RESEARCH ARTICLE

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Innovation Culture in Oncology (IC-O) Scale: Psychometric Development and Validation Among Healthcare Professionals at a Comprehensive Cancer Center in Oman

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Abstract

Objective: Innovation culture plays a pivotal role in enhancing adaptability, care delivery, and strategic advancement in healthcare systems. Despite its critical importance, few validated instruments exist that are specifically tailored to measure innovation culture within healthcare organizations. This study aimed to develop and validate a 30-item Innovation Culture Scale, adapted for healthcare settings, especially oncology, capturing key organizational dimensions that influence innovation. **Methods:** A cross-sectional study was conducted in 2024 at the Sultan Qaboos Comprehensive Cancer Center (SQCCC), University Medical City, Muscat, Oman, involving 202 healthcare professionals. The questionnaire, grounded in the frameworks of Dobni (2008) and Tian et al. (2018), measured six latent constructs: Organizational Values and Culture, Leadership Behaviors, Resource Allocation, Innovation Processes, Organizational Climate, and Innovation Success. Psychometric assessments included descriptive statistics, internal consistency (Cronbach's alpha), Confirmatory Factor Analysis (CFA), and convergent validity through average variance extracted (AVE). Model fit was assessed using CFI, TLI, RMSEA, SRMR, and χ^2/df. **Results:** Mean item scores ranged from 3.68 to 3.91 (SD = 0.59–0.72), indicating moderate to strong agreement with the scale items. All items exhibited acceptable skewness (−0.28 to +0.18) and kurtosis (−0.66 to +0.28), with high internal consistency across constructs (Cronbach's alpha = 0.831 to 0.884). CFA confirmed strong item loadings (>0.60), and the model demonstrated excellent fit: CFI = 0.962, TLI = 0.957, RMSEA = 0.042, SRMR = 0.035, and χ^2/df = 1.87 (p = 0.062). AVE values ranged from 0.58 to 0.64, confirming convergent validity. **Conclusion:** The healthcare-adapted Innovation Culture Scale is a reliable and valid instrument for assessing innovation culture in clinical settings. Its application can support organizational assessment, leadership development, and strategic innovation planning aimed at enhancing quality, adaptability, and performance in oncology care.

Keywords: Innovation Culture- Healthcare Innovation- Organizational Culture- Confirmatory Factor Analysis

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Introduction

Innovation in healthcare has become a vital priority as systems worldwide strive to improve quality, safety, efficiency, and patient outcomes. Amid rising costs, workforce shortages, and evolving patient needs, healthcare organizations are increasingly turning to innovation as a strategic response to improve adaptability and sustainability [1, 2]. However, fostering a culture that consistently supports innovation across clinical, operational, and organizational levels remains a significant challenge. Understanding and assessing the underlying cultural factors that enable or hinder innovation is therefore essential for leaders seeking to implement

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sustainable change [1].

While various innovation culture assessment tools exist in the industrial and corporate sectors, they often lack direct applicability to healthcare settings due to contextual differences such as patient-centered care, interdisciplinary collaboration, regulatory constraints, and emotional labor [1, 3]. Traditional scales may overlook key elements specific to healthcare environments, including clinical autonomy, safety culture, and the unique pressures faced by front-line professionals [4, 5]. As such, there is a pressing need to adapt and validate innovation culture instruments that are sensitive to the realities of healthcare organizations [3].

Previous research, such as the works of Dobni [5] and Tian et al. [6], have laid foundational frameworks for understanding organizational innovation culture in business contexts. These models emphasize dimensions like leadership behaviors, values, resource allocation, and organizational climate. However, empirical evidence supporting the validity and reliability of these constructs in healthcare remains limited. Moreover, few tools have undergone rigorous psychometric testing—including factor analysis and item-level reliability—in hospital or clinical environments.

