

From Craft to Sustainable Enterprise: How Entrepreneurial Capabilities and Design–Execution Integration Drive Product Quality and Sustainable Performance in Indian Furniture Handicraft Ventures



Neer Shah¹, Malay Patel²

¹Assistant Professor, Unitedworld Institute of Design, Karnavati University, Gandhinagar, Gujarat-382422, India. Email: neershah@karnavatiuniversity.edu.in. ORCID: 0009-0007-2183-8821

²Associate Professor, Unitedworld Institute of Design, Karnavati University, Gandhinagar, Gujarat-382422, India. Email: malaypatel@karnavatiuniversity.edu.in. ORCID: 0000-0001-8237-242X

Abstract

Purpose: Handicraft furniture ventures in India are typically owner-managed micro and small enterprises that must modernise their quality systems while remaining economically, socially and environmentally viable. This study examines how entrepreneurial and strategic capabilities shape design–execution integration, product quality and sustainable entrepreneurial performance.

Design/methodology/approach: An integrated resource-based view, dynamic capability, socio-technical systems and total quality management framework was tested using survey data from 384 entrepreneurs in five Indian furniture-handicraft clusters. Data were analysed with PLS-SEM, bootstrapped serial mediation and a neural network (ANN) sensitivity analysis.

Findings: Entrepreneurial orientation, digital design enablement, human capital design competence, supplier ecosystem alignment, client requirement integration and sustainability-oriented quality governance all significantly predicted design–execution integration excellence ($R^2 = 0.316$). Integration improved product quality ($\beta = 0.509$), and both integration and quality improved sustainable performance ($R^2 = 0.293$). Integration and quality served as sequential mediators. Client requirement integration was the most influential predictor.

Originality: The study reframes quality management in craft enterprises as an entrepreneurial capability and links it to triple-bottom-line outcomes, combining explanatory (PLS-SEM) and predictive (ANN) evidence in an under-studied Asian context.

Implications: Entrepreneurs, cluster agencies and policymakers should invest in client-integration routines, digital design tools and supplier partnerships to build sustainable craft enterprises.

Keywords: entrepreneurship; sustainable entrepreneurship; entrepreneurial orientation; dynamic capabilities; quality management; design–execution integration; handicraft MSMEs; India, JEL/Subject classification: L26, L67, M13, Q56, O14

1. Introduction

Entrepreneurship in the craft economy is a double-edged proposition. On one side, handicraft ventures preserve cultural heritage, absorb labour in artisan clusters and give small entrepreneurs a route into domestic and export markets. On the other, they typically operate with thin margins, fragmented supply chains, limited technical systems and heavy dependence on the individual skill of the artisan. In India, wooden and mixed-material furniture handicrafts are concentrated in clusters where owner-managers combine design, procurement, production supervision, selling and customer service in a single role. Such entrepreneurs are increasingly expected to deliver export-grade quality, respond to customised orders, adopt digital tools and, at the same time, demonstrate responsible use of timber,

finishes and labour. These pressures coincide with global attention to sustainable development (United Nations, 2015) and with a growing view that entrepreneurial ventures can be vehicles for, not merely participants in, sustainability transitions (Shepherd & Patzelt, 2011; Muñoz & Cohen, 2018).

Quality is the point at which these expectations converge. A well-made piece of furniture reduces returns, rework and waste of scarce raw material; it earns repeat orders and premium prices; it protects artisan livelihoods; and it lengthens product life, which is itself an environmental outcome. Yet quality in craft production is not simply a matter of inspection. It emerges from the way design intent is translated into production routines, materials and finishing decisions (Ulrich & Eppinger, 2012; Swink &

Calantone, 2004). When designers, artisans, suppliers and clients are poorly coordinated, even highly skilled craftspeople produce inconsistent outcomes. Quality management research has long argued that organisational practices, rather than isolated technical fixes, determine quality performance (Flynn et al., 1994; Sousa & Voss, 2002; Kaynak, 2003), but most evidence comes from large manufacturers and formal quality-certified firms. How owner-managed craft ventures build the integrative capability that quality requires, and whether doing so also advances sustainable performance, remains largely unexamined.

