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Creative implementation and technology orientation: associations with perceived performance in Saudi dental practices

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Abstract: Small regulated professional-service firms increasingly feature in SME policy, yet practitioner-survey evidence remains limited. Responses from 174 practitioners in Saudi private dental practices, retained after eligibility, attention-check and invariant-response screening, were analysed using polychoric exploratory factor analysis and HC3-robust regression. Two sample-specific dimensions emerged: creative process implementation and exploratory technology orientation. Both were positively associated with practitioner-perceived organisational performance ($\beta = 0.456$ and 0.401 ; $p < 0.001$; $R^2 = 0.478$). Associations remained positive in an authority-only subsample, under alternative outcome specifications and repeated cross-validation. Estimates varied across response-screening specifications, which cannot establish respondent invalidity or quantify common-method bias. Because measures and associations were developed in the same single-source, cross-sectional sample, findings are preliminary and non-causal. They do not establish dentistry-specific or regulatory effects. Independent confirmatory, multi-source and measurement-invariance research is required. The findings support evaluating, but do not validate, management-support pilots combining problem-solving, technology exploration and implementation assistance.

Keywords: creative process implementation; exploratory technology orientation; perceived organisational performance; professional-service firms; dental practices; Saudi Arabia.

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1 Introduction

This exploratory study addresses an applied measurement question: when practitioners in small regulated professional-service firms report on creativity, innovation and practice performance, what dimensions can be distinguished, and how stable are their associations under alternative screening, informant and outcome specifications? The setting is private dental practice in Saudi Arabia. The contribution is principally methodological and contextual; the study neither proposes a new theory nor tests whether dentistry behaves differently from other professional services.

The Saudi context makes the question timely. Vision 2030 positions SME development and private-sector expansion as central pillars of economic diversification (Kingdom of Saudi Arabia, 2016), and the latest global monitoring evidence places the Kingdom among the world's most entrepreneurially active environments: Saudi Arabia is one of only six economies in which more than one in four adults are actively starting or running a business, ranks among the five economies with the highest perceived-opportunity levels, and is one of only four of 53 participating economies meeting or exceeding sufficiency on all thirteen Entrepreneurial Framework Conditions (Global Entrepreneurship Monitor, 2026). The national health-sector transformation agenda simultaneously promotes greater private participation in healthcare delivery. Small private dental practices sit where these agendas converge, yet the support architecture available to them – incubation, acceleration and entrepreneurship training – was largely built on evidence from manufacturing, retail and technology ventures, and recent work on private clinics in other regulated markets shows such small businesses adopting new technologies and business models cautiously, inside close professional constraint (Naamati-Schneider, 2024).

Private dental practices display the defining features of professional-service firms: knowledge intensity, a professionalised workforce subject to codes of ethics and licensure, and comparatively low capital intensity (von Nordenflycht, 2010). Their core output is expert clinical judgement, and their legitimacy rests on professional regulation as well as market performance. They also commonly operate through small clinical teams and owner-manager structures: in the present sample, 77% of respondents worked in practices reporting ten or fewer dentists, including solo practices. Because the practice-size item captured the number of dentists rather than total employment or revenue, these practices are treated as small professional-service firms for analytical purposes rather than as formally classified SMEs under Monsha'at criteria (Monsha'at, 2024).

Two methodological issues shape what a practitioner survey in this setting can support. First, online convenience surveys may contain attention failures, repeated response patterns and invariant responding, all of which can materially affect correlations, reliability and factor solutions (Meade and Craig, 2012; Curran, 2016).

Second, context-adapted items cannot be assumed to reproduce their parent constructs. Their empirical structure must be examined with methods suited to ordinal Likert data (Holgado-Tello et al., 2010; Fabrigar et al., 1999). The present study therefore establishes an exploratory measurement structure before estimating concurrent associations and reports how the estimates vary across defensible analytical choices.

The study makes three bounded contributions. First, it provides contextual evidence from Saudi private dental practices, a population rarely represented in management surveys; this is a contextual extension, not a dentistry-specific theoretical claim. Second, it identifies two sample-specific practice-development dimensions and reports complete item-level evidence for their interpretation. Third, it quantifies the sensitivity of the regression results to response screening, informant authority, outcome composition and internal cross-validation. These analyses show which conclusions are stable and which magnitudes remain design-dependent. All claims are preliminary pending independent confirmatory and multi-source replication.

2 Background and research questions

2.1 Small regulated professional-service firms

Licensed professional practice offers a plausible context for interpreting practitioner innovation. Dental practitioners work within what may be described as a professional envelope comprising licensure, continuing-competency requirements, ethical duties, patient-safety obligations and legal liability. These conditions can restrict which ideas may be attempted and can make incremental, professionally defensible change more likely than unrestricted experimentation (Baron, 2006; Naamati-Schneider, 2024; Hoang and Perkmann, 2023).

The present survey did not measure regulatory stringency, licensing burden, malpractice exposure or professional autonomy. The professional envelope is therefore a contextual rationale for future research, not an operationalised construct or tested mechanism. The data cannot show that dental practices differ from accounting firms, law practices or unregulated service SMEs.