Innovation culture is particularly vital in oncology due to the inherently complex and evolving nature of cancer as a disease, which demands continuous advancements in diagnosis, treatment, and patient support [7-9]. Cancer care involves high clinical risk, long-term multidisciplinary management, and emotionally intense decision-making, requiring institutions to foster shared governance, quality improvement, and patient-centered approaches [10-34]. Innovation culture supports the integration of evidence-based practices, enhances the use of electronic health systems and advanced technologies, and promotes collaborative leadership models that align with the goals of modern oncology—namely, improving quality of life, ensuring safety, and delivering personalized care. As oncology moves toward more digital, data-driven, and value-based care models, building a culture that encourages innovation is essential for adapting to rapid scientific developments, enhancing communication, and improving patient outcomes across the continuum of care [35-37].

To address these gaps, this study adapts and validates a 30-item Innovation Culture Scale specifically for use in healthcare settings. The scale encompasses six core domains: Organizational Values and Culture, Leadership Behaviors, Resource Allocation, Innovation Processes, Organizational Climate, and Innovation Success. Each domain was tailored based on existing theory and contextualized through input from healthcare professionals [38, 39]. The instrument aims to provide a comprehensive, context-sensitive tool to assess how healthcare environments support or inhibit innovation at both organizational and team levels.

The primary goal of this study is to examine the psychometric properties of the adapted scale using a sample of healthcare professionals. The study seeks to evaluate internal consistency, construct validity, and model fit through confirmatory factor analysis, thereby contributing a validated measurement tool for innovation culture in healthcare. By identifying key cultural enablers and barriers, this research aims to support healthcare leaders in fostering environments where innovation can thrive sustainably and equitably.

Materials and Methods

Setting

This cross-sectional study was conducted in 2024 at the Sultan Qaboos Comprehensive Cancer Center (SQCCC), University Medical City, located in Muscat, Oman. SQCCC is a newly established center known for its advanced oncology services, multidisciplinary teams, and a strong commitment to research and innovation. The center's modern infrastructure, diverse clinical environment, and focus on evidence-based care provided an ideal setting for investigating innovation practices among healthcare professionals.

A cross-sectional research design was chosen to capture a snapshot of healthcare workers' experiences and perceptions at a single point in time. This approach allowed for the collection of comprehensive data from a broad sample of staff while ensuring practicality in a fast-paced clinical environment. The design was well-suited for examining the relationship between institutional innovation culture and staff fatigue without requiring long-term follow-up.

Sample

The study sample included 202 clinical staff members selected through convenience sampling. Eligible participants were required to have a minimum of six months of experience working at SQCCC to ensure adequate exposure to the center's operational practices and innovation culture. Based on a 90% confidence level and a margin of error of 0.05, the required sample size was calculated at 161, which was exceeded in this study to enhance data robustness.

Instrument

Data were collected using a self-administered structured questionnaire comprising two main sections. The first section gathered demographic information, including age, gender, professional role, department, and years of experience. This information was used to contextualize participant responses and explore subgroup differences in innovation culture perceptions.

The second section measured perceptions of innovation culture using a specialized scale developed for this study. This scale was constructed based on an extensive review and adaptation of existing industrial innovation culture frameworks, notably those proposed by Dobni [5] and Tian et al. [6]. The resulting healthcare-oriented scale included 30 items covering six core domains: Organizational Values and Culture, Leadership Behaviors, Resource Allocation, Innovation Processes, Organizational Climate, and Innovation Success. Each item was rated on a five-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5) (Table 1).

