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Adaptation and Validation of Responsible Innovation Practices Scale for Innovativeness and Competitiveness of Pharmaceutical Companies in Pakistan

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Abstract

The primary goal of this study was to examine the factor structure and psychometric properties of the adapted 5-Dimensional Responsible Innovation Practices Scale (5DRIPS) with identical measures and related outcomes, such as organizational innovativeness and comp etitiveness. This scale is designed to measure the responsible innovation practices of organizations aiming to achieve greater societal good in close consultation with the stakeholders. A group of academicians and industry experts established the face and content validity of the 5DRIPS. In a two-wave field survey, data were obtained from a randomized sample of 297 pharmaceutical managers approached conveniently. Results supported that 5DRIPS has excellent internal consistency, factor structure, and convergent, criterion, and discriminant validities. The scale significantly predicted organizational outcomes in terms of innovativeness and competitiveness. The mediation mechanism exhibited that all five dimensions of 5DRIPS significantly improved organizational innovativeness, which in turn enhanced organizational competitiveness. Implications of these findings are discussed. We suggest using 5DRIPS as a reliable and valid measure of responsible innovation practices in pharmaceutical organizations. It can also be applied in other small, medium, and large-scale manufacturing organizations.

Key Words: Responsible Innovation Practices, Sustainability-oriented Innovation Practices, Organizational Innovativeness, Organizational Innovativeness

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1. INTRODUCTION

The concept of responsible innovation entails generating, promoting, and implementing innovative ideas that benefit society through new valuable products and services or prevent the harmful effects of existing products and services in pursuit of economic, social, and environmental sustainability. Responsible innovation practices refer to action-oriented strategies, such as anticipation, reflexivity, inclusion, responsiveness (Burget et al., 2017; Long & Blok, 2018), and knowledge management (Gonzales-Gemio et al., 2020; Lubberink et al., 2017) that facilitate socially acceptable responsible innovation. Research suggests a need for the institutionalization of responsible innovation (Owen et al., 2021). It is because innovation has turned out to be the source of survival, competitive advantage, and success for organizations in current turbulent, competitive, and challenging markets (Long & Blok, 2018). Innovation is the process of looking for and implementing new ways, processes, and procedures that enable offering the best possible products and services (Lukes & Stephan, 2017). However, innovation initiatives often fail, and successful innovators face difficulty sustaining their performance. It is a costly task requiring a considerable number of resources and long-term commitment. Given the scarcity of available resources, most organizations find it challenging to decide the innovation requirements and the amount of money to invest. Increasing pressures for sustainability require organizations to constantly engage in evaluation and control to strengthen their strategic planning to exploit opportunities and reduce potential risks. Organizations must undertake activities demonstrating their responsibility towards society, such as corporate social responsibility activities, corporate sustainability, and responsible research and innovation. Innovation promotes creativity and economic growth; however, increasing research encourages investment in only ethically acceptable and socially desirable innovations (Gurzawska, 2021). The role of stakeholder engagement, therefore, is inevitable in the innovation process (L. M. da Silva et al., 2019) so that scientific and innovative outcomes are well aligned with the needs and values of the society (Gurzawska, 2021; Stilgoe et al., 2017).

Most of the innovation is funded, produced, and implemented by the industry. The growing body of research focuses on applying responsible innovation in the industry. Responsible innovation requires responsible innovation practices at the organizational level. The current literature offers several frameworks for applying and assessing responsible innovation in different organizational contexts (Burget et al., 2017; Deppeler & Aikens,

2020; Gonzales-Gemio et al., 2020; Lubberink et al., 2017). Nevertheless, the industry lacks awareness of this concept, especially in developing countries (Gurzawska, 2021; Lubberink et al., 2017). One key issue is the assessment to know how and how much an organization and its team members are involved in responsible innovation practices. A reliable measure of this multidimensional construct in the industrial context is unavailable. Therefore, the further development of scientific and empirical literature on the theory and practice of responsible innovation, concerning its antecedents and related outcomes at the individual, group, and organizational levels, is suffering due to the lack of reliable and valid measurement of this construct, among other reasons (Burget et al., 2017; Deppeler & Aikens, 2020; Gonzales-Gemio et al., 2020; Lubberink et al., 2017).

This investigation aimed to achieve three purposes. First, it adapted a five-dimensional responsible innovation practices scale (5DRIPS) from existing literature and tested its factor structure, reliability, and validity with identical measures of responsible innovation practices and sustainability-oriented innovation scale. Second, it examined the 5DRIPS with potential outcome measures of organizational innovativeness and competitiveness. Third, the SEM-based path analysis tested that 5DRIPS promotes organizational competitiveness through innovativeness (Figure 1).

2. LITERATURE REVIEW

Innovation contributes to competitive advantage (Lukes & Stephan, 2017). In the present era of the fourth industrial revolution (called industry 4.0), manufacturing firms must introduce technological innovations and systems that deliver value to stakeholders. The meaningful innovations may involve the usage of new technologies as well as business process optimization (K. Silva et al., 2020). Process innovation has three core stages; idea generation, promotion, and implementation (Palazzeschi et al., 2018; Scott & Bruce, 1994). Given the resource constraints and corporate social responsibilities, organizations must be responsive to what society desires and values. Thus, they have to be responsible for their choice of innovation.