2.2 Creativity, innovation and the possibility of blended capabilities

The creativity and innovation literatures distinguish idea generation from implementation (Amabile, 1996; Ward, 2004; Drucker, 1985; Schumpeter, 1934), while meta-analytic work connects innovation with SME performance (Rosenbusch et al., 2011). Recent applied-management work likewise treats creative involvement and strategic innovation as capability and implementation problems (Boikanyo, 2025; Sürücü et al., in press). In small professional firms, however, the person generating an idea may also be responsible for adopting it. Creativity under constraints can therefore blend ideation with implementation (Acar et al., 2019; Rosso, 2014), while digital transformation combines external search with internal service change (Naamati-Schneider, 2024). Whether context-adapted items recover their intended creativity and innovation constructs or yield blended practice-development orientations is therefore an empirical measurement question.

2.3 Response quality in online practitioner surveys

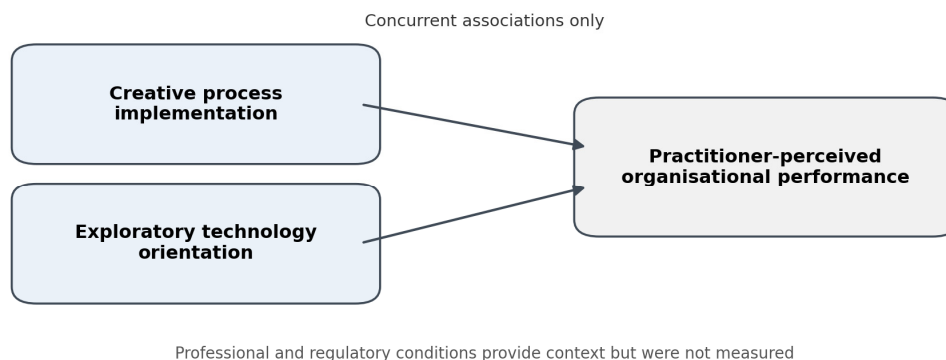
Research on careless and insufficient-effort responding shows that attention failures, long strings and duplicate patterns can alter covariance estimates and factor solutions (Meade and Craig, 2012; Curran, 2016). Screening is therefore relevant to applied practitioner surveys. However, a change after screening does not by itself prove that excluded respondents were invalid, nor does it identify the direction or size of common-method bias. The present study reports screening rules and sensitivity estimates so readers can evaluate the dependence of the results on those choices.

2.4 Research questions

Three research questions organise the study. RQ1: What sample-specific practice-development dimensions emerge from the creativity and innovation items reported by practitioners in Saudi private dental practices? RQ2: Do the retained dimensions carry independent concurrent associations with practitioner-perceived organisational performance? RQ3: How stable are those associations across response-screening rules, respondents with and without formal decision authority, alternative performance-item specifications and internal cross-validation? These questions address measurement and managerial interpretation. They do not test whether regulatory constraint suppresses adoption relative to unregulated firms, because regulation was not measured, and they do not advance causal hypotheses.

For applied management, RQ2 indicates whether CPI and ETO merit separate treatment as candidate capability domains when support programmes are designed. RQ3 tests whether that interpretation remains stable when evaluators change response screening, informant authority or outcome composition. Because formal authority can shape who selects and implements ideas (Cortes and Kiss, 2023; Keum and See, 2017), the authority check also informs respondent selection in future programme evaluations. Positive associations can justify testing support directed at these domains, but they cannot show that such support improves performance.

Figure 1 Exploratory non-causal analytical model



Note: Solid arrows denote concurrent associations estimated in the study; they do not denote causal effects. Professional and regulatory conditions were discussed as context but were not measured.

3 Method

3.1 Sample and procedure

The study used a quantitative, cross-sectional design targeting practitioners working in private dental practices in Saudi Arabia. Because no comprehensive sampling frame was available, respondents were recruited through professional networks, dental associations and online platforms, with participation across all five major Saudi regions (Bryman, 2016). An online Qualtrics questionnaire was administered from 4 February to 5 May 2026; 172 of the 174 retained responses were recorded in February 2026.

The unit of observation is the individual practitioner acting as an informant about a practice. No practice identifier was collected, so the data do not reveal how many distinct practices are represented or whether several respondents worked in the same practice. Practice-level clustering could not be estimated or corrected; this is addressed as a limitation rather than assuming all 174 responses represent independent firms.

A total of 250 records were exported. The analytic sample was defined by four sequential screening criteria applied to the raw export: (a) removal of 5 preview/test records generated during survey testing; (b) removal of 16 responses failing the opening eligibility screen confirming current work in a private dental practice; (c) removal of 9 responses failing an embedded attention-check item instructing respondents to select 'Agree'; and (d) removal of 46 responses with identical answers to every construct item, which were flagged as possible invariant or straight-line patterns under the prespecified screen (Meade and Craig, 2012; Curran, 2016). This yielded a final primary sample of $N = 174$. Flagged invariant patterns constituted 21% of eligibility- and attention-qualified responses. Section 4.3 reports how retaining them changed the estimates without assuming that every flagged response was invalid.

Table 1 presents the screening flow and sample profile. Respondents were evenly split by gender (87/87) and distributed across the five regions (29–39 per region). By role, 9 (5.2%) were owners, 24 (13.8%) partners, 21 (12.1%) managers, 103 (59.2%) employed dentists and 17 (9.8%) other practitioners. The outcome is therefore described throughout as practitioner-perceived organisational performance, not audited practice performance. Owners, partners and managers are more likely to observe income, expansion and competitive position directly; the authority-only analysis in Section 4.5 addresses this informant concern. In total, 134 respondents (77.0%) worked in practices reporting ten or fewer dentists. Practice size records the number of dentists, not formal SME status under Monsha'at criteria (Monsha'at, 2024).

