganda were the dimensions most similar to the second-order factor. By contrast, credibility had the weakest relationship with the perceived media convergence factor. Thus, the PMCS is established as a second-order factor that is determined by the six first-order factors.

3) THE BI-FACTOR MODEL

The examination of a bi-factor model aimed to determine whether the integration of general and specific factors, totaling six in number, offered a more succinct and accurate portrayal when contrasted with alternative models. This approach facilitated a simultaneous investigation into the influence of both general and specific factors on the formation of indicator variance while evaluating the structural plausibility of the model. Specifically, the bi-factor model comprised 24 items loading onto their respective factors. Additionally, it incorporated the general factor of the PMCS, which maintained orthogonality to the specific factors. The comparative analysis involving first-order CFA, second-order CFA, and the bi-factor model served to establish the appropriateness of the multifactor solution for the PMCS.

The bi-factor model demonstrates a better fit compared to the six correlated factors model (Figure. 4). The values of fitness indices in the bi-factor were as follows: $\chi^2/df = 1.81$, CFI = 0.963 \geq 0.9, GFI = 0.916 \geq 0.9,

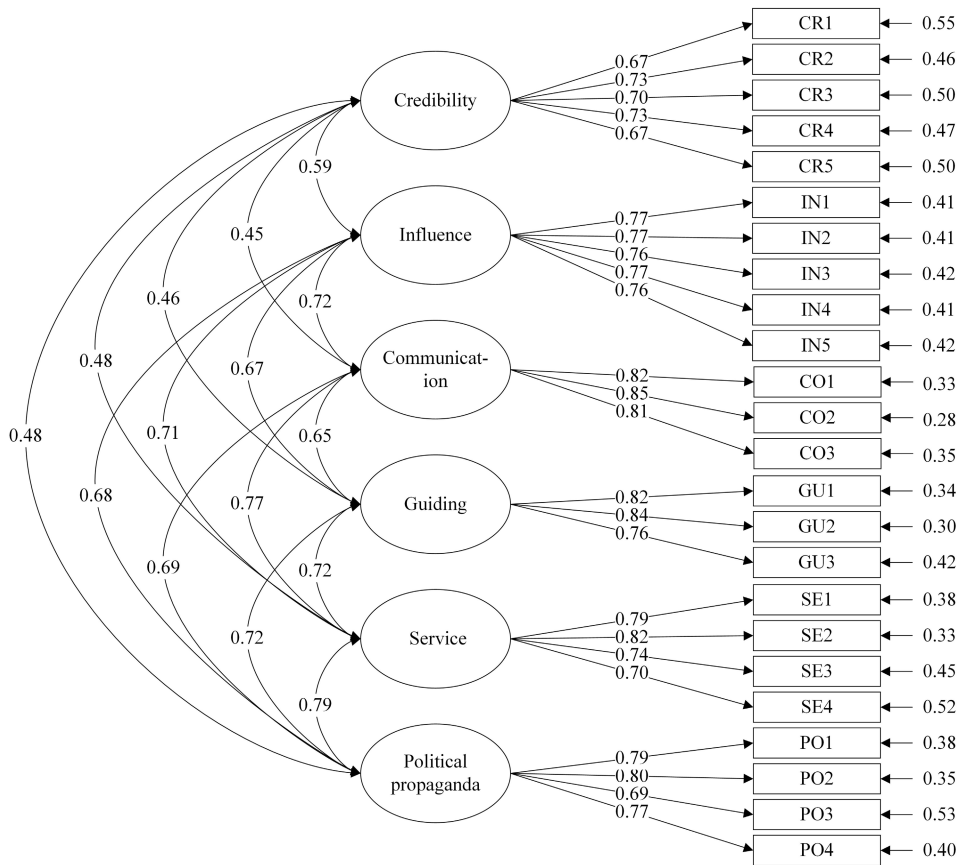


FIGURE 2. The first-order CFA model.

RMSEA = 0.046 ≤ 0.05, TLI = 0.955 ≥ 0.9, IFI = 0.963 ≥ 0.9, NFI=0.922 ≥ 0.9. The findings affirm the rationale for incorporating general factors in the PMCS. The ω coefficient for the PMCS, standing at 0.96, signifies that six factors collectively elucidate 96% of the variance in the total PMCS score. This study also explores the model’s Percent of Uncontaminated Correlations (PUC), Explained Common Variance (ECV), Proportional Reduction in Mean Squared Error (PRMSE), and Average Relative Parameter Bias (ARPB). The results show PUC=0.610, ECV=0.950, PRMSE=0.998, ARPB=0.039. Although the PUC index is slightly low, the combination of these indicators suggests that the bi-factor model has a good fit. The general factor is highly effective in explaining common variance, and there is a good distinction between specific factors and general factors. Within the bi-factor model, each item is loaded onto both a general factor and its respective specific factor, providing a rationale for the dimensional structure of the PMCS scale.

After our analysis, all three models demonstrate a favorable goodness of fit. To pinpoint the most suitable model for future comprehensive scoring studies of the PMCS scale, this study compared the AIC and BIC of these models. Although the AIC values among the models show little variance, the BIC, which accounts for model complexity’s impact on goodness of fit, became the deciding factor in our model selection process. Notably, the second-order CFA model

emerged with the lowest BIC value among all candidate models, aligning with our expectations for the scale structure. Consequently, after careful consideration, the second-order CFA model was chosen for practical applications and research.