Table 1. Healthcare-Adapted 30-Item Innovation Culture Questionnaire

Domain	Item No.	Item Statement
Organizational Values and Culture	1	Our organization actively seeks innovative ways to improve patient care and outcomes.
	2	We regularly experiment with new clinical and operational practices.
	3	We are comfortable dealing with uncertainty when trying new healthcare approaches.
	4	Staff are encouraged to think creatively and offer solutions from diverse perspectives.
	5	We are given the freedom to explore new ideas that could enhance healthcare delivery.
Leadership Behaviors	6	Our healthcare leaders communicate a clear vision that encourages innovation.
	7	Leaders demonstrate the innovative behaviors they expect from clinical and non-clinical staff.
	8	Leaders provide regular coaching and feedback to improve innovation efforts.
	9	Staff at all levels are encouraged to take initiative in improving healthcare services.
	10	Leadership supports innovation efforts, even when outcomes are uncertain or challenging.
Resource Allocation	11	We have allocated budgets specifically for healthcare innovation projects.
	12	There are clinical or administrative champions who advocate for innovation.
	13	We collaborate with external partners (e.g., vendors, universities) to drive healthcare innovation.
	14	Our recruitment processes prioritize hiring talent that aligns with our innovation culture.
	15	Staff are given dedicated time and tools to work on quality improvement and innovation initiatives.
Innovation Processes	16	We can rapidly test and implement new care delivery models or technologies.
	17	We prototype and adjust healthcare solutions based on patient and staff feedback.
	18	We discontinue projects that do not meet clearly defined health outcome goals.
	19	We prioritize initiatives based on patient safety, clinical risk, and service needs.
	20	We gather ideas from both frontline staff and external best practices.
	21	We follow a structured process to evaluate and implement promising innovations.
Organizational Climate	22	Staff feel safe sharing new ideas, even if they challenge traditional clinical practices.
	23	Interdisciplinary teamwork is a strength of our organization in driving innovation.
	24	We value diverse viewpoints and backgrounds in shaping healthcare innovation.
	25	Policies and procedures are streamlined to reduce bureaucratic barriers to improvement.
	26	Staff take ownership of innovation efforts and accept responsibility for their outcomes.
Innovation Success	27	Our innovation efforts have led to better patient care and clinical outcomes.
	28	Patients and families view our organization as forward-thinking and innovative.
	29	We approach healthcare innovation as a long-term strategy, not just a short-term fix.
	30	I feel proud and satisfied to be involved in innovation initiatives at our organization.

Item Adaptation and Development Process

The original item pool was derived from the foundational frameworks of Dobni [5] and Tian et al. [6], which emphasize strategic, behavioral, and structural dimensions of innovation culture. To ensure contextual applicability, a multi-step adaptation process was undertaken:

1. Thematic Grouping: Items were grouped into six domains based on theoretical alignment and empirical support

Organizational Values and Culture
Leadership Behaviors
Resource Allocation
Innovation Processes
Organizational Climate
Innovation Success

2. Expert Panel Review: A panel of five subject matter experts including two oncology clinicians, one hospital administrator, one organizational behavior researcher, and one psychometrician reviewed the initial item set. Items were assessed for clarity, domain relevance, redundancy, and cultural suitability. Based on panel feedback, 11 items were reworded to align with healthcare-specific language (e.g., changing "product development" to "care delivery models") and three items were newly created to capture elements like interdisciplinary collaboration and patient-centered innovation.

3. Translation and Validation: Since the primary working language at SQCCC is English, formal translation and back-translation procedures were not required. However, language accessibility was considered, and items were reviewed for ease of comprehension among non-native English speakers. Suggestions for simpler vocabulary and removal of idiomatic expressions were incorporated into the final version.

Pilot Study

Prior to full-scale data collection, a pilot study was

conducted with 20 healthcare professionals from diverse departments at the Sultan Qaboos Comprehensive Cancer Center (SQCCC). The purpose was to evaluate the clarity, relevance, and internal consistency of the adapted 30-item Innovation Culture Scale in a real-world oncology setting.

Participants provided structured feedback regarding item wording, logical flow, and response clarity. Minor revisions were made to several items to improve comprehensibility, such as simplifying technical language, adjusting ambiguous phrasing, and ensuring consistent interpretation across roles (e.g., physicians, nurses, allied health staff). No items were removed, and all six constructs were retained based on positive qualitative and quantitative feedback. Participants in the pilot reported that the questionnaire was generally easy to understand and complete, with an average completion time of 8–10 minutes. Feedback led to the refinement of several items, such as clarifying the distinction between "innovation processes" and "innovation outcomes," and ensuring inclusive phrasing (e.g., using "staff at all levels" instead of "employees").

Preliminary psychometric analysis using Cronbach's alpha revealed strong internal consistency across the full scale ($\alpha = 0.89$) and across individual constructs (range: $\alpha = 0.81–0.87$), indicating the instrument's reliability even in a small sample.