Three gaps motivate this study. First, entrepreneurship research has established that an entrepreneurial orientation (EO) is associated with firm performance (Rauch et al., 2009), but it has rarely been examined together with operational and quality capabilities in craft enterprises, leaving unclear whether EO affects outcomes directly or through the organisational routines that convert opportunity-seeking into reliable execution. Second, sustainable entrepreneurship scholarship has focused on motivations, opportunity recognition and venture creation (Dean & McMullen, 2007; Hockerts & Wüstenhagen, 2010; Pacheco et al., 2010), while the operational mechanisms through which established small ventures achieve triple-bottom-line outcomes (Elkington, 1997) are under-theorised. Third, the quality management literature has not systematically integrated resource-based, dynamic-capability and socio-technical perspectives for artisanal contexts, in which technical standardization must be reconciled with creative autonomy.

This paper addresses these gaps by developing and testing an integrated model in which six entrepreneurial and strategic capabilities – entrepreneurial orientation, digital design enablement, human capital design competence, supplier ecosystem alignment, client requirement integration capability and sustainability-oriented quality governance – shape design-execution integration excellence (DEIE), which in turn enhances product quality excellence (PQE) and sustainable entrepreneurial performance (SEP). The study addresses the following research questions:

- RQ1.** How do entrepreneurial and strategic capabilities influence design-execution integration excellence in furniture handicraft ventures?
- RQ2.** Does design-execution integration improve product quality and, through it, sustainable entrepreneurial performance?
- RQ3.** Do design-execution integration and product quality sequentially mediate the effect of entrepreneurial and strategic capabilities on sustainable performance?

- RQ4.** Which capabilities are the strongest predictors of integration excellence when non-linear relationships are allowed?

The study contributes in four ways. It positions quality management in craft MSMEs as an entrepreneurial capability rather than a compliance function. It extends sustainable entrepreneurship research by identifying an operational pathway from capabilities to triple-bottom-line performance. It integrates four theoretical lenses – the resource-based view, dynamic capabilities, socio-technical systems theory and total quality management – into a single testable framework. And it combines explanatory (PLS-SEM) and predictive (ANN) analyses, an approach that has been advocated for strengthening the practical value of structural models (Leong et al., 2020; Hair et al., 2019). The remainder of the paper is organized as follows: Section 2 develops the theory and hypotheses; Section 3 describes the method; Section 4 reports the results; Section 5 discusses theoretical, managerial and policy implications; and Section 6 concludes with limitations and directions for future research.

2. Theoretical Background and Hypothesis Development

2.1 Theoretical lenses

2.1.1 Resource-based view and the natural-resource-based view

The resource-based view (RBV) holds that sustained advantage arises from resources and capabilities that are valuable, rare, inimitable and organised for exploitation (Barney, 1991; Peteraf, 1993). For small craft ventures, such resources are rarely physical assets; they are tacit design knowledge, artisan skill, trusted supplier relationships and accumulated understanding of clients. Hart (1995) extended the logic to the natural environment, arguing that capabilities such as pollution prevention and product stewardship can themselves be sources of advantage, and Aragón-Correa and Sharma (2003) showed that the value of proactive environmental strategy depends on the firm's capabilities and context. RBV therefore explains why enterprises operating in the same cluster and market show markedly different quality and sustainability outcomes: they differ in the bundle of capabilities they have built and in how effectively they deploy them.

2.1.2 Dynamic capabilities

Dynamic capabilities are the ability to sense opportunities, seize them and reconfigure resources in changing environments (Teece et al., 1997; Teece, 2007; Eisenhardt & Martin, 2000; Wang & Ahmed, 2007). Craft ventures face continual shifts in client preferences, e-commerce channels, export standards, material availability and digital design tools. Entrepreneurial behaviours such as innovativeness

and proactiveness can be read as the micro-foundations of such sensing and seizing activities. Dynamic capability theory therefore complements RBV by explaining how the capability bundle is renewed rather than merely held.