B. ITEM RESPONSE THEORY

The final scale with 24 items met most of the requirements of the MGRM. All items fit the model and exhibited suitable discriminations within the observation trait range. However, some small measurement issues in the scale had not been identified in the first stage of Study 1. CR3, CR4 and CR5 showed a high difficulty parameter, which slightly exceeded the usual value range of -3 to 3. The issues could be because of the differences in the individual characteristics of the sample. DIF analysis revealed that among gender categories, only SE4 exhibited noteworthy variations in participants’ responses to the test questions.

C. FURTHER VALIDATION OF ALL SAMPLES

All samples were obtained simultaneously through a questionnaire survey, and subsamples A and B were randomly divided among all samples. Hence, various randomly divided subsets might create different model results, and unbalanced sample allocation may also lead to changes in the structure and items of the scale. Therefore, this article retested the full

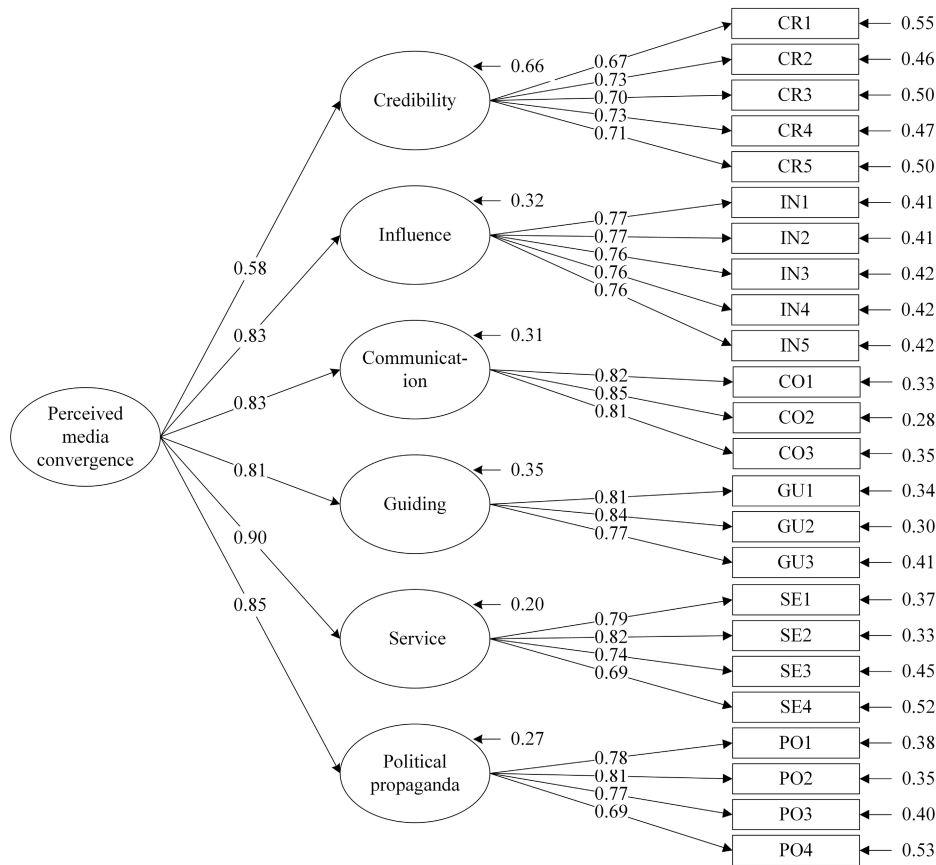


FIGURE 3. The second-order CFA model.

TABLE 4. MGRM results of the final scale.

Dimension	Item fit	Item parameters		DIF gender
		a_i	b_i	
CR	All OK	All OK	CR3&CR4&CR5	NO
IN	All OK	All OK	All OK	NO
GU	All OK	All OK	All OK	NO
CO	All OK	All OK	All OK	NO
SE	All OK	All OK	All OK	SE4
PO	All OK	All OK	All OK	NO

sample to verify the rationality of the scale structure obtained above.

The results of the CFA confirmed the results from Studies 1 and 2. All goodness-of-fit indicators of the full sample exceed the required thresholds and were better than those of subsample B. Moreover, discriminant validity was checked by comparing the square root of the AVE and the inter-correlation of each construct. The results indicated good discriminant validity between the factors (Table 5).

The MGRM analyses yielded an item-person map by dimension. The output of the item-person map provided a visual estimate of the latent trait, item difficulty, and each dimension in the sample, which presented the location of respondents and items on the same scale (Figure. 5). Items were ranked in the right-hand column by difficulty, with the first two digits indicating the number of items and the

digit after the decimal point representing the number of four threshold parameters of each item. Each dimension had its column with estimates of the respondents' abilities. Items were well dispersed around the mean, and the item difficulties appeared to be well matched to levels of the latent trait. Furthermore, based on the means of the dimensions ranging from -0.019 to 0.005 , all dimensions did a good job of representing all levels of these types of motivation [61].