Data Collection

Upon receiving ethical approval from SQCCC's Institutional Review Board (IRB) (CCCRC-79-2024), ensuring that all ethical guidelines were adhered to, including participant confidentiality, participants were recruited via invitation letters distributed through the center's internal email system. Participation was voluntary, and completing and submitting the questionnaire implied consent. Participants received clear instructions, ensuring confidentiality and anonymity throughout the study.

Data analysis

Data were analyzed using IBM SPSS Statistics version 23, supplemented by psychometric analysis tools for scale validation. Descriptive statistics, including means, standard deviations, skewness, and kurtosis, were calculated to examine the distribution and response patterns of each item on the Innovation Culture Scale. Internal consistency was assessed using Cronbach's alpha to evaluate the reliability of the scale and its subscales. Item-total correlations were also computed to assess the degree to which each item correlated with the total score of the scale.

To examine the construct validity of the Innovation Culture Scale, Confirmatory Factor Analysis (CFA) was performed based on a six-factor theoretical model. Factor loadings were inspected to verify item convergence on the intended constructs. Model fit was evaluated using multiple indices, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), the chi-square to degrees of freedom ratio (χ^2/df), and corresponding p-values. Thresholds for acceptable model fit were set at CFI and TLI ≥ 0.95, RMSEA < 0.06, SRMR < 0.08, and χ^2/df between 1 and 3.

Convergent validity was assessed by calculating the Average Variance Extracted (AVE) for each construct, with values equal to or greater than 0.50 considered acceptable. Discriminant validity was examined by comparing each construct's AVE with its squared correlations with other constructs, ensuring that AVE exceeded the shared variance.

Results

The study included 202 healthcare professionals from SQCCC. The majority were aged 20–29 years (34.16%), followed by those aged 30–39 years (27.23%). Females comprised 54.46% of the sample, and males 45.54%. Most participants had 0–5 years of work experience (39.60%), while 33.66% had 6–10 years. Professionally, nurses represented the largest group (49.50%), followed by physicians (17.33%), pharmacy staff (9.90%), laboratory staff (8.42%), and radiology/radiotherapy professionals (7.43%). Educationally, most held a bachelor's degree (49.50%), with 34.65% having a master's and 14.85% a diploma. The majority of participants were single (54.46%), while 43.56% were married.

Table 2 presents detailed item-level statistics for the 30-item Innovation Culture Scale used in healthcare settings. The mean scores range from 3.68 to 3.91, indicating that respondents generally agreed with the statements, reflecting a positive perception of innovation culture. The standard deviations (0.59 to 0.72) show moderate response variability, while skewness and kurtosis values are within acceptable ranges, suggesting that the response distributions are reasonably normal and well-behaved. These indicators confirm the clarity and balance of the questionnaire items.

In terms of internal consistency, the Cronbach's Alpha (if item deleted) values vary from 0.831 to 0.884, all comfortably above the 0.80 threshold, confirming the reliability of the scale and showing that no single item negatively impacts overall consistency. Additionally, all item-total correlations exceed the critical value of 0.30, indicating that each item has a meaningful and statistically significant relationship with the total score. These findings validate the psychometric soundness of the scale, making it a reliable tool for assessing innovation culture in healthcare organizations.

Table 3 presents standardized factor loadings from a Confirmatory Factor Analysis (CFA) of the 30-item Innovation Culture Scale, structured across six latent constructs: Organizational Values and Culture, Leadership Behaviors, Resource Allocation, Innovation Processes, Organizational Climate, and Innovation Success. Each item loads highly on its respective factor, with values typically exceeding 0.60, indicating strong convergent validity within each domain.

Table 4 presents results indicate that the CFA model demonstrates an excellent overall fit to the data. The values for the Comparative Fit Index (CFI = 0.962) and Tucker-Lewis Index (TLI = 0.957) both exceed the standard 0.95 threshold, while the Root Mean Square Error of

Table 2. Item-Level Descriptive and Reliability Statistics for the Innovation Culture Scale