2.1. Responsible Innovation Practices

Responsible innovation is increasingly recognized as a necessary organizational-level practice due to the benefits of open and inclusive innovation (Grieger et al., 2022; Zhang et al., 2019). Organizational practices and structures are crucial in bringing responsible innovation to reality (Metz

& Rathert, 2022). The literature identifies responsible innovation as a multidimensional construct comprising various strategies and practices that facilitate responsible innovation. Anticipation, reflexivity, inclusion and deliberation, and responsiveness are the most common dimensions explained by the researchers (Burget et al., 2017; Long & Blok, 2018). In addition, knowledge management is also recognized as an essential dimension of responsible innovation (Gonzales-Gemio et al., 2020; Lubberink et al., 2017). Anticipation strategy and practices allow firms to determine desired innovations and their impact and outcome. In reflexivity practices, the firms reflect upon the values and motivations concerning desired innovations to be well aligned with each other. Nothing contrary to values is pursued to avoid the potential harm of innovative outcomes. Including all stakeholders in all stages of the innovation process is another essential aspect of responsible innovation. It provides organizations with increased commitment and contribution of stakeholders in pursuing and realizing innovation goals. Responsiveness of organizations as an aspect of responsible innovation is required to devise a response strategy, decide on a real response to the changes in the environment, and initiate a mutually well-coordinated response to address the big challenges. Knowledge management is required to create and develop strategic knowledge that facilitates responsible innovation, offers a competitive advantage, and increases organizational performance (Gonzales-Gemio et al., 2020; Lubberink et al., 2017). Relying upon these research reviews, we considered responsible innovation practices a five-dimensional second-order construct. To empirically test this assumption, we constructed and validated a five-dimensional responsible innovation practices scale, named 5DRIPs, by adapting items proposed in relevant systematic reviews (Deppeler & Aikens, 2020; Inkinen et al., 2015).

2.2. Responsible Innovation Practices and Organizational Competitiveness

Responsible innovation is positively associated with firm performance (Adomako & Tran, 2022). Competitiveness is the function of market factors (Vilanova et al., 2009) that define the economic success of an institution (Cetindamar & Kilitcioglu, 2013), such as sustainability capacity to endure market share, profitability, and returns (Battaglia et al., 2014). Organizational practices that emphasize sustainability are positively associated with organizational performance, financial and market performance, quality performance, innovation performance, environmental performance, and social performance (Maletič et al., 2014, 2016). Integration

of responsible innovation in the industry is in the infancy stage. In an increasingly competitive world, one of the significant challenges of organizations is to responsibly innovate to generate economic benefits that also have sustainable social value (Gonzales-Gemio et al., 2020). Responsible innovation in the developing world is an emerging concept, and very little research shows its impact on organizational capacities and sustainable development (Gonzales-Gemio et al., 2020). The core aim of responsible innovation is to align the innovation process and its outcomes with the societal stakeholders' values, needs, and expectations. Given this aspect, it is novel for firms to understand how responsible innovation can benefit in terms of performance and competitiveness. As manufacturing organizations are innovation-intensive, they would likely engage in responsible innovation practices that ensure their survival and offer them competitive strength in the market. Hadj (2020) found that organizations focusing on corporate social responsibility engage in responsible innovation practices of anticipation, reflexivity, inclusion, and responsiveness that promote an organization's competitiveness. Likewise, the research also shows that acts of corporate social responsibility encourage green innovation that leads to organizational competitiveness (Padilla-Lozano & Collazzo, 2022). Ivanova (2021) examined that enterprise competitiveness increases with the increased level of implementation of responsible innovation. Accordingly, we predicted that: -

> *Hypothesis 1: Responsible innovation practices: (a) anticipation, (b) reflexivity, (c) inclusion, (d) responsiveness, and (e) strategic knowledge management are positively associated with organizational competitiveness.*

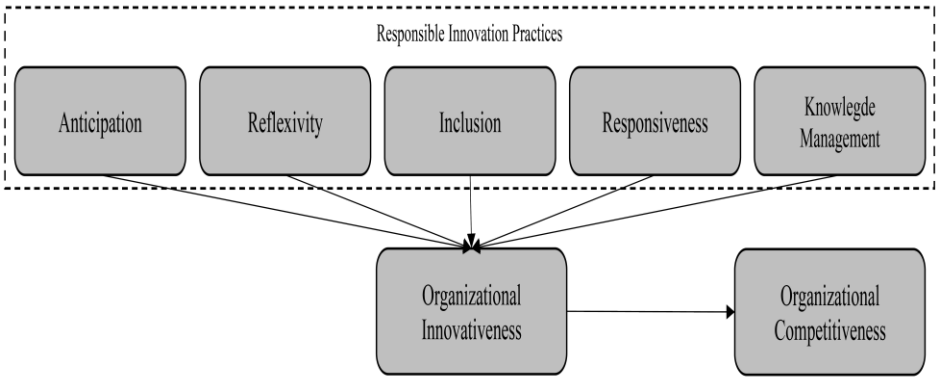
2.3. Mediating Role of Organizational Innovativeness