2.1.3 Socio-technical systems theory

Socio-technical systems (STS) theory argues that performance depends on the joint optimisation of the social subsystem (people, skills, relationships) and the technical subsystem (tools, processes, technologies) (Trist & Bamforth, 1951; Mumford, 2006). The theory is particularly apt for craft enterprises, where the introduction of CAD, standard operating procedures or quality checkpoints may fail if it alienates artisans whose creative judgement is the venture's core asset. Design-execution integration is, in STS terms, the point at which social and technical subsystems must be aligned if design intent is to survive the journey to the finished product.

2.1.4 Total quality management

Total quality management (TQM) emphasises customer focus, leadership commitment, employee involvement, process management, supplier partnership and continuous improvement (Flynn et al., 1994; Kaynak, 2003). Evidence suggests that the combination of "soft" people-oriented and "hard" process-oriented practices improves quality and innovation performance (Zeng et al., 2015), and recent work discusses how digital technologies are reshaping TQM into "Quality 4.0" (Liu et al., 2023; Frank et al., 2019). In handicrafts, TQM does not seek to eliminate the distinctiveness of handmade work; it seeks to reduce harmful variation (defects, mismatches, delays) while preserving valued variation (aesthetic individuality).

2.1.5 Sustainable entrepreneurship

Sustainable entrepreneurship is concerned with entrepreneurial action that preserves nature, life support and community while creating gains for others (Shepherd & Patzelt, 2011) and with the discovery and exploitation of opportunities created by market failures that damage sustainability (Dean & McMullen, 2007). Reviews emphasize its multi-dimensional outcomes and the need to study how ventures operationalize sustainability beyond intentions (Hall et al., 2010; Muñoz & Cohen, 2018; Kraus et al., 2018; Schaltegger & Wagner, 2011). In line with the triple bottom line (Elkington, 1997), this study conceptualizes sustainable entrepreneurial performance as the venture's combined economic, environmental and social outcomes.

2.2 Hypotheses

2.2.1 Capabilities and design-execution integration excellence

Design-execution integration excellence is defined here as the degree to which design specifications,

material choices, production routines and quality requirements are coordinated so that finished products faithfully realise design intent. It parallels the design-manufacturing integration construct, which has been shown to mediate the influence of organisational antecedents on design quality (Swink & Calantone, 2004), and builds on the broader argument that internal and external integration improves operational performance (Koufteros et al., 2005; Swink et al., 2007; Flynn et al., 2010). Six capabilities are expected to promote it.

Entrepreneurial orientation. EO – innovativeness, proactiveness and risk-taking (Covin & Slevin, 1989; Lumpkin & Dess, 1996) – drives owners to seek new designs, markets and processes. Entrepreneurs high in EO are more likely to experiment with new workflows, adopt tools and reorganise how design and production communicate. EO is linked to performance especially when combined with supportive resources and knowledge (Wiklund & Shepherd, 2003, 2005; Rauch et al., 2009). We therefore expect EO to foster integration.

Digital design enablement. Digital design tools (CAD, shared design repositories, visual communication with clients and workshops) reduce ambiguity between designers and artisans and make specifications explicit. Digital technologies have been linked to improved coordination and sustainability opportunities in manufacturing (Frank et al., 2019; Ghobakhloo, 2020).

Human capital design competence. The ability of designers, supervisors and artisans to interpret design intent in production – including ergonomics, joinery and finishing knowledge – is a knowledge-based resource that supports performance in small firms (Wiklund & Shepherd, 2003) and is central to RBV logic (Barney, 1991).

Supplier ecosystem alignment. Furniture quality depends on timber quality, hardware, finishes and fabricators' reliability. Close, information-sharing relationships with suppliers and sub-contractors improve responsiveness and operational integration (Flynn et al., 2010; Zeng et al., 2015).

Client requirement integration capability. Capturing, interpreting and embedding client requirements in design and production specifications is a form of external integration with customers (Koufteros et al., 2005) and is fundamental to customer-focused quality management (Flynn et al., 1994).

Sustainability-oriented quality governance. Quality governance – standards, checkpoints, feedback loops and continuous improvement – shapes how design and production are aligned (Sousa & Voss, 2002; Kaynak, 2003). Where these systems also embed material efficiency, responsible sourcing and worker safety, the quality system becomes a vehicle for sustainability (Hart, 1995; Aragón-Correa & Sharma, 2003).