In addition, for the results of the MGRM based on all samples, this study also focused on empirical reliability and measurement precision. The empirical reliabilities for the six dimensions ranged from 0.82 to 0.87 . Measurement precision is generally considered to depend on the expected a posteriori (EAP) score and is most useful when it is consistent across the trait continuum. According to [41], the measurement error might not depend on EAP scores, and this study found the same result. Figure. 6 shows that the amount of measurement error did not strongly depend on EAP scores for the center of the distribution between -2 and 2 for all dimensions. However, for the communication, guiding, and service dimensions, the measurement error distributions of the samples were scattered when the EAP scores were less than -2 . This result indicates that the accuracy level of these dimensions was not stable enough for respondents with low scores. In other words, these scales could work greatly for respondents with high scores. Furthermore, the

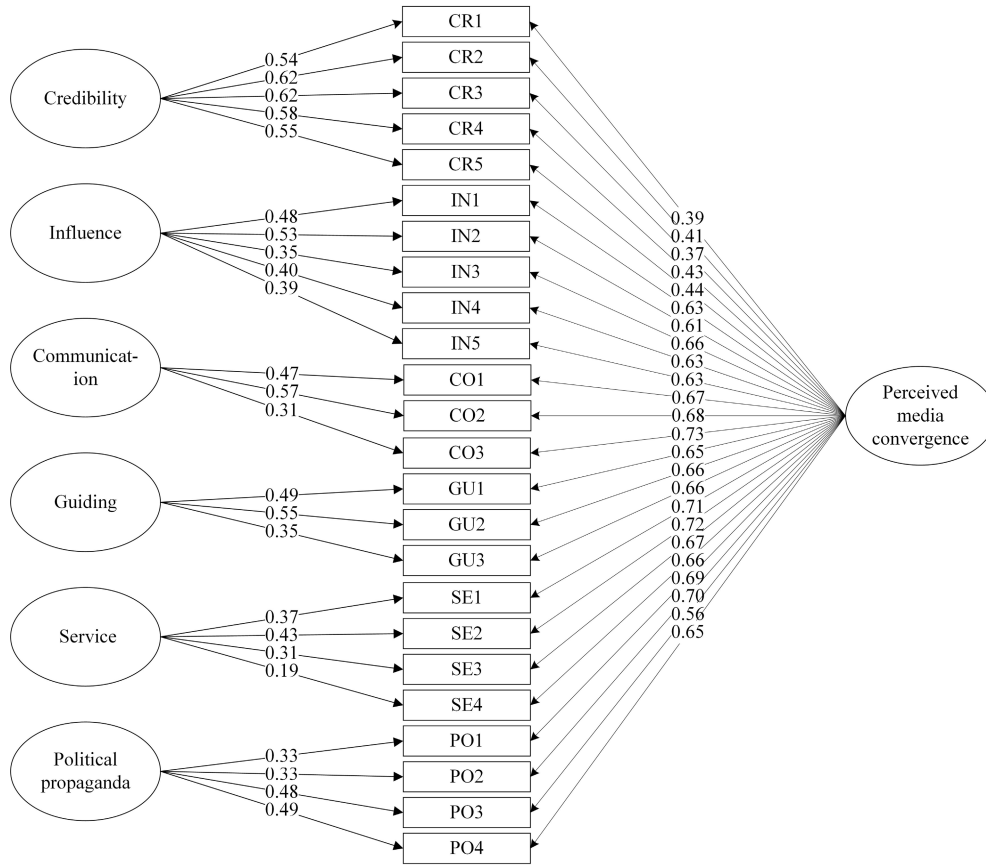


FIGURE 4. The bi-factor model.

TABLE 5. Reliability & validity.

Construct	AVE	Omega	Composite Reliability	CR	IN	GU	CO	SE	PO
CR	0.514	0.841	0.841	0.717					
IN	0.589	0.877	0.877	0.579	0.767				
GU	0.674	0.861	0.861	0.466	0.721	0.821			
CO	0.632	0.838	0.838	0.448	0.636	0.682	0.795		
SE	0.610	0.862	0.862	0.455	0.713	0.732	0.720	0.781	
PO	0.581	0.847	0.847	0.505	0.646	0.622	0.609	0.747	0.762