3.2 Instrument and item pool

The questionnaire used five-point agreement scales (1 = strongly disagree; 5 = strongly agree). The items were context-adapted and, in several cases, newly worded for this study; they are not presented as verbatim items from one validated scale. Item-level conceptual sources are reported in Appendix A. Entrepreneurial-trait items were informed by Lumpkin and Dess (1996) and Rauch et al. (2009); creative-thinking items by Amabile (1996) and Ward (2004); innovation-implementation items by Drucker (1985), Rosenbusch et al. (2011) and healthcare-innovation work (Omachonu and Einspruch, 2010); and subjective performance items by the entrepreneurial-orientation and SME-performance traditions (Rauch et al., 2009; Rosenbusch et al., 2011). The

analysed pool comprised ten creativity/innovation items, six performance items and eleven entrepreneurial-trait items. The item-development and retention trail is reported in line with established guidance for survey measures (Hinkin, 1998).

One performance item ('Our innovative efforts have resulted in measurable business growth') was excluded before outcome construction because it attributes growth to innovation in the item wording and would create predictor-outcome overlap. The reverse-worded entrepreneurial-trait item ('I avoid making changes in my clinic unless success is guaranteed') behaved inconsistently after reverse scoring; the traits pool was ultimately excluded because it did not yield a stable, interpretable solution. Appendix A reports every item and its analytic disposition.

Table 1 Sample screening flow and profile

<i>Screening step/characteristic</i>	<i>n</i>
Records exported	250
Preview/test records removed	−5
Ineligible responses removed (eligibility screen)	−16
Attention-check failures removed	−9
Invariant response patterns removed	−46
Final primary sample	174
Practice owners / partners / managers	9 / 24 / 21
Employed dentists	103
Other roles (15 interns, 1 master's student, 1 consultant)	17
Practices with ten or fewer dentists	134 (77.0%)
Gender (even split)	87 / 87
Distinct practices represented	Not collected

Note: Responses collected 4 February–5 May 2026; 172 of 174 collected in February 2026.

3.3 Measure development: polychoric exploratory factor analysis

Because responses were ordinal, exploratory factor analysis used polychoric correlations, principal-axis extraction and promax rotation (Holgado-Tello et al., 2010). Parallel analysis compared observed eigenvalues with the 95th-percentile eigenvalues from 1,000 random normal datasets with the same N and number of variables (Horn, 1965). It was run for both the initial ten-item pool (seed 355435) and the final eight-item pool (seed 355436). Items in the prespecified two-factor screening step required a primary pattern loading of at least 0.40 and no cross-loading of 0.30 or higher. Table 2 reports every numerical parallel-analysis result. Tables 3A–3C report the initial three-factor inspection, the complete two-factor screening matrix and the final solution separately. Internal consistency is reported as Cronbach's alpha and McDonald's omega (Dunn et al., 2014).

In the initial ten-item pool, three observed roots (3.386, 1.518 and 1.298) exceeded the corresponding random 95th-percentile benchmarks (1.510, 1.344 and 1.238). Parallel analysis therefore suggested a possible third factor. The three-factor promax solution was inspected (Table 3A) but not retained because its salient indicators combined generating multiple solutions (CT2), willingness to change routines (CT6) and digital tools for

patient experience (IN4), which did not define a coherent domain distinct from the two candidate orientations. The third root exceeded its benchmark only narrowly, and the solution reassigned theoretically heterogeneous items. This judgement is exploratory and does not rule out a three-factor structure in another sample.

The study then applied the prespecified two-factor item-screening criteria to the complete ten-item pool (Table 3B). CT3 loaded 0.292 on CPI and 0.251 on ETO; CT6 loaded 0.306 and 0.363. Neither met the 0.40 primary-loading threshold, and CT6 exceeded the 0.30 cross-loading threshold. After their removal and re-estimation, parallel analysis of the eight retained items supported two factors: the first two observed eigenvalues (2.762 and 1.517) exceeded their random benchmarks (1.444 and 1.287), whereas the third did not (1.064 versus 1.167). The final pattern matrix appears in Table 3C. ETO comprised finding new solutions to recurring problems, seeking ideas outside dentistry, introducing techniques or technologies and using digital tools to improve patient experience. CPI comprised generating multiple solutions, connecting ideas to improve services, implementing service-delivery methods and improving internal workflows. The removal and re-estimation sequence is sample-dependent and requires independent replication.

For perceived organisational performance (POP), the primary three-item composite retained income and patient growth, service expansion and competitive position. Patient retention correlated more strongly with the CPI item set ($r = 0.56$) than with the other performance items (item-rest $r = 0.26$), while capacity growth correlated more strongly with ETO ($r = 0.48$) than with its own scale (item-rest $r = 0.37$). These two items were excluded from the primary outcome to preserve predictor-outcome separation and were restored individually and jointly in Section 4.5 as sensitivity tests. The innovation-attributing growth item remained excluded.