On these grounds we hypothesize:

H1: Entrepreneurial and strategic capabilities positively influence design-execution integration excellence (DEIE), specifically:

H1a: Entrepreneurial orientation (EO) → DEIE

H1b: Digital design enablement (DDE) → DEIE

H1c: Human capital design competence (HCDC) → DEIE

H1d: Supplier ecosystem alignment (SEA) → DEIE

H1e: Client requirement integration capability (CRIC) → DEIE

H1f: Sustainability-oriented quality governance (SQG) → DEIE

2.2.2 Integration, quality and sustainable performance

When design and execution are well integrated, mismatches, rework and late changes fall and the finished product more reliably meets specifications (Swink & Calantone, 2004; Ulrich & Eppinger, 2012). Hence, DEIE is expected to improve product quality excellence – conformance, durability, workmanship, finish and customer satisfaction.

H2: DEIE positively influences product quality excellence (PQE).

Quality has direct sustainability implications for craft ventures. Fewer defects and returns reduce waste of timber and finishing materials; durable products extend usage life; consistent quality supports repeat

orders, price premiums and stable employment for artisans. Quality management practices have been linked to operational and financial performance (Kaynak, 2003; Zeng et al., 2015). Sustainable entrepreneurial performance – economic, environmental and social outcomes (Elkington, 1997) – is therefore expected to improve with quality. Integration may also affect sustainable performance directly, because coordinated design and production lead to better use of materials, shorter lead times and more predictable work for artisans (Bocken et al., 2014; Silvestre & Țîrcă, 2019).

H3: PQE positively influences sustainable entrepreneurial performance (SEP).

H4: DEIE positively influences SEP directly.

2.2.3 Mediation

Following the capability-to-outcome logic of RBV and dynamic capabilities, capabilities are not expected to yield performance directly but through the organisational routines they enable (Teece, 2007). Integration is the routine that translates capabilities into quality, and quality is the proximate output through which sustainability benefits materialise. We therefore propose:

H5: PQE mediates the relationship between DEIE and SEP.

H6: Entrepreneurial and strategic capabilities influence SEP indirectly through the sequential mediation of DEIE and PQE (capability → DEIE → PQE → SEP).

Figure 1 depicts the conceptual model. Firm size and firm age are included as control variables because larger and older ventures may differ in resources and performance.

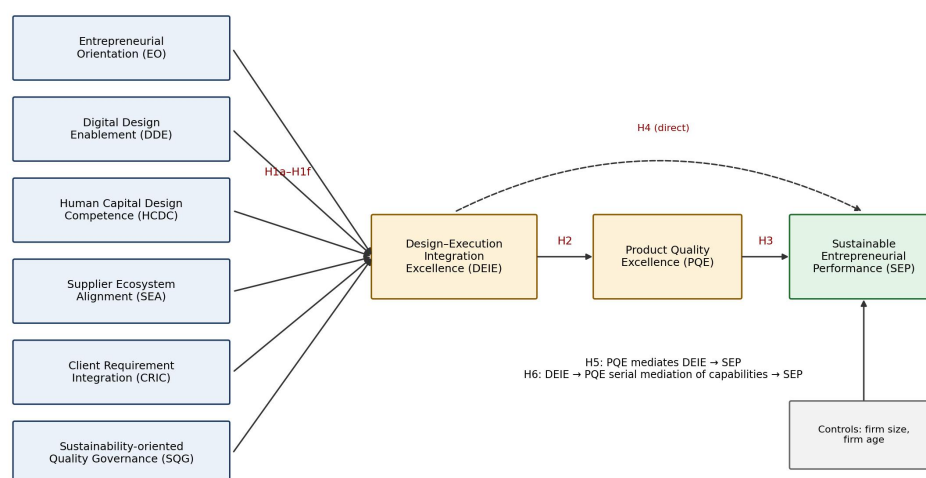


Figure 1. Conceptual model and hypotheses.