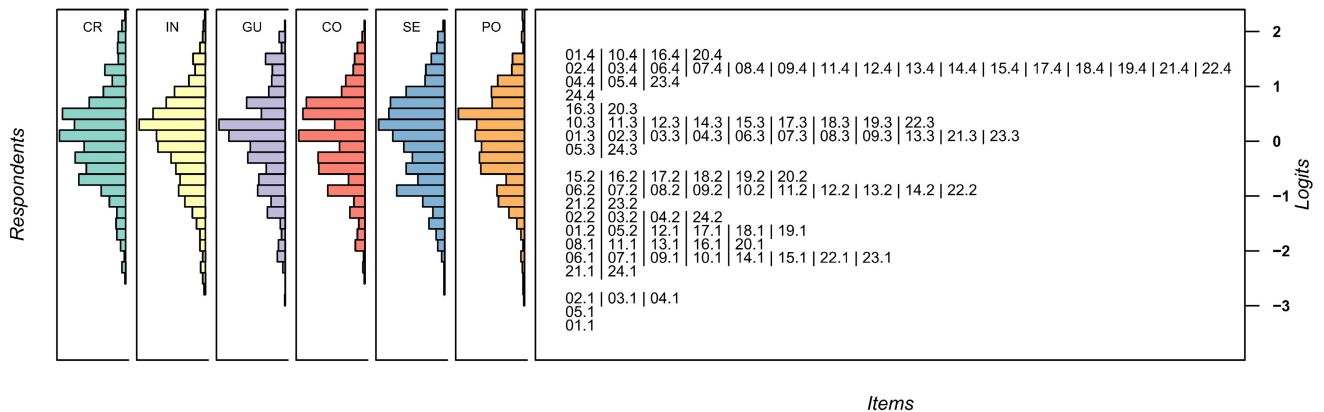


FIGURE 5. The item-person map.

communication and credibility dimensions tended to have a slightly large wide variability in standard errors across

the EAP score continuum. This result implies that although these two dimensions have acceptable levels of credibility and

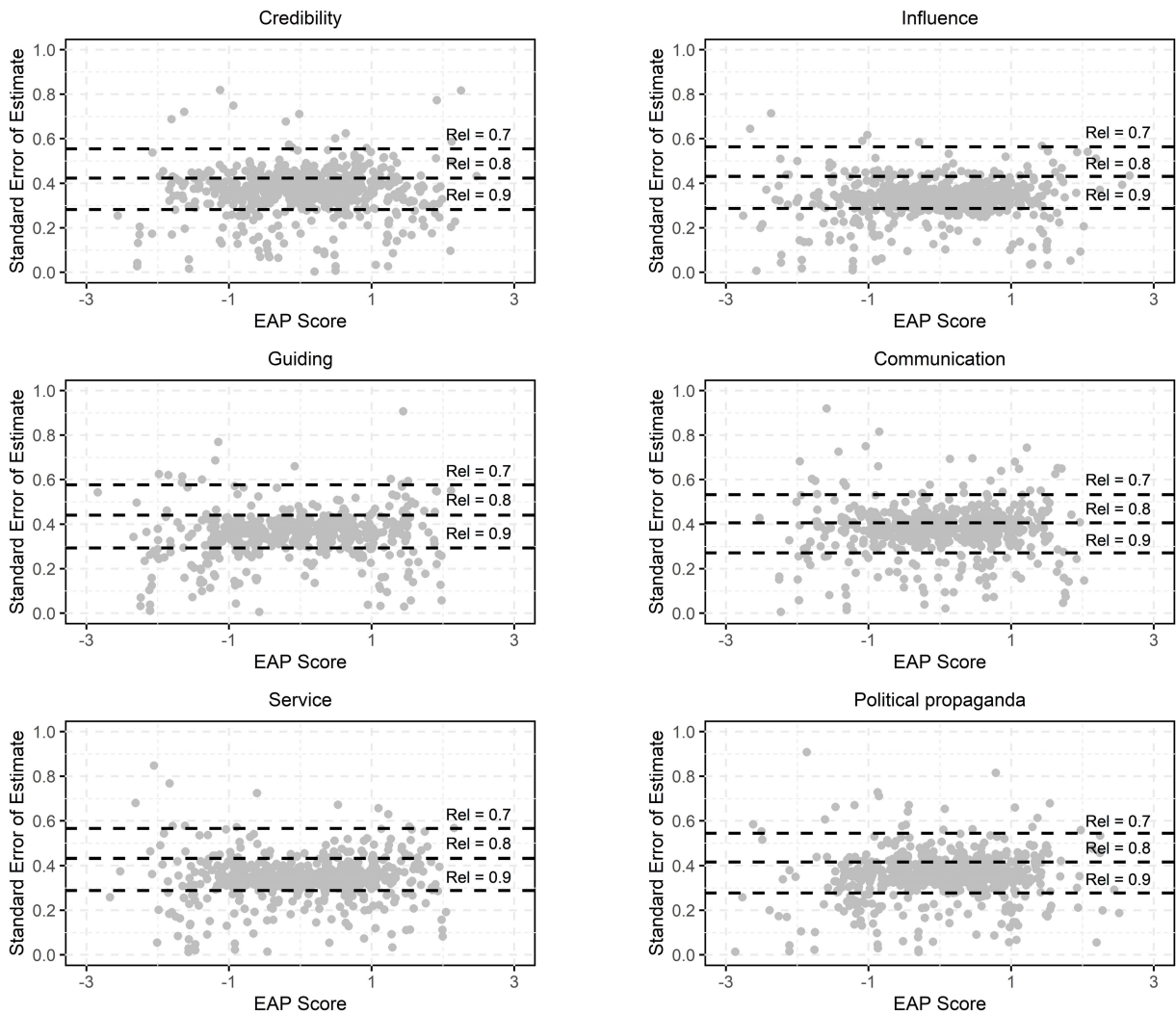


FIGURE 6. Standard error of estimates with estimated expected a posteriori scores (Rel = marginal reliability for selected levels).

measurement precision, individual scores may be more or less precise.