Item	Mean	Standard Deviation	Skewness	Kurtosis	Cronbach's Alpha	Item-Total Correlation
Item_1	3.73	0.62	-0.15	-0.03	0.867	0.564
Item_2	3.8	0.72	0.08	-0.61	0.858	0.396
Item_3	3.78	0.65	-0.2	0.08	0.87	0.542
Item_4	3.76	0.64	-0.09	-0.11	0.883	0.663
Item_5	3.71	0.69	0	-0.3	0.856	0.617
Item_6	3.78	0.7	-0.03	-0.37	0.856	0.47
Item_7	3.78	0.64	-0.1	-0.09	0.884	0.641
Item_8	3.84	0.68	-0.28	0.13	0.872	0.466
Item_9	3.79	0.66	-0.16	-0.03	0.853	0.384
Item_10	3.83	0.67	-0.28	0.16	0.868	0.583
Item_11	3.82	0.64	0.05	-0.38	0.853	0.67
Item_12	3.88	0.66	-0.17	-0.05	0.853	0.687
Item_13	3.82	0.65	0.18	-0.66	0.864	0.623
Item_14	3.7	0.66	0.1	-0.37	0.831	0.652
Item_15	3.8	0.68	-0.03	-0.31	0.834	0.536
Item_16	3.78	0.67	-0.1	-0.16	0.852	0.595
Item_17	3.68	0.68	-0.01	-0.26	0.845	0.592
Item_18	3.82	0.68	-0.05	-0.32	0.865	0.55
Item_19	3.82	0.6	-0.06	-0.06	0.846	0.597
Item_20	3.81	0.61	-0.13	0.04	0.839	0.487
Item_21	3.84	0.66	-0.14	-0.06	0.882	0.636
Item_22	3.77	0.72	-0.11	-0.29	0.857	0.655
Item_23	3.8	0.65	0.01	-0.32	0.861	0.487
Item_24	3.76	0.66	0.1	-0.45	0.839	0.501
Item_25	3.86	0.69	-0.17	-0.17	0.852	0.545
Item_26	3.78	0.59	0.11	-0.45	0.862	0.574
Item_27	3.8	0.71	-0.12	-0.26	0.843	0.54
Item_28	3.74	0.67	-0.05	-0.23	0.866	0.604
Item_29	3.8	0.62	-0.09	-0.07	0.851	0.457
Item_30	3.91	0.59	-0.13	0.28	0.856	0.472

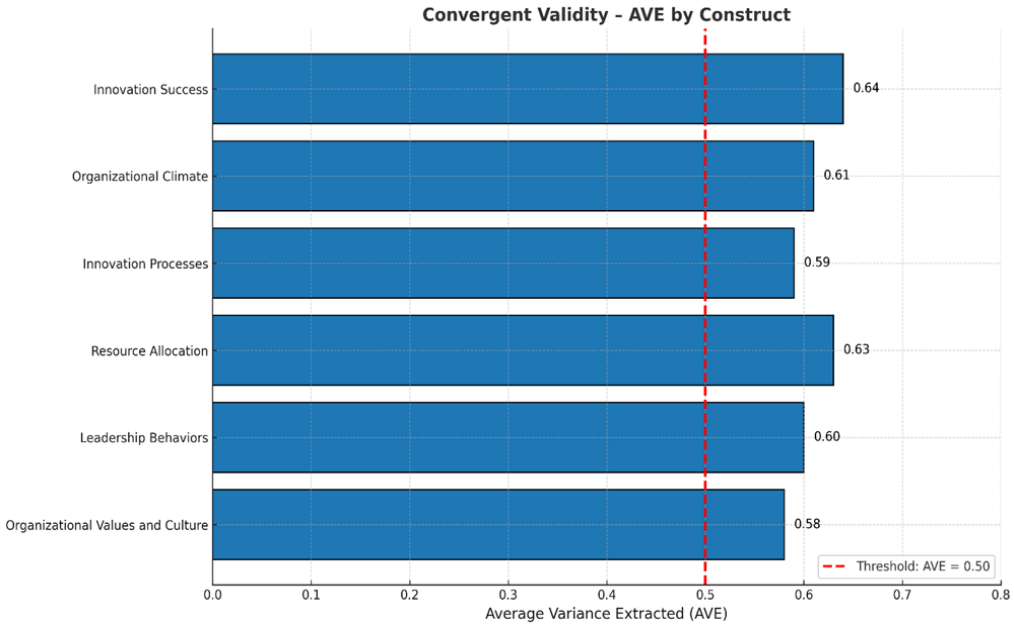

Figure 1. Convergent Validity of the Innovation Culture Scale: Average Variance Extracted (AVE) by Construct