3. Research Methodology

3.1 Research design and context

A quantitative, cross-sectional survey design was adopted to test the hypothesized relationships among established multi-item constructs. The study context is Indian furniture handicraft ventures – enterprises that design and produce wooden or mixed-material furniture and decorative furnishings using predominantly hand-based, small-batch methods. Five clusters were selected to capture regional diversity: Saharanpur (Uttar Pradesh), Jodhpur and Jaipur (Rajasthan), Ahmedabad-Gandhinagar (Gujarat) and Kochi-Ernakulam (Kerala). These clusters combine established artisan traditions, export-oriented firms and a growing presence of design-led start-ups.

3.2 Population, sampling and data collection

The unit of analysis is the enterprise, and the respondent is the owner-entrepreneur or founder-manager, who is the individual most knowledgeable about strategy, design, supplier relations and quality. Eligible respondents had owned or co-managed a furniture handicraft venture for at least three years. Purposive sampling was used to select information-rich respondents, and snowball sampling through cluster associations, trade-fair contacts and artisan networks was used to reach informal and unregistered units for which no sampling frame exists. The questionnaire was administered through

personal visits and an online form between [January and May 2026]. Participation was voluntary and anonymous, and respondents were informed of the academic purpose of the study. Incomplete or straight-lined responses were removed, leaving 384 valid responses.

A priori power analysis for a multiple regression with six predictors of DEIE ($\alpha = 0.05$, power = 0.80, small-to-medium effect $f^2 = 0.05$; Cohen, 1988) indicated a minimum sample of 279; the achieved sample of 384 provides power of approximately 0.92 for such an effect and satisfies common PLS-SEM sample-size heuristics (Hair et al., 2022).

3.3 Measures

All constructs were measured with reflective multi-item scales adapted from the literature and rated on five-point Likert scales (1 = strongly disagree, 5 = strongly agree). Items were adapted to the craft-furniture context, reviewed by three academics and two cluster entrepreneurs for content validity, and pilot-tested with 30 entrepreneurs who were excluded from the final sample. Table 1 summarizes the constructs, number of items and primary sources; the full item list appears in Appendix A. Firm size (micro, small, medium) and firm age were used as controls.

Table 1. Questionnaire structure

Construct	Code	Items	Adapted from
Entrepreneurial Orientation	EO	4	Covin & Slevin (1989); Lumpkin & Dess (1996)
Digital Design Enablement	DDE	3	Frank et al. (2019); Ghobakhloo (2020)
Human Capital Design Competence	HCDC	3	Wiklund & Shepherd (2003)
Supplier Ecosystem Alignment	SEA	3	Flynn et al. (2010); Zeng et al. (2015)
Client Requirement Integration Capability	CRIC	3	Koufteros et al. (2005); Flynn et al. (2010)
Sustainability-oriented Quality Governance	SQG	3	Sousa & Voss (2002); Kaynak (2003); Hart (1995)
Design-Execution Integration Excellence	DEIE	5	Swink & Calantone (2004); Koufteros et al. (2005)
Product Quality Excellence	PQE	5	Kaynak (2003); Zeng et al. (2015)
Sustainable Entrepreneurial Performance	SEP	6	Elkington (1997); Shepherd & Patzelt (2011)

Note. All items adapted to the furniture-handicraft context.

3.4 Common method bias and analytical approach

Procedural remedies (anonymity, neutral item wording, separation of predictor and outcome sections) were applied ex ante (Podsakoff et al., 2003). Ex post, Harman's single-factor test and the full-collinearity VIF approach (Kock, 2015) were used. The hypothesised model was estimated with partial least squares structural equation modelling (PLS-SEM) using SmartPLS (Ringle et al., 2024), which is suitable for prediction-oriented, complex models with several constructs and non-normal ordinal data (Hair et al., 2019, 2022). Reflective measurement quality was assessed through indicator loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE; Fornell & Larcker, 1981) and the heterotrait-monotrait ratio (HTMT; Henseler et al., 2015). The structural model was evaluated through collinearity (VIF), path coefficients and their bootstrapped significance (5,000 resamples), R^2 , and f^2 effect sizes (Cohen, 1988). Indirect effects, including the serial mediation, were tested with bootstrapped percentile confidence

intervals (Preacher & Hayes, 2008; Zhao et al., 2010). Finally, following the two-stage SEM-ANN approach (Leong et al., 2020), significant predictors of DEIE were entered into a multilayer-perceptron neural network (one hidden layer, sigmoid activation, 70:30 training-testing split, ten runs) to assess non-linear predictive importance, with root mean square error (RMSE) used to evaluate predictive accuracy.