Innovation is one of the critical determinants of an organization's survival and success. Innovative ideas are at the center of organizational efforts to deliver superior market performance and secure sustainable competitive advantages (Cillo et al., 2019). An organization's innovation capacity is a source of innovation (Cabrilo & Dahms, 2018; Campanella et al., 2014). An organization's innovativeness refers to its orientation toward innovation in five key domains: behavior, products, processes, market, and strategy (Wang & Ahmed, 2004). Innovations in all these areas make organizations dominant among rivals and help them stay ahead of the competition. Product innovation offers opportunities for growth and expansion of business, while process innovation captures new and unique

approaches to producing innovative products. Behavioral innovation embodies the sustained behavioral change of individuals, work teams, and the management towards innovation in the organization. Behavioral innovativeness enables innovative culture and underlines all innovative outcomes. Market innovation demonstrates the novelty adopted in approaching the market and determines how well the new products are placed, promoted, and accepted by the market. Strategic innovativeness defines how an organization positions itself and pursues its ambitious goals within the more extensive industrial setup by identifying gaps and taking them as an opportunity for its competitive benefit (Wang & Ahmed, 2004). Leadership, organizational culture, knowledge processes, and intellectual capital enhance organizational innovativeness across various industries (Kucharska, 2021). Responsible innovation practices of anticipation, reflexivity, inclusion, responsiveness, and knowledge management define an organization's culture and ability to produce, promote, and execute ideas that encourage and facilitate innovativeness to sustain tough market competitions (Lubberink et al., 2017). Organizational innovativeness improves firm performance (Groza et al., 2021). Innovation capabilities are also linked with competitive firm performance (Momaya, 2018). Evidence demonstrates that organizational activities of corporate social responsibility promote (green) innovation, leading to organizational competitiveness (Padilla-Lozano & Collazzo, 2022). In this context, we predicted that:

> *Hypothesis 2: Organizational innovativeness mediates the relationship of responsible innovation practices: (a) anticipation, (b) reflexivity, (c) inclusion, (d) responsiveness, and (e) strategic knowledge management with organizational competitiveness.*

Figure 1: Hypothetical Model



3. METHOD

3.1. Procedure and Sample

A two-wave field survey with an interval of fifteen days was conducted to collect data on study variables. This approach of temporal separation between data collection for different variables helps prevent common method bias (Bozionelos & Simmering, 2022; Rahaman et al., 2022). A list containing the email addresses of pharmaceutical managers from across Pakistan was available to the first author (Farrukh et al., 2021). They were contacted as potential participants for this study with the request to invite their colleagues further to participate in a survey on a volunteer basis. This network-based approach to sample selection was adopted as a convenience to quickly access a randomized sample from a diverse set of pharmaceutical organizations throughout Pakistan. *At time-1*, the online survey link (Google Form) containing questionnaires on participant profile (five items), organizational innovativeness (three items), and organizational competitiveness (three items) was emailed to potential participants, which returned 312 responses. *At time-2* (fifteen days after time 1), the respondents of the time-1 survey were again invited to complete the questionnaires on 5-DRIPS (twenty items), Scholten & Duin's responsible innovation practices (eleven items), and sustainability-oriented innovation practices (fourteen items). The survey was terminated with a final sample of 297 responses (fifteen days after time-2).

The frequency analysis showed that both male (69%) and female (31%) managers working at first-level (44%), middle-level (35%), and senior-level (21%) managerial positions participated in the survey from different organizational locations across Pakistan: Islamabad (13%), Punjab (34%), Sindh (41%), Khyber Pakhtunkhwa (7%), and Balochistan (5%). The participants reported their ages as 20-30 years (34%), 31-40 years (31%), 41-50 years (23%), 51-60 years (9%), and above 60 years (3%). They also reported to be well-educated (doctorate 13%, MS/M.Phil 50%, BS/Masters 29%, and BA/B.Sc 8%) and experienced (1-5 years 30%, 6-10 years 22%, 11-15 years 13%, 16-20 years 15%, and above 20 years 20%). Hence, the overall sample consisted of young, well-qualified, and experienced managers from the pharmaceutical industry.

3.2. Measures

The primary aim of this study was to examine the factor structure, reliability, and validity of the proposed 5-Dimensional Responsible

Innovation Practices Scale (5DRIPS). Therefore, to test convergent validity, we collected data on scales measuring identical constructs, such as Scholten and van der Duin (2015)'s 3-dimensional responsible innovation practices and sustainability-oriented innovation practices. To assess the criterion validity, we collected data on related outcome variables, organizational innovativeness and competitiveness. All these variables were tapped on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree).