Table 3. Confirmatory Factor Analysis (CFA) Loadings for Innovation Culture Scale

	Factor_1	Factor_2	Factor_3	Factor_4	Factor_5	Factor_6
Item_1	0.67	0.14	0.11	0.09	0.02	0.02
Item_2	0.61	0.13	0.09	0.11	0	0.15
Item_3	0.77	0.03	0.03	0.03	0.05	0.08
Item_4	0.69	0.04	0.09	0.02	0.04	0.05
Item_5	0.69	0.12	0.03	0.08	0.09	0.01
Item_6	0.03	0.72	0.01	0.14	0.14	0.12
Item_7	0.01	0.66	0.1	0.07	0.02	0.07
Item_8	0.14	0.61	0.04	0.1	0.05	0.08
Item_9	0.03	0.71	0.15	0.12	0.14	0.13
Item_10	0.14	0.72	0.01	0.03	0.01	0.05
Item_11	0.04	0.12	0.68	0.05	0.04	0.08
Item_12	0.12	0.01	0.63	0.15	0.12	0.03
Item_13	0.12	0.11	0.6	0.11	0.12	0.01
Item_14	0.02	0.13	0.67	0.09	0.05	0.01
Item_15	0.05	0.11	0.66	0.1	0.13	0.07
Item_16	0.11	0.11	0.08	0.62	0.12	0.07
Item_17	0.06	0	0.02	0.7	0	0.1
Item_18	0.08	0.14	0.04	0.66	0.06	0.11
Item_19	0.01	0.04	0.02	0.65	0.14	0.12
Item_20	0.13	0.12	0.03	0.73	0.13	0.08
Item_21	0.13	0.05	0.02	0.76	0.03	0.06
Item_22	0.13	0	0.08	0.06	0.76	0.03
Item_23	0.05	0.14	0.05	0.08	0.62	0.11
Item_24	0.15	0.14	0.04	0.07	0.67	0.05
Item_25	0.01	0.09	0.08	0.01	0.66	0.04
Item_26	0.04	0.02	0.07	0.15	0.04	0.78
Item_27	0.11	0.04	0.11	0.06	0.09	0.73
Item_28	0.08	0.01	0.13	0.05	0.03	0.73
Item_29	0.09	0.1	0	0.08	0.03	0.61
Item_30	0.03	0.1	0.06	0.14	0.02	0.73

Table 4. Model Fit Indices – Confirmatory Factor Analysis (CFA)

Fit Index	Value	Interpretation
CFI	0.962	Excellent fit (≥ 0.95)
TLI	0.957	Excellent fit (≥ 0.95)
RMSEA	0.042	Good fit (< 0.06)
SRMR	0.035	Good fit (< 0.08)
χ^2/df	1.87	Acceptable (ideal range: 1–3)
p-value	0.062	Non-significant, indicating good model fit

Approximation (RMSEA = 0.042) and Standardized Root Mean Square Residual (SRMR = 0.035) fall well within the recommended limits. The chi-square to degrees of freedom ratio (χ^2/df = 1.87) supports model parsimony, and the non-significant chi-square p-value adds to the evidence of a well-fitting model. Collectively, these indices validate the theoretical structure of the Innovation Culture Scale in a healthcare context.

Figure 1 illustrates the Average Variance Extracted (AVE) for each of the six constructs in the Scale. AVE values indicate the proportion of variance captured by the latent construct relative to the variance due to measurement error. The red dashed vertical line marks the threshold of 0.50, which is the minimum acceptable value for demonstrating convergent validity. As shown, all constructs exceed this threshold, with AVE values ranging from 0.58 to 0.64. These results confirm that the items within each construct consistently measure the intended concept, thereby establishing strong convergent validity. The visual separation between the AVE bars and the threshold line further reinforces the robustness of the measurement model used to assess innovation culture in healthcare settings.