4. Results

4.1 Sample profile

Table 2 profiles the 384 responding entrepreneurs. Most ventures were micro (53.9%) or small (36.5%) enterprises, 64.8% were registered under Udyam, and 41.1% had export experience. Respondents were predominantly aged 31–50 (62.2%) and 75.8% were male, which reflects the male-dominated ownership pattern in furniture crafts but also highlights the comparatively small share of women entrepreneurs (24.2%) who participated. The sample therefore covers diverse regions, firm sizes and market orientations.

Table 2. Profile of respondents and ventures (N = 384)

Characteristic	Category	Frequency	Percent
Cluster	Saharanpur (UP)	92	24.0
	Jodhpur (Rajasthan)	96	25.0
	Jaipur (Rajasthan)	78	20.3
	Ahmedabad–Gandhinagar (Gujarat)	62	16.1
	Kochi–Ernakulam (Kerala)	56	14.6
Gender	Male	291	75.8
	Female	93	24.2
Age (years)	21–30	41	10.7
	31–40	112	29.2
	41–50	127	33.1
	51–60	77	20.1
	Above 60	27	7.0
Education	Up to higher secondary	74	19.3
	Diploma/ITI	88	22.9
	Undergraduate	134	34.9
	Postgraduate	71	18.5

Characteristic	Category	Frequency	Percent
	Other	17	4.4
Venture age (years)	Up to 5	58	15.1
	6–10	119	31.0
	11–20	121	31.5
	Above 20	86	22.4
Enterprise size	Micro	207	53.9
	Small	140	36.5
	Medium	37	9.6
Registration	Udyam-registered	249	64.8
	Unregistered/informal	135	35.2
Market orientation	Exporting	158	41.1
	Domestic only	226	58.9

4.2 Common method bias and descriptive statistics

The first unrotated factor accounted for 25.0% of the variance, well below the 50% threshold, and all full-collinearity VIFs were below 2.00 (maximum = 1.91),

Below the conservative cut-off of 3.3 (Kock, 2015). Common method bias is therefore unlikely to distort the findings. Construct means ranged from 3.70 to 3.75 on the five-point scale (Table 3), indicating generally favorable self-assessments, and inner VIFs among the six predictors of DEIE ranged from 1.16 to 1.28, indicating no multicollinearity concerns.

Table 3. Descriptive statistics and collinearity diagnostics

Construct	Mean	SD	Full-collinearity VIF	Inner VIF (DEIE)
Entrepreneurial Orientation (EO)	3.73	0.68	1.20	1.16
Digital Design Enablement (DDE)	3.72	0.70	1.21	1.17
Human Capital Design Competence (HCDC)	3.75	0.67	1.26	1.24
Supplier Ecosystem Alignment (SEA)	3.70	0.73	1.29	1.24
Client Requirement Integration Capability (CRIC)	3.73	0.70	1.25	1.18
Sustainability-oriented Quality Governance (SQG)	3.73	0.68	1.30	1.28
Design–Execution Integration Excellence (DEIE)	3.72	0.71	1.91	–
Product Quality Excellence (PQE)	3.72	0.73	1.53	–
Sustainable Entrepreneurial Performance (SEP)	3.73	0.67	1.43	–

Note. Means and SDs computed from item averages on a 1–5 scale.

4.3 Measurement model

Table 4 reports the reflective measurement model. All outer loadings (0.758–0.886) exceeded 0.70; Cronbach's alpha ranged from 0.757 to 0.889, composite reliability from 0.859 to 0.918, and AVE from 0.628 to 0.707, all above the recommended

thresholds of 0.70 (reliability) and 0.50 (convergent validity; Fornell & Larcker, 1981; Hair et al., 2019). Discriminant validity was supported: HTMT values (Table 5) ranged from 0.136 to 0.572, below the conservative 0.85 criterion (Henseler et al., 2015).