D. CONCLUSIONS OF STUDY 2

The results from Study 2 suggest that PMCS is a valid and reliable multidimensional measure of presence. The first-order CFA demonstrates robust reliability and validity for PMCS, as evidenced across different subsamples used for model measurement. The second-order CFA reveals that the perceived media convergence factor is comprehensively accounted for by the six dimensions outlined in the proposed scale. This finding substantiates the generalizability of the outcomes observed in Study 1. Furthermore, the bi-factor model furnishes evidence supporting the notion that each item within the reduced scale adeptly captures the essence of perceived media convergence. Additionally, the MGRM analysis contributes valuable insights into the quality of items within each scale, with each subdimension in PMCS exhibiting an acceptable overall fit. Of course, the subdimensions

have some acceptable minor problems, such as the difficulty parameters of CR1 in the credibility dimension slightly exceeding the threshold. In addition, the analysis results of all samples now further verify the rationality of PMCS. These results also provide information on the measurement precision of each dimension of the scale at a specific point. Although the measurement accuracy level of some dimensions is not stable enough, the overall measurement error concentration shows that the measurement accuracy is acceptable.

VII. DISCUSSION AND CONCLUSION

This year marks the 10th year of media convergence as a national strategy in China. Although diversified communication channels have brought a vast audience, settling the audience is a significant challenge for the media. Moreover, as media convergence is a rapidly and dynamically evolving phenomenon, and everyone is exposed to converged media to a greater or lesser extent, timely measurement of the audience’s perception of media convergence is essential for

the future development direction and to reflect the latest development in the media field. Therefore, this study aims to develop measurement tools for perceived media convergence to provide practical bottom-up responses to perception from the audience's perspective. This study focuses on China's functional positioning of converged media, adds two new dimensions of political propaganda and service to the four powers, and improves the item pool of perceived media convergence by combining theoretical research and personal interviews.

The scale developed in this study passed strict normative validation. In Study 1, we utilized EFA and MGRM to examine subsample A, aiming to assess the hypothesized structure of PMCS and streamline its items. The results not only confirmed the anticipated scale structure comprising six dimensions but also led to the removal of 14 redundant items. Subsequently, Study 2 focused on validating the 24 items identified in Study 1, affirming PMCS as a valid and reliable measure of multidimensional presence. The second-order CFA provided robust support, indicating that perceived media convergence could logically be explained by the six first-order factors, solidifying the structural integrity of PMCS. Moreover, the bi-factor model in Study 2 reaffirmed the foundational structure of PMCS, demonstrating that each item effectively contributes to elucidating the overarching concept of perceived media convergence. In addition, the service and political propaganda dimensions were highly correlated with the perceived media convergence factor, which echoes the underlying logic of "news, politics, and service" in constructing China's converged media. With the public's demand for media participation in public services rising dramatically, mainstream media can expand the scope of their service business while converging new media so that the media can serve the public extensively [62]. For the political propaganda dimension, the propaganda of politics by state-owned mainstream media can increase citizens' understanding and support of the political system [63], directly affecting the public's perception of media convergence. Moreover, all the samples were used for further verification, measurement errors were analyzed, and all the results were satisfactory, which is one of the highlights of our study.

This study provides a scientific multidimensional measurement tool for the study of audience perception of media convergence, which enriches the research in the field of media convergence. The item pool constructed under factor analysis and IRT dramatically improves the measurement accuracy, reduces the redundant item, and has solid functional scalability. Each item reflects the audience's response to a particular dimension. Thus, the developed scale enhances the understanding of individuals' cognitive and emotional responses to media convergence.

Therefore, based on the total score of the PMCS scale, researchers can gain a comprehensive and profound understanding of how audiences perceive media convergence from an individual perspective. The scale of the study can help to

identify groups that perceive media convergence to be more and less effective so that targeted communication strategies can be carried out with them to realize the multiple visions of media convergence. For rural residents, in particular, the spread of mobile phones and the Internet has changed how they receive information. Contrary to the findings of Williams and Tkach [64], field surveys have found that many rural youths and older people prefer short-video platforms, such as Douyin and Kuaishou, which make their public opinion and ideology seriously affected by new media. Therefore, whether converged media can better guide and serve the public can be studied comprehensively and realistically by measuring the audience's perception of the effectiveness of media convergence. This case, in turn, interests policymakers and media practitioners, who can quickly adjust their policies and efforts based on the perception of media convergence.