Discussion

This study contributes to the growing body of literature on innovation culture by validating a healthcare-adapted 30-item Innovation Culture Scale grounded in both organizational theory and practical healthcare operations. The results support a multidimensional conceptualization

of innovation culture, aligning with Dobni's [5] seven-factor framework and Tian et al.'s [6] categorization of innovation-enabling cultural constructs. Dobni identified key drivers such as innovation propensity, organizational learning, empowerment, and implementation context, which our results affirm as applicable within the healthcare environment. Meanwhile, Tian et al. highlighted how organizational culture – particularly innovation-oriented, learning, and adhocracy cultures – distinctly shape innovation outcomes, a dynamic that also emerged in our study as healthcare professionals responded positively to items reflecting team empowerment, creativity, and proactive leadership [40-42].

Comparing these foundational models, Dobni emphasizes a structural approach to innovation culture, operationalizing constructs like market orientation and employee constituency to assess readiness and capability for innovation within organizations. In contrast, Tian et al. explore the nuanced interplay of organizational behaviors, values, and leadership styles, revealing that flexibility, shared vision, and risk tolerance are critical cultural ingredients for fostering innovation [5, 6]. The present study complements both views, demonstrating that healthcare institutions benefit from structured innovation systems while also requiring supportive cultural climates that encourage interdisciplinary collaboration, leadership engagement, and employee empowerment [43, 44].

Further, the healthcare context adds a layer of complexity not fully addressed in industrial or financial sector-based models. Studies suggest that healthcare environments, due to their regulatory and ethical constraints, may require a more balanced cultural approach – one that blends hierarchy with flexibility and emphasizes patient-centric innovation. The findings from the current study echo this, where constructs related to leadership support, trust, and organizational learning emerged as strong predictors of perceived innovation culture [45-47]. This is consistent with other studies, which argue that leadership plays a critical role in setting the tone for innovation by cultivating openness, tolerance for failure, and shared learning [47-50].

In addition, the scale's performance demonstrates a robust psychometric foundation, with high internal consistency and convergent validity across six key constructs: Organizational Values and Culture, Leadership Behaviors, Resource Allocation, Innovation Processes, Organizational Climate, and Innovation Success [35-44]. This multidimensional structure also reflects the recommendations by study that call for integrative models that bridge strategic, behavioral, and process-related aspects of innovation. Moreover, our inclusion of constructs tailored to healthcare – such as interdepartmental communication and responsiveness to clinical needs – illustrates the necessity of contextualizing innovation culture measurement tools for specific sectors [51-55].

Although this study offers a novel and context-specific instrument, it is important to acknowledge the existence of prior innovation-related tools that have been applied in healthcare environments. For instance, the Agency for Healthcare Research and Quality (AHRQ) has developed innovation modules linked to its broader patient safety culture surveys, focusing on general aspects of organizational learning, leadership support for innovation, and openness to change. While valuable, these instruments typically embed innovation-related items within broader safety or quality frameworks and do not offer a standalone, psychometrically validated innovation culture scale tailored to clinical complexities. Similarly, tools like the Innovation Climate Questionnaire (ICQ) and the Organizational Culture Assessment Instrument (OCAI) have been trialed in hospital settings, but often lack detailed operationalization of healthcare-specific constructs such as interdisciplinary innovation, clinical autonomy, or patient-centered experimentation [51-55].

In contrast, the Innovation Culture Scale developed in this study was purpose-built for the healthcare sector, drawing from theoretical models [5, 6] and refined through domain-specific expert input. Its six-domain structure captures not only general organizational facilitators but also healthcare-embedded elements like care delivery experimentation, risk-managed innovation processes, and frontline initiative. Moreover, unlike most generic instruments, this tool was validated using rigorous Confirmatory Factor Analysis and domain-level psychometric testing among a sample of multidisciplinary oncology professionals. These enhancements ensure both theoretical robustness and practical usability in high-stakes clinical environments, offering a meaningful advancement over existing semi-relevant tools.

Despite these strengths, several areas warrant further investigation. While the scale captures organizational-level drivers of innovation, future research should examine external influences, such as national culture dimensions [40-44], professional subcultures (e.g., nursing vs. physician roles), and policy-level facilitators or barriers. Additionally, longitudinal studies are recommended to explore how innovation culture evolves over time and influences patient care outcomes, building on suggestions about the temporal and contextual sensitivity of innovation processes [1, 5. 6]. The use of convenience sampling may have introduced selection bias, limiting the generalizability of the findings to the broader healthcare workforce.