Table 4. Measurement model: loadings, reliability and convergent validity

Construct	Item	Loading	Cronbach's α	CR	AVE
EO	EO1	0.791	0.838	0.891	0.672
	EO2	0.860			
	EO3	0.844			
	EO4	0.782			
DDE	DDE1	0.872	0.793	0.878	0.706
	DDE2	0.845			
	DDE3	0.802			
HCDC	HCDC1	0.848	0.788	0.876	0.702
	HCDC2	0.837			
	HCDC3	0.829			
SEA	SEA1	0.845	0.793	0.878	0.707
	SEA2	0.886			
	SEA3	0.788			
CRIC	CRIC1	0.864	0.788	0.875	0.701
	CRIC2	0.860			
	CRIC3	0.786			
SQG	SQG1	0.766	0.757	0.859	0.671
	SQG2	0.868			
	SQG3	0.821			
DEIE	DEIE1	0.758	0.881	0.913	0.678
	DEIE2	0.860			
	DEIE3	0.823			
	DEIE4	0.836			
	DEIE5	0.836			
PQE	PQE1	0.819	0.889	0.918	0.693
	PQE2	0.861			

Construct	Item	Loading	Cronbach's α	CR	AVE
	PQE3	0.873			
	PQE4	0.827			
	PQE5	0.778			
SEP	SEP1	0.797	0.882	0.910	0.628
	SEP2	0.796			
	SEP3	0.819			
	SEP4	0.775			
	SEP5	0.798			
	SEP6	0.771			

Note. CR = composite reliability; AVE = average variance extracted.

Table 5. Discriminant validity: HTMT ratios

	EO	DDE	HCDC	SEA	CRIC	SQG	DEIE	PQE	SEP
EO									
DDE	0.234								
HCDC	0.281	0.289							
SEA	0.348	0.361	0.162						
CRIC	0.222	0.280	0.315	0.368					
SQG	0.268	0.332	0.500	0.314	0.331				
DEIE	0.383	0.397	0.354	0.437	0.448	0.386			
PQE	0.242	0.210	0.188	0.194	0.209	0.229	0.572		
SEP	0.136	0.203	0.154	0.165	0.266	0.247	0.508	0.542	

Note. All values < 0.85.

4.4 Structural model and hypothesis tests

Table 6 and Figure 2 present the structural results. Entrepreneurial and strategic capabilities jointly explained 31.6% of the variance in DEIE ($R^2 = 0.316$, adjusted $R^2 = 0.305$). All six capabilities were significant positive predictors: CRIC ($\beta = 0.208$, $t = 4.68$, $p < 0.001$), SEA ($\beta = 0.174$, $t = 3.84$, $p < 0.001$), EO ($\beta = 0.166$, $t = 3.62$, $p < 0.001$), DDE ($\beta = 0.156$, $t = 3.41$, $p < 0.001$), SQG ($\beta = 0.108$, $t = 2.44$, $p = 0.015$) and HCDC ($\beta = 0.107$, $t = 2.27$, $p = 0.023$). Hypotheses H1a–H1f are therefore supported. CRIC had the largest coefficient, followed by SEA and EO. Individual f^2 values were small (0.013 to 0.053), which is typical of models with several correlated

predictors, but together they provide a substantial explanation of integration.

DEIE had a strong positive effect on PQE ($\beta = 0.509$, $t = 12.89$, $p < 0.001$; $f^2 = 0.350$, a large effect), explaining 25.9% of its variance (H2 supported). PQE positively influenced SEP ($\beta = 0.342$, $t = 7.20$, $p < 0.001$; $f^2 = 0.122$; H3 supported), and DEIE also had a direct positive effect on SEP ($\beta = 0.277$, $t = 5.40$, $p < 0.001$; $f^2 = 0.080$; H4 supported). The model explained 29.3% of the variance in SEP ($R^2 = 0.293$). Neither control variable – firm size ($\beta = -0.051$, $t = -1.16$, $p = 0.245$) nor firm age ($\beta = 0.024$, $t = 0.54$, $p = 0.586$) – was significant, suggesting that the observed effects hold irrespective of venture scale and maturity.