Each composite was scored as the arithmetic mean of its retained items; the retained sample had complete item responses, so no imputation was used. Composite scores were standardised only for regression. CPI had $\alpha = 0.667$ and $\omega = 0.692$; ETO had $\alpha = 0.656$ and $\omega = 0.703$; POP had $\alpha = 0.620$ and $\omega = 0.681$. These values are modest. CPI and ETO are therefore sample-specific exploratory dimensions, not validated scales. The final two-factor correlation was 0.410, while the correlation between mean composites was 0.297. Independent research should test confirmatory fit and measurement invariance across professional roles, regulatory institutions, professions and national contexts before comparing scores.

Table 2 Parallel-analysis results for the initial ten-item and final eight-item pools

<i>Item pool</i>	<i>Root</i>	<i>Observed eigenvalue</i>	<i>Random 95th percentile</i>	<i>Decision</i>
Initial 10-item	1	3.386	1.510	Retain
Initial 10-item	2	1.518	1.344	Retain
Initial 10-item	3	1.298	1.238	Inspect third factor
Initial 10-item	4	0.998	1.150	Do not retain
Initial 10-item	5	0.873	1.071	Do not retain
Initial 10-item	6	0.569	1.003	Do not retain
Initial 10-item	7	0.469	0.937	Do not retain
Initial 10-item	8	0.361	0.869	Do not retain

Table 2 Parallel-analysis results for the initial ten-item and final eight-item pools (continued)

<i>Item pool</i>	<i>Root</i>	<i>Observed eigenvalue</i>	<i>Random 95th percentile</i>	<i>Decision</i>
Initial 10-item	9	0.272	0.798	Do not retain
Initial 10-item	10	0.257	0.725	Do not retain
Final 8-item	1	2.762	1.444	Retain
Final 8-item	2	1.517	1.287	Retain
Final 8-item	3	1.064	1.167	Do not retain
Final 8-item	4	0.912	1.079	Do not retain
Final 8-item	5	0.714	1.006	Do not retain
Final 8-item	6	0.468	0.935	Do not retain
Final 8-item	7	0.295	0.858	Do not retain
Final 8-item	8	0.268	0.776	Do not retain

Note: $N = 174$. Each comparison used 1,000 random normal datasets. Seeds were 355435 for the initial pool and 355436 for the final pool.

Table 3A Initial 10-item three-factor promax pattern matrix

<i>Item</i>	<i>Full questionnaire wording</i>	<i>Candidate CPI</i>	<i>Candidate ETO</i>	<i>Unstable F3</i>
CT1	I often find new ways to solve recurring problems in my clinic.	−0.047	0.892	−0.072
CT2	I generate more than one solution before choosing the best one.	0.119	−0.181	0.938
CT3	I can quickly adapt my thinking when circumstances in my clinic change.	0.424	0.401	−0.181
CT4	I connect ideas from different sources to improve clinic services.	0.457	−0.117	0.122
CT5	I actively seek creative ideas outside the dental field to apply in my clinic.	−0.040	0.632	0.066
CT6	I enjoy experimenting with new ideas even if they require changing existing routines.	0.101	0.165	0.486
IN1	My clinic frequently introduces new techniques or technologies.	−0.018	0.346	0.154
IN2	We implement new service-delivery methods to enhance patient satisfaction.	0.564	−0.081	0.204
IN3	We improve internal workflows to reduce time, errors or patient waiting.	0.899	0.104	−0.149
IN4	We use digital tools (for example, online booking, CRM or follow-up systems) to improve patient experience.	−0.119	0.315	0.592

Note: $N = 174$. Polychoric principal-axis factoring with promax rotation. Factors were ordered and signed for interpretability. Factor correlations were 0.332 (candidate CPI/ETO), 0.377 (candidate CPI/F3) and 0.406 (candidate ETO/F3). F3 was not retained because its salient items did not form a coherent distinct domain.

Table 3B Initial 10-item two-factor item-screening matrix

<i>Item</i>	<i>Full questionnaire wording</i>	<i>CPI</i>	<i>ETO</i>	<i>Screening decision</i>
CT1	I often find new ways to solve recurring problems in my clinic.	−0.185	0.837	Retained for re-estimation
CT2	I generate more than one solution before choosing the best one.	0.468	0.209	Retained for re-estimation
CT3	I can quickly adapt my thinking when circumstances in my clinic change.	0.292	0.251	Removed
CT4	I connect ideas from different sources to improve clinic services.	0.539	−0.133	Retained for re-estimation
CT5	I actively seek creative ideas outside the dental field to apply in my clinic.	−0.121	0.708	Retained for re-estimation
CT6	I enjoy experimenting with new ideas even if they require changing existing routines.	0.306	0.363	Removed
IN1	My clinic frequently introduces new techniques or technologies.	−0.035	0.461	Retained for re-estimation
IN2	We implement new service-delivery methods to enhance patient satisfaction.	0.787	−0.149	Retained for re-estimation
IN3	We improve internal workflows to reduce time, errors or patient waiting.	0.671	−0.007	Retained for re-estimation
IN4	We use digital tools (for example, online booking, CRM or follow-up systems) to improve patient experience.	0.131	0.554	Retained for re-estimation

Note: $N = 174$. Complete pattern matrix from the prespecified two-factor screening step. Primary loadings below 0.40 and cross-loadings of 0.30 or higher were grounds for removal. Factor correlation = 0.527.