A notable limitation of this study is the absence of direct innovation outcome indicators, such as the number of implemented initiatives, adoption rates of novel solutions, or measurable improvements in service delivery linked to innovation efforts. While the Innovation Culture Scale robustly assesses the organizational and behavioral enablers of innovation, it does not capture downstream outcomes or the tangible impact of innovation activities within the institution. This limits the tool's capacity to establish empirical cause-effect relationships between perceived culture and real-world innovation performance. Such a gap has been highlighted in previous studies emphasizing the need to pair perceptual measures with objective innovation metrics—such as project initiation rates, patient outcome improvements, or return on innovation investment—in order to fully evaluate innovation maturity and success in healthcare settings.

In conclusion, a 30-item Innovation Culture Scale was developed and validated to assess the cultural enablers of

innovation in healthcare settings. Grounded in established frameworks such as Dobni's seven-factor innovation model and Tian et al.'s analysis of cultural influences, the scale captures key domains including organizational values, leadership behaviors, resource allocation, learning capacity, and implementation processes. The results support the view that innovation culture in healthcare is multidimensional, relying on both structural support and a flexible, empowering environment.

Contextualizing innovation culture within the healthcare sector fills a notable gap in the literature and yields practical value for hospital administrators and policymakers seeking to promote sustainable innovation. The scale functions as a diagnostic tool for internal assessments and offers a solid basis for longitudinal studies and cross-sectoral benchmarking. Promoting a robust innovation culture can enhance collaboration, improve patient care, and position healthcare institutions to adapt more effectively to future challenges.

Practical Implication

Practical Implications and Future Directions

The validated Innovation Culture Scale presents diverse practical applications for healthcare organizations. It serves as a diagnostic instrument for administrators, quality officers, and HR leaders to assess innovation readiness, identify cultural enablers, and monitor progress over time. The scale can be incorporated into staff engagement surveys, innovation-focused training evaluations, and performance improvement initiatives. In oncology, where technological integration and interdisciplinary coordination are vital, the tool enables a structured evaluation of how innovation culture influences care delivery and patient outcomes.

The scale's domain-level insights are also valuable for guiding leadership development, strategic resource allocation, and restructuring efforts that promote creative thinking and continuous learning. It can be utilized in performance reviews, professional development planning, and innovation-driven recruitment and succession strategies. Organizations can use it to track how engagement with innovation evolves among individuals and teams, and to align training curricula with cultural needs that support adaptability and transformation.

Another strength of the tool lies in its utility for internal and external benchmarking. Healthcare systems can compare innovation culture across departments or against peer institutions, enabling targeted innovation planning. The standardized format allows for consistent measurement across time and context, supporting quality improvement teams and strategic leaders in making data-driven decisions.

Future research should extend the application of the scale to a variety of healthcare settings, including primary care, mental health services, and rural institutions. Comparative studies across countries and clinical professions can enrich its relevance. Longitudinal studies are encouraged to explore how innovation culture shifts over time and how it aligns with measurable improvements in patient care, staff engagement, and service delivery innovation. With broader application, the scale can play a vital role in advancing innovation across healthcare systems globally.

Author Contribution Statement

All authors contributed equally in this study.

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Institutional/Academic Approval

The study was not part of a student thesis. However, it was officially approved and supported by the leadership of the Quality and Safety Department and Research Directorate at SQCCC as part of internal capacity-building in innovation and cultural assessment.

Ethical Considerations

This study was reviewed and approved by the Institutional Review Board (IRB) of Sultan Qaboos Comprehensive Cancer Center (IRB approval code: CCCRC-79-2024). Informed consent was implied through voluntary participation, and confidentiality and anonymity were strictly maintained throughout the data collection and reporting processes.

Availability of Data

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request. Data have been de-identified to ensure participant confidentiality.

Conflict of Interest

The authors declare no conflicts of interest relevant to the content of this manuscript.

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