5-Dimensional Responsible Innovation Practices Scale (5DRIPS) is an adapted version of 20 items representing five dimensions (four items each); anticipation, reflexivity, inclusion, responsiveness (Deppeler & Aikens, 2020), and knowledge management (Inkinen et al., 2015). Table 1 shows the items with relevant literature sources measuring this multidimensional construct. The entire construct, as well as its five dimensions, showed good reliability and validity: entire construct (α=0.90, CR=0.96, and AVE=0.60), anticipation (α=0.75, CR=0.84, and AVE=0.58), reflexivity (α=0.90, CR=0.93, and AVE=0.77), inclusion (α=0.82, CR=0.88, and AVE=0.64), responsiveness (α=0.83, CR=0.89, and AVE=0.67), and knowledge management (α=0.92, CR=0.94, and AVE=0.79).

Responsible Innovation Practices is an eleven-item scale (Scholten & van der Duin, 2015) comprising three dimensions: sustainability practices, stakeholder engagement, and social responsiveness. Sustainability practices consist of three items, such as “Sustainability is important and is stated clearly in our company’s mission”. Stakeholder engagement consists of four items, such as “Very often, we have consultation with societal groups about our innovation and the developments in our market and technology”. Social responsiveness consists of four items (α=0.899), such as “We put great value on moral responsibility for society”. In the current study, the entire scale showed good reliability and validity (α=0.88, CR=0.95, and AVE=0.63) for comparison with the proposed 5DRIPs.

Sustainability-Oriented Innovation Practices is a fourteen-item scale (Maletič et al., 2016) comprising two dimensions: sustainability-oriented process and product deployment (SOPPD) and sustainability-oriented innovation competencies deployment (SOICD). SOPPD consists of eight items (α=0.89), such as “We consider sustainability as an opportunity for product/service differentiation”. SOICD consists of six items (α=0.86), such as “We develop new competencies supporting innovation in the organization”. In the current study, the entire scale showed good reliability and validity (α=0.91, CR=0.96, and AVE=0.64) for comparison with the proposed 5DRIPs.

Organizational innovativeness was tapped using three items (α=0.82; Hughes & Morgan, 2007 and α=0.81; Groza et al., 2021, such as "Our business seeks out new ways to do things". In the current study, the scale showed good reliability and validity: α=0.79, CR=0.88, and AVE=0.70.

Organizational competitiveness was assessed by adapting three items (α=0.89; (Sellitto & Hermann, 2019), such as "My company has a positive corporate image due to its innovation practices". In the current study, the scale showed good reliability and validity: α=0.93, CR=0.90, and AVE=0.75.

4. RESULTS

4.1. Descriptive Analysis

Item-wise descriptive analysis was performed to examine item means, standard deviations, skewness, and kurtosis. Results showed the means for all 51 items ranging between 3.13 to 3.90 (16 items) and 4.01 to 4.50 (35 *items*), with a standard deviation ranging from 0.723 to 0.166. The skewness ranged from -1.401 to -0.176, with a standard error of 0.141. The range of kurtosis was observed between -1.044 and 1.534, with a standard error of 0.282. These values of both skewness and Kurtosis are acceptable, being within the desired range of ±2 (George & Mallery, 2018), which is also considered acceptable up to ±3 (Kline, 1998, 2015).

4.2. Measurement Model Assessment

Face and Content Validity of 5DRIPS. A panel of six management professionals, three from academia and three from industry (one from pharmaceutical, textile, and automotive), reviewed the face and content validity of 5DRIPs (Alfuqaha et al., 2022). They evaluated each item as a responsible innovation practice in relation to five established dimensions. As per the panel recommendations, the original items were modified for better adaptation and application in the context of the manufacturing industry in Pakistan. The adapted items are shown in Table 1.

Factor Analysis of 5-DRIPS. First, we performed exploratory factor analysis using varimax rotation in SPSS. It generated five factors above the initial Eigenvalue of 1 with significant Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (0.868) and Bartlett's Test of Sphericity (Chai-seqaure = 3576.716, df=190, $p < 0.01$). These values are acceptable (KMO>0.700 and $p<0.05$), which indicates construct validity (Alfuqaha et al., 2022). The five factors explained a total variance of 71.266%, each contributing between

11.776% and 16.499%. It confirmed the theoretical five-factor structure of the adapted 5DRIPS. Second, we performed the confirmatory composite analysis using Bootstrapping procedure in Smart PLS software to examine the reliability and validity of 5DRIPS. The model fit was acceptable (SMSR=0.08, d_ULS=1.348, d_G=0.852, Chi-Square=431.128, NFI=0.695), and all the items loaded perfectly well, above 0.600 (Mehrvarz et al., 2021) on their respective factors (Table 1, Figure 2). These established construct reliability, convergent validity, and discriminant validity with acceptable collinearity statistics (1.297<VIF<4.512). Third, we executed the PLS Algorithm, which showed the contribution of all factors toward the overall construct of 5DRIPS confirming its five-dimensionality (Figure 2).