Table 3C Final eight-item two-factor promax pattern matrix

<i>Item</i>	<i>Full questionnaire wording</i>	<i>CPI</i>	<i>ETO</i>	<i>Retained dimension</i>
CT1	I often find new ways to solve recurring problems in my clinic.	−0.115	0.781	ETO
CT2	I generate more than one solution before choosing the best one.	0.477	0.234	CPI
CT4	I connect ideas from different sources to improve clinic services.	0.580	−0.108	CPI
CT5	I actively seek creative ideas outside the dental field to apply in my clinic.	−0.080	0.672	ETO
IN1	My clinic frequently introduces new techniques or technologies.	0.001	0.425	ETO
IN2	We implement new service-delivery methods to enhance patient satisfaction.	0.652	−0.064	CPI
IN3	We improve internal workflows to reduce time, errors or patient waiting.	0.658	0.029	CPI
IN4	We use digital tools (for example, online booking, CRM or follow-up systems) to improve patient experience.	0.177	0.566	ETO

Note: $N = 174$. Complete pattern matrix after CT3 and CT6 were removed and the model was re-estimated. CPI = creative process implementation; ETO = exploratory technology orientation. Factor correlation = 0.410.

3.4 *Analytical strategy*

RQ2 was examined by regressing standardised POP on standardised CPI and ETO using ordinary least squares with HC3 heteroscedasticity-robust standard errors. RQ3 used four sets of checks: alternative response-screening samples; models restricted to owners, partners and managers and, separately, employed dentists; restoration of patient-retention and capacity-growth items to POP; and 50 repetitions of ten-fold cross-validation of the fixed composite regression. Within each repetition, predictions for the ten held-out folds were pooled and one out-of-sample R^2 was calculated against the complete observed outcome vector; reported summaries describe the 50 repetition-level R^2 statistics. The random seed was 355435. Cross-validation evaluates internal regression stability but does not provide an independent validation sample for the factor structure. A split-sample EFA was not used because halves of $N = 174$ would be too small for stable ordinal factor recovery. Harman's single-factor result is reported descriptively only and is not treated as evidence that common-method bias is absent (Podsakoff et al., 2003; Podsakoff et al., 2024).

3.5 *Ethical considerations and declarations*

Formal ethics-committee review was not sought before data collection, and no committee-issued approval, waiver or exemption was obtained. The investigators judged the non-clinical professional survey to involve no more than minimal risk; this was an investigator determination rather than an institutional decision. Participation was voluntary and required electronic consent. The opening information stated: 'Participation is voluntary, and all responses are anonymous and will be used for research purposes only. The questionnaire will take approximately 5–7 minutes to complete. By continuing with this questionnaire, you confirm your informed consent to participate in this study'. The questionnaire requested no names, contact details, patient information or other direct identifiers. Participants could stop before submitting the questionnaire. Data were stored securely and used only for academic research. All authors declare that they have no conflicts of interest. The study received no external funding.

4 **Results**

4.1 *Descriptive statistics and correlations*

Table 4 reports descriptive statistics and inter-composite correlations. All means were above the scale midpoint. CPI and ETO correlated 0.297 with each other and 0.575 and 0.537, respectively, with practitioner-perceived performance. Harman's single-factor extraction across the eleven retained items produced a first factor accounting for 33.7% of item variance. This statistic does not diagnose or rule out common-method bias; it is retained only as a descriptive comparison with the earlier analysis (Podsakoff et al., 2024).

Table 4 Descriptive statistics and correlations ($N = 174$)

<i>Composite</i>	<i>M</i>	<i>SD</i>	<i>1</i>	<i>2</i>	<i>3</i>
1 Creative process implementation	3.54	0.78	—		
2 Exploratory technology orientation	3.61	0.75	0.297***	—	
3 Perceived organisational performance	3.54	0.80	0.575***	0.537***	—

Note: Scale range = 1-5. *** $p < 0.001$ (two-tailed). POP denotes practitioner-perceived organisational performance.

4.2 Primary model: concurrent associations with perceived performance (RQ2)

Table 5 reports the primary model. CPI ($\beta = 0.456$, HC3 SE = 0.085, $p < 0.001$) and ETO ($\beta = 0.401$, HC3 SE = 0.069, $p < 0.001$) each carried an independent concurrent association with practitioner-perceived performance, with $R^2 = 0.478$. The model demonstrates that each self-reported orientation contains information about the respondent's performance evaluation beyond the other orientation. It does not show that either orientation causes objective practice performance.

Table 5 Regression of practitioner-perceived organisational performance on the retained dimensions

<i>Predictor</i>	β (HC3 SE)	95% CI	<i>p</i>
Creative process implementation	0.456 (0.085)	[0.290, 0.623]	<0.001
Exploratory technology orientation	0.401 (0.069)	[0.266, 0.537]	<0.001
R^2	0.478		

Note: $N = 174$. Standardised OLS coefficients with HC3 heteroscedasticity-robust standard errors. Associations are concurrent and non-causal.

4.3 Stability across specifications (RQ3)

Table 6 reports sensitivity to response-screening specifications. Both coefficients remained positive and statistically significant in every specification. The unique-response-vector sample ($n = 141$) yielded CPI $\beta = 0.406$, ETO $\beta = 0.378$ and $R^2 = 0.418$. The February-only sample ($n = 172$) was close to the primary model ($R^2 = 0.480$). Retaining the 46 invariant responders produced larger coefficients and $R^2 = 0.645$ rather than 0.478. This comparison establishes sensitivity to the screening rule. It does not prove that every invariant response was invalid, determine why the estimates changed or quantify common-method bias.