VIII. LIMITATIONS AND FUTURE RESEARCH

This study has several limitations that should be mentioned. First, this study is a PMCS developed and validated in a Chinese cultural context, which may limit the generalizability of the findings. Therefore, cross-cultural applicability requires continued research. Second, in the actual survey, as some residents cannot communicate in Mandarin. The enquirer needs to express the questions in a specific dialect to increase the respondents' understanding, which may also lead to some bias in the sample data. Thirdly, despite the preliminary exploration of individual response bias, a comprehensive understanding of the specific reasons behind the inappropriate scores of certain respondents, suspected to be invalid due to their inconsistency with the measurement model, has not yet been achieved. This limitation is attributed to the constraints of the current data and the research design's scope. To address this, future research endeavors should expand data collection and consider the implementation of diverse measurement models to elucidate the causes of the discrepancy in scores among respondents and enable a more rigorous evaluation of their validity. Finally, future research can combine the scale with other observed behavioral data for correlation analysis or causal inference to enhance the scale's usefulness and increase the reader's understanding of media convergence. We are open to suggestions for replicating this study with more robust analysis in the future, and we believe that such replication work can contribute to a more comprehensive understanding of the model and its applicability in this field.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

AUTHOR CONTRIBUTIONS

Yuanyuan Wang: Conceptualization, methodology, validation, investigation, resources, data curation, formal analysis, writing—original draft, and writing—review and editing. Xiawei Tan: Formal analysis, investigation, data curation,

and writing—review and editing. Zhineng Hu: Conceptualization, methodology, supervision, and writing—review and editing. Linling Zhong: Data curation and formal analysis.

ACKNOWLEDGMENT

The authors thank those who provided constructive comments and feedback to help improve this article. They also thank the members who participated in the field survey and the logistical support staff.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