Reliability and Convergent Validity. Table 2 shows the results of mean, standard deviation, Cronbach's alpha (α), composite reliability (CR), and average variance extracted (AVE) for all variables/constructs. The values were acceptable, above 0.70 and 0.50 for α and AVE, respectively (Fornell & Larcker, 1981). The values for CR were also above the acceptable threshold of 0.70 (Adomako & Tran, 2022; Alfuqaha et al., 2022; Hair et al., 2020). The values of CR greater than AVE for all variables also pointed out the convergent validity of all measures (Alfuqaha et al., 2022; Hair et al., 2020; Mehrvarz et al., 2021).

Criterion and Discriminant Validity. The inter-construct correlations were examined and compared with the squared-rooted AVE to ensure that all variables sufficiently discriminate from each other to exhibit their uniqueness in the proposed model (Table 3). The values of $\sqrt{AVE}$ of all variables were greater than their correlations with all other variables, which revealed discriminant validity of all variables (Alfuqaha et al., 2022; Mehrvarz et al., 2021), which was also confirmed by all the HTMT values found below the threshold of 0.85 (Henseler et al., 2015). All dimensions of 5DRIPS correlated highly with the overall construct and the identical measures of RIP and SOIP, indicating criterion validity. The inter-item correlations (0.10 to 0.80) and item-total correlations (above 0.3) were also observed, which supported sufficient variance and scale dimensionality (Jaracz et al., 2022; Olatunji et al., 2007; Piedmont & Hyland, 1993; Pretorius & Padmanabhanunni, 2022).

Table 1. Reliability and Convergent Validity

Factor Name and Items		Mean	SD	Loadings
My company/firm…				
Factor 1: Anticipation [a] (AVE=0.58)				
1.	Provides resources for anticipated challenges at each stage of innovation.	3.13	0.96	0.700
2.	Provides professional learning and strategic engagement to address challenges.	3.24	1.10	0.769
3.	Is flexible to adapt for multiple purposes, users, conditions, and sustainability.	3.17	1.13	0.795
4.	Models evidence-informed practices to support professional understanding.	3.27	1.04	0.789
Factor 2: Reflexivity [a] (AVE=0.77)				
5.	Incorporates stakeholder-based learning into solutions for the next project.	4.07	1.07	0.771
6.	Evaluates innovations to govern outcome effectiveness and future challenges.	4.24	1.00	0.909
7.	Reflects on practices that support flexibility, agency, and collaboration.	4.33	0.89	0.904
8.	Use findings from evaluations to inform professional learning and future goals.	4.28	0.94	0.921
Factor 3: Inclusion [a, b] (AVE=0.64)				
9.	Provides incentives to engage diverse stakeholders for different purposes.	4.45	0.79	0.768
10.	Includes equitable and accountable processes of engagement with stakeholders.	4.36	0.77	0.857
11.	Has the authority to resolve stakeholder conflicts and resistance to innovation.	4.39	0.79	0.767
12.	Ensures that its staff collectively provides input on innovation. [b]	4.29	0.82	0.812
Factor 4: Responsiveness [a] (AVE=0.67)				
13.	Engages all stakeholders in innovation development and implementation.	4.47	0.74	0.852
14.	Provides leadership to build capacity and align with local contextual conditions.	4.53	0.73	0.868
15.	Creates innovation hubs as spaces to develop and assess learning practices.	4.17	0.86	0.773
16.	Promotes user autonomy to adapt to contextual learning environments.	4.48	0.79	0.806
Factor 5: Knowledge Management [c] (AVE=0.79)				
17.	Has a strategy to develop knowledge and competencies.	4.23	1.02	0.935
18.	Has specified a person responsible for strategic knowledge management.	4.01	1.13	0.869
19.	Formulates and updates strategies using its knowledge and competencies.	4.23	1.06	0.905
20.	Benchmarks its strategic knowledge and competence against competitors.	4.05	1.17	0.859

Sources: a. Items number 1-11 and 13-16 adapted from Deppeler and Aikens (2020); b. Item number 12 adapted from Zhang et al. (2019); c. Items number 17 to 20 adapted from Inkinen et al. (2015).