4.4 Exploratory secondary analysis: decision authority

The interaction model compared owners, partners and managers ($n = 54$) with employed dentists ($n = 103$), excluding other roles (model $n = 157$). Neither interaction reached significance (CPI x authority: $\beta = 0.100$, $p = 0.608$; ETO x authority: $\beta = -0.196$, $p = 0.195$), and the authority main effect was null ($p = 0.948$). These null interactions are underpowered and hypothesis-generating. They do not establish equivalence between roles.

Table 6 Sensitivity analyses across response-screening specifications

<i>Specification</i>	<i>CPI β (HC3 SE)</i>	<i>ETO β (HC3 SE)</i>	<i>R²</i>
Primary screened sample ($n = 174$)	0.456 (0.085)***	0.401 (0.069)***	0.478
Eligibility/attention only, invariant responders retained ($n = 220$)	0.486 (0.078)***	0.429 (0.067)***	0.645
Unique response vectors ($n = 141$)	0.406 (0.114)***	0.378 (0.089)***	0.418
February-only ($n = 172$)	0.458 (0.085)***	0.402 (0.069)***	0.480

Note: *** $p < 0.001$. The unique-response-vector specification excludes all members of any duplicated answer pattern across the questionnaire items (33 responses in duplicate groups). Differences across rows show sensitivity to screening; they do not identify invalid responses or common-method bias.

4.5 Informant, outcome and internal-validation checks

Restricting the model to owners, partners and managers ($n = 54$) produced positive coefficients for CPI ($\beta = 0.524$, HC3 SE = 0.157, $p = 0.002$) and ETO ($\beta = 0.313$, HC3 SE = 0.124, $p = 0.015$), with $R^2 = 0.449$. The employed-dentist model showed the same direction. Restoring patient retention, capacity growth or both items to POP also preserved both positive associations, although coefficients and R^2 increased. That increase supports the decision to keep the less overlapping three-item outcome as primary. Across 50 repeated ten-fold partitions (seed 355435), the fixed primary model had mean out-of-sample $R^2 = 0.451$ (2.5th-97.5th percentile across the 50 pooled-prediction repetition statistics: 0.439-0.464). This is an internal regression check, not independent factor validation.

Table 7 Informant and performance-item robustness checks

<i>Specification</i>	<i>n</i>	<i>CPI β (HC3 SE)</i>	<i>ETO β (HC3 SE)</i>	<i>R²</i>
Owners, partners and managers	54	0.524 (0.157)**	0.313 (0.124)*	0.449
Employed dentists	103	0.417 (0.117)***	0.464 (0.092)***	0.503
POP core + patient retention	174	0.588 (0.055)***	0.400 (0.047)***	0.646
POP core + capacity growth	174	0.441 (0.069)***	0.487 (0.070)***	0.560
POP core + both restored items	174	0.549 (0.049)***	0.470 (0.052)***	0.676

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. POP core contains income/patient growth, service expansion and competitive position. The innovation-attributing growth item remains excluded in every specification.

5 Discussion

The study provides preliminary measurement and sensitivity evidence rather than a dentistry-specific theory. In this sample, eight context-adapted items formed two blended practice-development dimensions. Creative process implementation (CPI) combined the generation of alternative solutions with the implementation of service and workflow improvements, whereas exploratory technology orientation (ETO) combined recurring-problem solving, external idea search and the use of new technologies. Both dimensions

were independently and positively associated with practitioner-perceived organisational performance. The direction of these associations remained stable across response-screening, informant and outcome specifications, although coefficient magnitudes and explained variance varied materially. Repeated ten-fold cross-validation also indicated internal predictive stability, but it did not independently validate the factor structure.

The blended item structure is compatible with work settings in which practitioners both generate and implement improvements (Acar et al., 2019; Dąbrowski et al., 2025; Tuan, 2025). It is also consistent with applied-management research that treats creative involvement and strategic innovation as capability and implementation processes (Boikanyo, 2025; Sürücü et al., in press). In small professional-service firms, the individuals identifying problems and generating ideas may also be responsible for introducing new practices and technologies. The structure may therefore reflect the close relationship between ideation and implementation in small firms or digital change that combines external search with internal workflow redesign (Naamati-Schneider, 2024). However, the study cannot determine whether this structure is distinctive to dentistry, shared by other regulated professional services or produced by the wording of this particular item pool. Addressing that question requires comparative samples and measurement-invariance testing across professions, institutions and national contexts.

The response-quality analysis provides a methodological contribution. Retaining invariant response patterns produced larger coefficients and explained variance, while the direction and statistical significance of both associations remained stable. This demonstrates that estimated magnitudes can depend materially on screening decisions in practitioner surveys. It does not demonstrate that every excluded response was careless or invalid, explain why the estimates changed, or establish that screening corrected common-method bias. Applied studies should therefore report their screening rules, exclusion counts and sensitivity estimates so that readers can evaluate the consequences of those decisions.

The relatively large correlations and R^2 values require caution. The predictors and outcome were reported by the same respondents at the same time, and employees may have uneven access to information concerning income, growth and competitive position. Restricting the analysis to owners, partners and managers partially addresses this informant concern but does not eliminate it because the resulting model remains cross-sectional and perceptual. Contemporary reviews emphasise that no single diagnostic, including Harman's single-factor test, can establish the absence or magnitude of common-method bias (Podsakoff et al., 2024). The estimates therefore describe associations within this particular sample and research design; they should not be interpreted as causal effects on objective organisational performance or as a quantified upper bound.