- [1] *Global Digital Population as of July 2022*, Statista, Hamburg, Germany, 2022.
- [2] X. Li, X. Gong, and R. Mou, "Pioneering the media convergence: Lifestyle media production in the digital age in China," *J. Media Bus. Stud.*, vol. 18, no. 4, pp. 304–320, Oct. 2021.
- [3] D. Domingo, "Four dimensions of journalistic convergence: A preliminary approach to current media trends at Spain," in *Proc. 8th Int. Symp. Online Journalism*, Austin, TX, USA, 2007, pp. 1–18.
- [4] C. S. Saba and O. O. David, "Convergence patterns in global ICT: Fresh insights from a club clustering algorithm," *Telecommun. Policy*, vol. 44, no. 10, Nov. 2020, Art. no. 102010.
- [5] S. Sparviero, C. Peil, and G. Balbi, *Media Convergence and Deconvergence*. Berlin, Germany: Springer, 2017.
- [6] E. Y. Liu and J. H. C. Leung, "Corpus insights into the harmonization of commercial media in China: News coverage of migrant worker issues as a case study," *Discourse, Context Media*, vol. 41, Jun. 2021, Art. no. 100482.
- [7] L.-G. Yin and X.-Y. Liu, "A gesture of compliance: Media convergence in China," *Media, Culture Soc.*, vol. 36, no. 5, pp. 561–577, 2014.
- [8] J. Guo, J. Mast, R. Vosters, W. Yang, and A. Penso, "Convergence or divergence? A computer-assisted analysis of how Chinese state-sponsored and market-oriented newspapers discursively construct the newsworthiness of the Kunming terrorist attack," *Discourse, Context Media*, vol. 45, Mar. 2022, Art. no. 100578.
- [9] L. Gui, "Media framing of fighting COVID-19 in China," *Sociol. Health Illness*, vol. 43, no. 4, pp. 966–970, May 2021.
- [10] H. Xiong and J. Zhang, "How local journalists interpret and evaluate media convergence: An empirical study of journalists from four press groups in Fujian," *Int. Commun. Gazette*, vol. 80, no. 1, pp. 87–115, Jan. 2018.
- [11] G. A. Churchill, "A paradigm for developing better measures of marketing constructs," *J. Marketing Res.*, vol. 16, no. 1, pp. 64–73, Feb. 1979.
- [12] J. A. García-Avilés, A. Kaltenbrunner, and K. Meier, "Media convergence revisited," *Journalism Pract.*, vol. 8, no. 5, pp. 573–584, 2014.
- [13] I. Pool, *Technologies of Freedom*. MA, USA: Harvard Univ. Press, 1983.
- [14] H. Jenkins, "The cultural logic of media convergence," *Int. J. Cultural Stud.*, vol. 7, no. 1, pp. 33–43, Mar. 2004.
- [15] G. Lawson-Borders, "Integrating new media and old media: Seven observations of convergence as a strategy for best practices in media organizations," *Int. J. Media Manage.*, vol. 5, no. 2, pp. 91–99, Jan. 2003.
- [16] R. Gordon, "Implications of convergence," in *Digital Journalism: Emerging Media and the Changing Horizons of Journalism*, vol. 57, K. Kawamoto, Ed. Washington, DC, USA: Rowman & Littlefield, 2003.
- [17] M. B. von Rimscha, M. Verhoeven, I. Krebs, C. Sommer, and G. Siegert, "Patterns of successful media production," *Convergence, Int. J. Res. into New Media Technol.*, vol. 24, no. 3, pp. 251–268, Jun. 2018.
- [18] L. Dailey, L. Demo, and M. Spillman, "The convergence continuum: A model for studying collaboration between media newsrooms," *Atlantic J. Commun.*, vol. 13, no. 3, pp. 150–168, Aug. 2005.
- [19] A. Shehata and J. Strömbäck, "Not (yet) a new era of minimal effects: A study of agenda setting at the aggregate and individual levels," *Int. J. Press/Politics*, vol. 18, no. 2, pp. 234–255, Apr. 2013.
- [20] W. J. Potter and K. Riddle, "A content analysis of the media effects literature," *Journalism Mass Commun. Quart.*, vol. 84, no. 1, pp. 90–104, Mar. 2007.
- [21] S. J. Ball-Rokeach and M. L. DeFleur, "A dependency model of mass-media effects," *Commun. Res.*, vol. 3, no. 1, pp. 3–21, Jan. 1976.
- [22] R. Karasneh, S. Al-Azzam, S. Muflih, O. Soudah, S. Hawamdeh, and Y. Khader, "Media's effect on shaping knowledge, awareness risk perceptions and communication practices of pandemic COVID-19 among pharmacists," *Res. Social Administ. Pharmacy*, vol. 17, no. 1, pp. 1897–1902, Jan. 2021.
- [23] M. Näsi, M. Tanskanen, J. Kivivuori, P. Haara, and E. Reunanen, "Crime news consumption and fear of violence: The role of traditional media, social media, and alternative information sources," *Crime Delinquency*, vol. 67, no. 4, pp. 574–600, May 2021.
- [24] J. Kleijnijenhuis, A. M. J. van Hoof, and W. van Atteveldt, "The combined effects of mass media and social media on political perceptions and preferences," *J. Commun.*, vol. 69, no. 6, pp. 650–673, Dec. 2019.
- [25] M. Scopelliti, M. G. Pacilli, and A. Aquino, "TV news and COVID-19: Media influence on healthy behavior in public spaces," *Int. J. Environ. Res. Public Health*, vol. 18, no. 4, p. 1879, Feb. 2021.
- [26] L. Su and X. Li, "Perceived agenda-setting effect in international context: Impact of media coverage on American audience's perception of China," *Int. Commun. Gazette*, vol. 83, no. 7, pp. 708–729, Nov. 2021.
- [27] Z.-F. Sheng, "Construction of the driving force of development on news and public opinion," (In Chinese), *Mod. Commun.*, vol. 306, no. 1, pp. 9–18, 2022.
- [28] X. Luo and Y.-T. Cai, "Model construction of county-level converged media innovation in grassroots social governance," (In Chinese), *News Writing*, vol. 37, no. 3, pp. 48–55, 2020.
- [29] A. Banerjee, R. Hanna, J. Kyle, B. A. Olken, and S. Sumarto, "Tangible information and citizen empowerment: Identification cards and food subsidy programs in Indonesia," *J. Political Economy*, vol. 126, no. 2, pp. 451–491, Apr. 2018.
- [30] L. R. Fabrigar and D. T. Wegener, *Exploratory Factor Analysis*. London, U.K.: Oxford Univ. Press, 2011.
- [31] S. Bürgler, K. Kleinke, and M. Hennecke, "The metacognition in self-control scale (MISCS)," *Personality Individual Differences*, vol. 199, Dec. 2022, Art. no. 111841.
- [32] W. R. Zwick and W. F. Velicer, "Comparison of five rules for determining the number of components to retain," *Psychol. Bull.*, vol. 99, no. 3, pp. 432–442, 1986.
- [33] B. Muzaffar, "The development and validation of a scale to measure training culture: The TC scale," *J. Culture, Soc. Develop.*, vol. 23, pp. 49–58, 2016.
- [34] J. Y. J. Choe and S. S. Kim, "Development and validation of a multidimensional tourist's local food consumption value (TLFCV) scale," *Int. J. Hospitality Manage.*, vol. 77, pp. 245–259, Jan. 2019.
- [35] K. Tanwar and A. Prasad, "Employer brand scale development and validation: A second-order factor approach," *Personnel Rev.*, vol. 46, no. 2, pp. 389–409, Mar. 2017.
- [36] G. Petruzzello, R. Chiesa, D. Guglielmi, B. I. J. M. van der Heijden, J. P. de Jong, and M. G. Mariani, "The development and validation of a multi-dimensional job interview self-efficacy scale," *Personality Individual Differences*, vol. 184, Jan. 2022, Art. no. 111221.
- [37] R. J. De Ayala, *The Theory and Practice of Item Response Theory*. New York, NY, USA: Guilford Press, 2013.
- [38] F. Samejima, "Estimation of latent ability using a response pattern of graded scores," *Psychometrika*, vol. 34, no. S1, pp. 1–97, Mar. 1969.
- [39] L. Yao and R. D. Schwarz, "A multidimensional partial credit model with associated item and test statistics: An application to mixed-format tests," *Appl. Psychol. Meas.*, vol. 30, no. 6, pp. 469–492, Nov. 2006.
- [40] R. J. Adams, M. Wilson, and W.-C. Wang, "The multidimensional random coefficients multinomial logit model," *Appl. Psychol. Meas.*, vol. 21, no. 1, pp. 1–23, Mar. 1997.
- [41] M. D. Toland, P. Bowen, and D. M. Dueber, "Multidimensional item response theory analysis of work-related, after-hours contact, and psychosocial measurement scales for construction professionals," *J. Construct. Eng. Manage.*, vol. 146, no. 7, Jul. 2020, Art. no. 04020062.
- [42] J. R. Rossiter, "The C-OAR-SE procedure for scale development in marketing," *Int. J. Res. Marketing*, vol. 19, no. 4, pp. 305–335, Dec. 2002.
- [43] R. F. DeVellis and C. T. Thorpe, *Scale Development: Theory and Applications*. Newbury Park, CA, USA: Sage, 2021.
- [44] T. Yuan, Z. Honglei, X. Xiao, W. Ge, and C. Xianting, "Measuring perceived risk in sharing economy: A classical test theory and item response theory approach," *Int. J. Hospitality Manage.*, vol. 96, Jul. 2021, Art. no. 102980.