Figure 3. Factor Structure of 5DRIPS

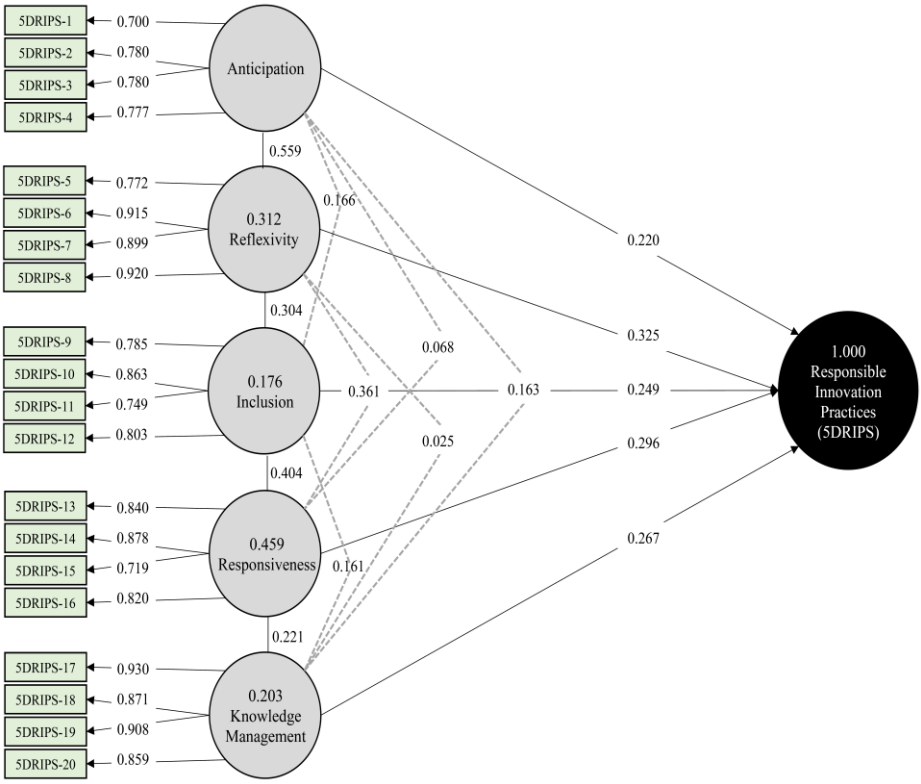


Table 2. Reliability and Convergent Validity

	Items	Mean	SD	α	CR	AVE
5DRIPS (Entire Scale)	20	3.91	0.54	0.90	0.96	0.60
Anticipation	5	3.20	0.82	0.75	0.84	0.58
Reflexivity	5	4.23	0.81	0.90	0.93	0.77
Inclusion	5	4.37	0.65	0.82	0.88	0.64
Responsiveness	5	4.41	0.61	0.83	0.89	0.67
Knowledge Management	5	4.13	0.97	0.92	0.94	0.79
RIP	11	4.21	0.56	0.88	0.95	0.63
SOIP	14	3.97	0.66	0.91	0.96	0.64
OI	3	4.00	0.68	0.79	0.88	0.70
OC	3	4.13	0.74	0.83	0.90	0.75

Notes: α=Cronbach's Alpha, 5DRIPS=5-Dimensional Responsible Innovation Practices Scale, AVE=Average Variance Extracted, CR=Composite Reliability, KM=Knowledge Management, OC=Organizational Competitiveness, OI=Organizational Innovativeness, RIP=Responsible Innovation Practices, SOIP=Sustainability-Oriented Innovation Practices.

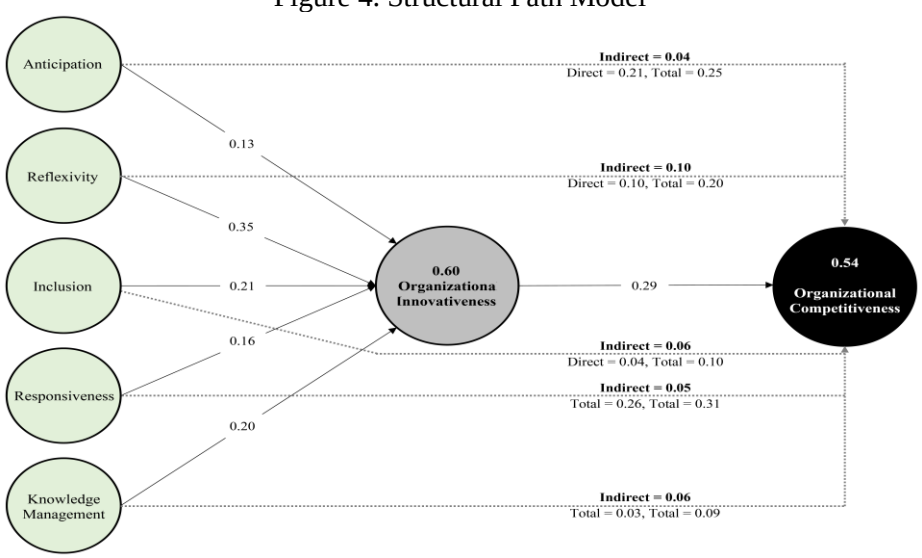
Table 3. Criterion and Discriminant Validities

Variables	5DRIPS (Entire Scale) and Dimensions						Identical Measures		Outcome Measures	
	1	1.1	1.2	1.3	1.4	1.5	2	3	4	5
1. 5DRIPS	0.77	0.66**	0.79**	0.64**	0.69**	0.73**	0.89**	0.82**	0.68**	0.53**
1.1. Anticipation		0.75	0.50**	0.21**	0.25**	0.29**	0.44**	0.37**	0.34**	0.23**
1.2. Reflexivity			0.88	0.38**	0.44**	0.44**	0.74**	0.69**	0.59**	0.42**
1.3. Inclusion				0.80	0.52**	0.30**	0.69**	0.60*	0.62**	0.36**
1.4. Responsiveness					0.82	0.42**	0.76**	0.56**	0.54**	0.61**
1.5. KM						0.89	0.58**	0.67**	0.41**	0.32**
2. RIP							0.79	0.75**	0.68**	0.60**
3. SOIP								0.80	0.76**	0.43**
4. OI									0.84	0.52**
5. OC										0.87

n= 297, **p<0.01. Notes: Bold values in diagonal are √AVE, 5DRIPS=5-Dimensional Responsible Innovation Practices Scale, KM=Knowledge Management, OC=Organizational Competitiveness, OI=Organizational Innovativeness, RIP=Responsible Innovation Practices, SOIP=Sustainability-Oriented Innovation Practices.