6 Implications for policy and practice

The applied implication is a testable programme hypothesis. Providers serving small professional firms could pilot an integrated package combining structured problem-solving, exposure to external techniques and technologies, and support for translating selected ideas into service or workflow changes. The present survey did not evaluate such a programme, so it does not establish effectiveness, dosage or cost-effectiveness. A

suitable evaluation would use pre-registered outcomes, comparison practices, multi-source data and administrative indicators of verified adoption and performance.

7 Limitations and future research

Several limitations define the study's scope. First, CPI and ETO were developed and related to POP in the same sample. Repeated cross-validation supports internal regression stability but cannot substitute for independent confirmatory measurement. Second, all variables are concurrent self-reports. POP is a practitioner's perception, not audited revenue, patient volume, service quality or market position, and same-source bias cannot be quantified from these data. Third, most respondents were employed dentists or other non-owner practitioners with uneven access to organisational information; the $n = 54$ authority-only model is reassuring but small. Fourth, practice identifiers were not collected. The number of distinct practices is unknown, multiple respondents may come from the same practice, and standard errors could be optimistic if responses are clustered. Fifth, convenience sampling and inclusion of interns and other roles limit population generalisation. Sixth, regulatory stringency, licensing burden, liability exposure, professional autonomy, competition, practice age and formal firm size were not measured. The professional-envelope argument is therefore contextual scaffolding, not an empirical finding. Future studies should refine the item pool, test confirmatory fit and measurement invariance across roles, professions, institutions and countries, sample identifiable practices for multilevel analysis, and link practitioner reports to longitudinal objective outcomes. Future research should measure regulatory-navigation needs directly and test whether they influence adoption; until then, regulatory-navigation assistance remains an untested hypothesis rather than a recommendation supported by these data.

8 Conclusions

Using screened survey responses from 174 practitioners in Saudi private dental practices, this study identified two sample-specific dimensions from eight context-adapted creativity and innovation items: creative process implementation (CPI) and exploratory technology orientation (ETO). Both dimensions were independently and positively associated with practitioner-perceived organisational performance. The direction of these associations remained stable across response-screening, informant and outcome specifications, although their magnitude varied materially. Repeated cross-validation also indicated internal predictive stability. These findings do not establish causality, objective performance effects, dentistry-specific behaviour or a regulatory mechanism. The study's main contribution is a transparent exploratory measurement and sensitivity analysis that provides a basis for independent confirmatory research using multi-source data and for the rigorous evaluation of management-support pilots.

Declarations

The authors declare that they have no conflicts of interest.

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Appendix A: Questionnaire items and item-specific sources

All construct items used a five-point response scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). Items were context-adapted or newly worded for this study and are not claimed as verbatim items from a single validated instrument. Demographic variables were not included in the factor models. The table reproduces the exact question and section wording preserved in the supplied Qualtrics export, the consent wording supplied by the authors, item-specific conceptual sources and analytic use.

Participant information and consent wording presented at the start of the questionnaire: ‘Participation is voluntary, and all responses are anonymous and will be used for research purposes only. The questionnaire will take approximately 5–7 minutes to complete. By continuing with this questionnaire, you confirm your informed consent to participate in this study’.

Table A1 Complete questionnaire content recoverable from the supplied records

<i>Code</i>	<i>Questionnaire wording</i>	<i>Response options, source and analytic use</i>
Consent	Participation is voluntary, and all responses are anonymous and will be used for research purposes only. The questionnaire will take approximately 5–7 minutes to complete. By continuing with this questionnaire, you confirm your informed consent to participate in this study.	Electronic continuation/consent required. The wording is reproduced as administered; Section 3.5 clarifies the platform-generated metadata.
Eligibility	Do you currently work in a private dental practice in Saudi Arabia?	Yes/No; eligibility screen.
D1	What is your gender?	Export codes 1–2; category labels were not retained in the supplied export. Demographic item.
D2	What is your age group?	Export codes 1–5; category labels were not retained in the supplied export. Demographic item.
D3	What is your highest academic qualification?	Export codes 1–3; category labels were not retained in the supplied export. Demographic item.
D4	Which region do you currently practise in?	Export codes 1–5 for the five Saudi regions; category labels were not retained in the supplied export. Demographic item.
D5	How many years of experience do you have in dentistry?	Export codes 1–4; category labels were not retained in the supplied export. Demographic item.
D6	What is your current role in the clinic?	Owner; partner; manager; employed dentist; other (please specify). Used for the authority robustness analysis.