- [45] G. O. Boateng, T. B. Neilands, E. A. Frongillo, H. R. Melgar-Quiñonez, and S. L. Young, "Best practices for developing and validating scales for health, social, and behavioral research: A primer," *Frontiers Public Health*, vol. 6, p. 149, Jun. 2018.
- [46] H.-L. Zhang and L. Tian, "An empirical study on the evaluation of the effect of traditional media convergence," (In Chinese), *Publishing J.*, vol. 28, no. 4, pp. 62–74, 2020.
- [47] F. F. R. Morgado, J. F. F. Meireles, C. M. Neves, A. C. S. Amaral, and M. E. C. Ferreira, "Scale development: Ten main limitations and recommendations to improve future research practices," *Psicologia, Reflexão e Crítica*, vol. 30, no. 1, p. 3, Jan. 2018.
- [48] D. F. Polit, C. T. Beck, and S. V. Owen, "Is the CVI an acceptable indicator of content validity? Appraisal and recommendations," *Res. Nursing Health*, vol. 30, no. 4, pp. 459–467, Aug. 2007.
- [49] C. Merino-Soto, M. Martí-Vilar, and L. Serrano-Pastor, "Careless responses and construct validity of Wong-Law Emotional Intelligence Scale," *Psych J.*, vol. 10, no. 6, pp. 944–946, 2021.
- [50] N. Kiratli, F. Rozemeijer, T. Hilken, K. de Ruyter, and A. de Jong, "Climate setting in sourcing teams: Developing a measurement scale for team creativity climate," *J. Purchasing Supply Manage.*, vol. 22, no. 3, pp. 196–204, Sep. 2016.
- [51] H. F. Kaiser, "An index of factorial simplicity," *Psychometrika*, vol. 39, no. 1, pp. 31–36, Mar. 1974.
- [52] A. Field, *Discovering Statistics Using IBM SPSS Statistics*. Newbury Park, CA, USA: Sage, 2013.
- [53] M. Yadav and Z. Rahman, "Measuring consumer perception of social media marketing activities in e-commerce industry: Scale development & validation," *Telematics Informat.*, vol. 34, no. 7, pp. 1294–1307, Nov. 2017.
- [54] J. F. Pallant and A. Tennant, "An introduction to the Rasch measurement model: An example using the hospital anxiety and depression scale (HADS)," *Brit. J. Clin. Psychol.*, vol. 46, no. 1, pp. 1–18, Mar. 2007.
- [55] S. Stark, O. S. Chernyshenko, and F. Drasgow, "An IRT approach to constructing and scoring pairwise preference items involving stimuli on different dimensions: The multi-unidimensional pairwise-preference model," *Appl. Psychol. Meas.*, vol. 29, no. 3, pp. 184–203, May 2005.
- [56] S. P. Reise, K. F. Widaman, and R. H. Pugh, "Confirmatory factor analysis and item response theory: Two approaches for exploring measurement invariance," *Psychol. Bull.*, vol. 114, no. 3, pp. 552–566, 1993.
- [57] G. Makransky, L. Lilleholt, and A. Aaby, "Development and validation of the multimodal presence scale for virtual reality environments: A confirmatory factor analysis and item response theory approach," *Comput. Hum. Behav.*, vol. 72, pp. 276–285, Jul. 2017.
- [58] R. B. Kline, *Principles and Practice of Structural Equation Modeling*. New York, NY, USA: Guilford Press, 2023.
- [59] J. F. Hair, W. C. Black, B. J. Babin, R. E. Anderson, and R. L. Tatham, *Multivariate Data Analysis*. Upper Saddle River, NJ, USA: Prentice-Hall, 2006.
- [60] P. M. Bentler and D. G. Bonett, "Significance tests and goodness of fit in the analysis of covariance structures," *Psychol. Bull.*, vol. 88, no. 3, pp. 588–606, 1980.
- [61] P. Osteen, "An introduction to using multidimensional item response theory to assess latent factor structures," *J. Soc. Social Work Res.*, vol. 1, no. 2, pp. 66–82, Jan. 2010.
- [62] D. Agostino, M. Arnaboldi, and M. D. Lema, "New development: COVID-19 as an accelerator of digital transformation in public service delivery," *Public Money Manage.*, vol. 41, no. 1, pp. 69–72, Jan. 2021.
- [63] X. Wang and T. Kobayashi, "Nationalism and political system justification in China: Differential effects of traditional and new media," *Chin. J. Commun.*, vol. 14, no. 2, pp. 139–156, Apr. 2021.
- [64] A. Williams and B. K. Tkach, "Access and dissemination of information and emerging media convergence in the Democratic Republic of Congo," *Inf., Commun. Soc.*, vol. 25, no. 10, pp. 1383–1399, Jul. 2022.



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