Based on the established five-factor structure (Table 1), reliability and convergent validities (Table 2), and criterion and discriminant validities (Table 3), we concluded that 'responsible innovation practices' is a reliable and valid five-dimensional second-order construct. Hence, the 5DRIPS can be relied upon as a valid five-dimensional measure of responsible innovation practices.

Figure 4. Structural Path Model



4.3. Structural Model Assessment

The proposed mediation model of 5DRIPS with its outcome of organizational competitiveness via organizational innovativeness was examined using Bootstrapped PLS Path Analysis (SMSR=0.08, d_ULS=2.417, d_G=1.65), which showed good model fit: SMSR<=0.08 (Burkholder & Harlow, 2003; Huang et al., 2022). It was observed that overall responsible innovation practices (5DRIPS) are positively associated with organizational completeness (total effect=0.70; hypothesis 1 accepted) via organizational innovativeness (indirect effect=0.28; hypothesis 2 accepted). A further mediation analysis was performed to examine the contribution of each dimension of 5DRIPS (anticipation, reflexivity, inclusion, responsiveness, and strategic knowledge management) toward organizational competitiveness through innovativeness (Figure 3, Table 4). The model fit was acceptable: SMSR=0.07, d_ULS=2.05, d_G=1.499 (Burkholder & Harlow, 2003; Huang et al., 2022). All dimensions revealed significant total and direct associations with organizational competitiveness; thus, hypotheses 1a to 1e were accepted. Likewise, the indirect association of each dimension with organizational competitiveness via organizational innovativeness was also found to be significant. Therefore, hypotheses 2a to 2e were supported.

Table 4. Mediation Path Analysis

Path	Indirect Effect [LL, UL]	Direct Effect [LL, UL]	Total Effect [LL, UL]	Hypotheses (H)	Outcome
Entire 5DRIPS → OI → OC	0.28** [0.17, 0.40]	0.42** [0.25, 0.59]	0.70** [0.57, 0.83]	$H1, H2$	Supported
Anticipation → OI → OC	0.15** [0.10, 0.21]	0.06^{ns} [-0.04, 0.15]	0.21** [0.11, 0.31]	$H1_a, H2_a$	Supported
Reflexivity → OI → OC	0.22** [0.15, 0.29]	0.15** [0.05, 0.26]	0.37** [0.28, 0.46]	$H1_b, H2_b$	Supported
Inclusion → OI → OC	0.33** [0.25, 0.42]	0.06** [-0.08, 0.20]	0.39** [0.27, 0.51]	$H1_c, H2_c$	Supported
Responsiveness → OI → OC	0.18** [0.10, 0.26]	0.56** [0.44, 0.69]	0.74** [0.63, 0.85]	$H1_d, H2_d$	Supported
KM → OI → OC	0.15** [0.10, 0.21]	0.09** [0.01, 0.17]	0.24** [0.16, 0.32]	$H1_e, H2_e$	Supported

Notes: **p<0.01, 5DRIPS=5-Dimensional Responsible Innovation Practices Scale, OC=Organizational Competitiveness, OI=Organizational Innovativeness, KM=Knowledge Management, LL=Lower-Level Confidence Intervals, UL=Upper-Level Confidence Interval.

5. DISCUSSION

The present study examined the factor structure and psychometric properties of the proposed 5DRIPS. The empirical data has confirmed the theoretically accepted five-dimensional structure of responsible innovation practices and that 5DRIPS is a valid and reliable measure of this construct. The scale is at par with the identical measures of responsible innovation practices and sustainability-oriented practices. The scale has also been significantly associated with related outcomes of organizational innovativeness and competitiveness. In a mediation mechanism, it has been confirmed that organizational innovation resulting from responsible innovation practices can predict organizational competitiveness. These findings are consistent with the prior literature, which supports that innovation leads to improvement in firm-level competitiveness (Hadj, 2020), performance (Adomako & Tran, 2022; Groza et al., 2021), and that responsible innovation is an inevitable requirement in business (Gurzawska, 2021). The theoretical and practical implications of these findings are discussed below.