Table A1 Complete questionnaire content recoverable from the supplied records (continued)

<i>Code</i>	<i>Questionnaire wording</i>	<i>Response options, source and analytic use</i>
D7	What is the size of your clinic (in terms of number of dentists)?	Export codes 1–4. Study documentation indicates a solo category and that codes 1–3 represented 10 or fewer dentists; exact labels were not retained.
Section B	The following statements assess entrepreneurial characteristics related to managing and developing a dental practice. These traits reflect risk-taking, proactiveness, achievement motivation, and internal locus of control. Please indicate your level of agreement.	1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.
ET1	I enjoy taking calculated risks to improve my practice.	Lumpkin and Dess (1996); Rauch et al. (2009). Traits pool not retained.
ET2	I invest in new equipment or technology even when outcomes are uncertain.	Lumpkin and Dess (1996); Rauch et al. (2009). Traits pool not retained.
ET3	I try new services or treatment approaches before other clinics do.	Lumpkin and Dess (1996); Rauch et al. (2009). Traits pool not retained.
ET4	I avoid making changes in my clinic unless success is guaranteed.	Lumpkin and Dess (1996); Rauch et al. (2009). Reverse-worded; excluded.
ET5	I set challenging goals and strive to achieve them.	McClelland (1961). Newly worded achievement-motivation item; traits pool not retained.
ET6	I regularly monitor my clinic's performance to ensure improvement.	McClelland (1961); Drucker (1985). Newly worded achievement/performance-monitoring item; traits pool not retained.
ET7	I feel dissatisfied when my clinic's performance remains unchanged for a long period.	McClelland (1961). Newly worded achievement-motivation item; traits pool not retained.
ET8	I push myself to improve even when my clinic is already performing well.	McClelland (1961). Newly worded achievement-motivation item; traits pool not retained.
ET9	My clinic's success mainly depends on my decisions and actions.	Rotter (1966). Newly worded internal-locus-of-control item; traits pool not retained.
ET10	When problems occur in my clinic, I focus on what I can personally do to solve them.	Rotter (1966). Newly worded internal-locus-of-control item; traits pool not retained.
ET11	I believe that my management decisions directly influence patient satisfaction.	Rotter (1966). Newly worded internal-locus-of-control item; traits pool not retained.

Table A1 Complete questionnaire content recoverable from the supplied records (continued)

<i>Code</i>	<i>Questionnaire wording</i>	<i>Response options, source and analytic use</i>
Section C	The following statements assess your creative thinking abilities and approaches to problem-solving within your dental practice. Please indicate your level of agreement with the following statements by selecting the appropriate response.	1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.
CT1	I often find new ways to solve recurring problems in my clinic.	Amabile (1996); Ward (2004). Retained in ETO.
CT2	I generate more than one solution before choosing the best one.	Amabile (1996); Ward (2004). Retained in CPI.
CT3	I can quickly adapt my thinking when circumstances in my clinic change.	Amabile (1996); Ward (2004). Removed after exploratory item screening.
CT4	I connect ideas from different sources to improve clinic services.	Amabile (1996); Ward (2004). Retained in CPI.
CT5	I actively seek creative ideas outside the dental field to apply in my clinic.	Amabile (1996); Ward (2004). Retained in ETO.
CT6	I enjoy experimenting with new ideas even if they require changing existing routines.	Amabile (1996); Ward (2004). Removed after exploratory item screening.
Section D	The following statements assess the extent to which innovative practices, technologies, and service-delivery methods are implemented in your dental clinic. Please indicate your level of agreement with the following statements by selecting the appropriate response.	1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.
IN1	My clinic frequently introduces new techniques or technologies.	Drucker (1985); Rosenbusch et al. (2011); Omachonu and Einspruch (2010). Retained in ETO.
IN2	We implement new service-delivery methods to enhance patient satisfaction.	Drucker (1985); Rosenbusch et al. (2011); Omachonu and Einspruch (2010). Retained in CPI.
AC	To confirm that you are paying attention, please select Agree (4).	Instructional attention check; expected response = 4.
IN3	We improve internal workflows to reduce time, errors or patient waiting.	Drucker (1985); Rosenbusch et al. (2011); Omachonu and Einspruch (2010). Retained in CPI.
IN4	We use digital tools (for example, online booking, CRM or follow-up systems) to improve patient experience.	Drucker (1985); Rosenbusch et al. (2011); Omachonu and Einspruch (2010). Retained in ETO.
Section E	The following statements assess the level of growth and performance of your dental practice over time. Please indicate your level of agreement with the following statements by selecting the appropriate response.	1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.

Table A1 Complete questionnaire content recoverable from the supplied records (continued)

<i>Code</i>	<i>Questionnaire wording</i>	<i>Response options, source and analytic use</i>
POP1	My clinic's income and patient numbers have increased steadily over the past two years.	Rauch et al. (2009); Rosenbusch et al. (2011). Primary POP.
POP2	Our innovative efforts have resulted in measurable business growth.	Rauch et al. (2009); Rosenbusch et al. (2011). Newly worded; excluded a priori because it attributes growth to innovation.
POP3	The clinic has expanded its services over time.	Rauch et al. (2009); Rosenbusch et al. (2011). Primary POP.
POP4	Patient retention and repeat visits have improved over time.	Rauch et al. (2009); Rosenbusch et al. (2011). Removed from primary POP; restored in sensitivity analysis.
POP5	The clinic's competitive position in the market has improved.	Rauch et al. (2009); Rosenbusch et al. (2011). Primary POP.
POP6	Over the past two years, my clinic has increased its clinical capacity (for example, staff, chairs or operating hours).	Rauch et al. (2009); Rosenbusch et al. (2011). Removed from primary POP; restored in sensitivity analysis.

Note: The supplied spreadsheet preserved numeric response codes but not the category labels for D1-D5 and D7. The code sets are reported rather than reconstructing unverified labels. If the original Qualtrics QSF or survey PDF is recovered, it should be supplied as supplementary material so those labels can be reproduced exactly.