5.1. Theoretical Implications

The present and the emerging high-tech world is facing critical challenges in achieving sustainability goals, mainly within social, economic, and environmental domains, where organizations need to assume more social responsibility to address the issues that hinder sustainability (Grieger et al., 2022; Kjellgren & Richter, 2021; Lubberink et al., 2017; Martínez-Ferrero et al., 2021). Responsible innovation practices are widely acknowledged as desired practices to align fast-spreading innovation and development with social and sustainability requirements (Hadj, 2020). These practices will likely encourage and invest only in innovations that comply with moral values and social acceptance after engaging with the stakeholders to ethically meet society's current and future needs (Metz & Rathert, 2022). However, the empirical literature on antecedents and outcomes of responsible innovation practices at organizational levels, especially in the manufacturing industry, is suffering further development due to the lack of an empirically tested, reliable, and valid scale of this theoretically multidimensional construct (Deppeler & Aikens, 2020; Lubberink et al., 2017). This study has empirically confirmed the five dimensionality of responsible innovation practices construct involving anticipation, reflexivity, inclusion, responsiveness, and knowledge management. It offers valuable foresight to help further develop

and test theoretical knowledge of responsible innovation practices with its antecedents and outcomes at the employee, work groups, organizational, and sector levels.

5.2. Practical Implications

Present global society is suffering from several issues, such as pollution, climate change, new forms of critical diseases, and social insecurities as direct outcomes of innovations and industrialization in the past. Modern organizations are considered responsible and accountable for their (un)ethical roles in social, economic, and environmental sustainability (Grieger et al., 2022; Kjellgren & Richter, 2021; Lubberink et al., 2017; Martínez-Ferrero et al., 2021). They need to participate in responsible innovation practices that facilitate and produce innovations most useful for the society in terms of sustainability. In this regards, a reliable and valid multidimensional scale is essential to gauge the extent to which organizations engage in responsible innovation practices. The adapted 5DRIPS has shown sufficient empirical reliability and validity in the context of pharmaceutical manufacturing organizations in Pakistan. It is expected that it may return consistent results if applied to other manufacturing contexts; small, medium, and large-scale manufacturing organizations. However, its items may be modified to suit the context of its application better. We suggest using 5DRIPS in a mixed sample of organizations from different sectors of the large-scale manufacturing industry. The scale may also be applied in service sector organizations to assess the level of their responsible innovation practices in relation to their organizational and technological innovation for increasing overall organizational performance and competitiveness, especially the education sector organizations as they confront rapidly internationalizing global education challenges.

5.3. Limitations and Future Research

This study examined the psychometric properties of the proposed 5DRIPS using data from the pharmaceutical industry. However, we expect this scale to be equally reliable and valid for application in other manufacturing industries, including small and medium enterprises to large-scale manufacturing. Future studies will likely use this scale in different industrial sectors, which will further validate this scale for use in empirical studies testing the theoretical implications of responsible innovation practices in organizational contexts. We examined responsible innovation practices using subjective measures of organizational innovativeness and competitiveness. We suggest that future studies use objective measures of

organizational innovativeness and competitiveness to validate 5DRIPS further. We are also researching 5DRIPS as a facilitator of technological innovation in products and processes to attain sustainable competitive advantage as the desired outcome in large-scale manufacturing industries in Pakistan. Likewise, responsible innovation should also be studied in the context of projects and project organizations to understand if it could help improve the implementation of project management tools and techniques and achieve project success within the resource constraints, such as time and budget.

Furthermore, although the existing literature fully supports the proposed direction of the relationship between 5DRIPS and organizational competitiveness, including the mediating role of innovation, the possibility of reverse causality exists. An innovative organization can be competitive, and a competitive organization can be innovative to maintain its long-term competitiveness. However, not every innovation will be beneficial and acceptable to society (customers/stakeholders). When specific innovations pose a threat to society at large and organizational competitiveness, they may be discouraged. Therefore, innovation may not always be positively linked to competitiveness. To gain and maintain long-term competitiveness, organizations need to focus on responsible innovation practices, which is why the cyclical relationship between innovation and competitiveness remains an important area of research in the context of emerging technologies. This study aimed to adapt and validate the desired RIP scale with organizational innovation and competitiveness. The potential reverse causality between organizational innovativeness and competitiveness was beyond the purpose and scope of this study and therefore has not been examined and discussed in this study. Future research may be considered this aspect to examine and discuss if competitive vs. non-competitive organizations engage in responsible innovation practices or otherwise to gain vs. maintain their competitiveness.

6. CONCLUSION

The findings support that the 5-Dimensional Responsible Innovation Practices Scale (5DRIPS) represents an excellent factor structure, reliability, and validity. It has high correlations with the scales measuring the identical constructs, such as the three-dimensional responsible innovation scale and sustainability-oriented innovation practices, establishing convergent validity. The 5DRIPS also predicted related outcomes in this study, such as

organizational innovativeness and organizational competitiveness, indicating criterion and discriminant validity. The results further supported the hypothesized mediation model, predicting that all dimensions of 5DRIPS significantly contribute to organizational innovativeness, which in turn facilitate organizational competitiveness. We suggest using 5DRIPS as a valid and reliable measure of responsible innovation practices in the manufacturing industry, subject to its context-specific assessment of reliability and validity.

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