Table 6. Structural model and hypothesis testing (5,000 bootstrap resamples)

Hyp.	Path	β	t	p	95% CI	f ²	Decision
H1a	EO → DEIE	0.166	3.62	<0.001	[0.077, 0.255]	0.035	Supported
H1b	DDE → DEIE	0.156	3.41	<0.001	[0.069, 0.248]	0.030	Supported
H1c	HCDC → DEIE	0.107	2.27	0.023	[0.015, 0.202]	0.014	Supported
H1d	SEA → DEIE	0.174	3.84	<0.001	[0.086, 0.263]	0.036	Supported
H1e	CRIC → DEIE	0.208	4.68	<0.001	[0.121, 0.293]	0.053	Supported
H1f	SQG → DEIE	0.108	2.44	0.015	[0.022, 0.194]	0.013	Supported
H2	DEIE → PQE	0.509	12.89	<0.001	[0.430, 0.585]	0.350	Supported
H3	PQE → SEP	0.342	7.20	<0.001	[0.252, 0.434]	0.122	Supported
H4	DEIE → SEP	0.277	5.40	<0.001	[0.175, 0.374]	0.080	Supported
Control	SIZE → SEP	-	-1.16	0.245	[-0.138, 0.034]	0.004	n.s.
Control	AGE → SEP	0.024	0.54	0.586	[-0.064, 0.106]	0.001	n.s.

Note. R²: DEIE = 0.316; PQE = 0.259; SEP = 0.293. n.s. = not significant.

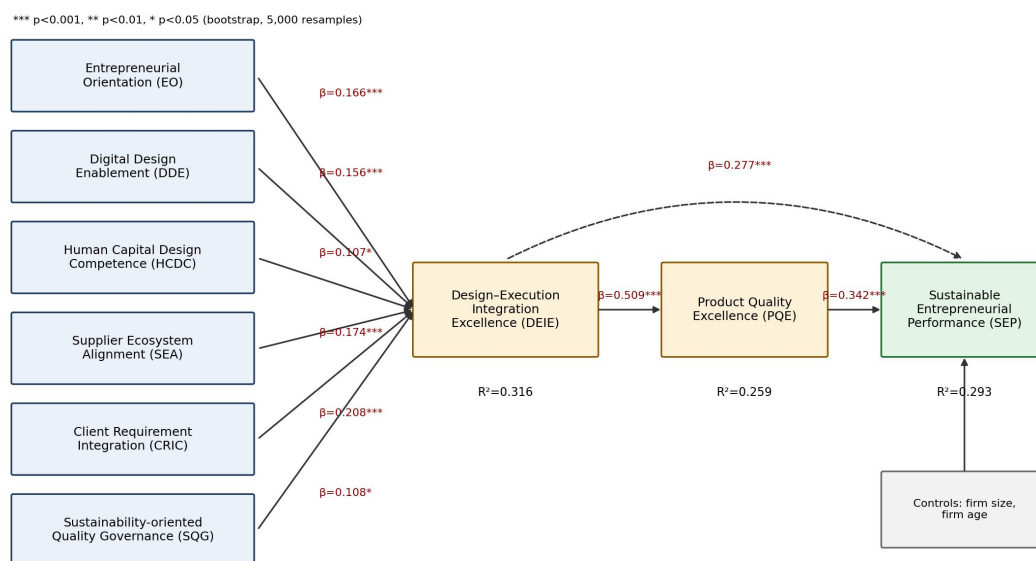


Figure 2. Structural model results

4.5 Mediation analysis

Table 7 shows the indirect effects. PQE mediated the DEIE–SEP relationship ($\beta = 0.174$, 95% CI [0.122, 0.232]); because the direct effect of DEIE on SEP remained significant, the mediation is complementary (partial; Zhao et al., 2010), and the total effect of DEIE on SEP was 0.451 (H5 supported). The sequential indirect effects of each capability through DEIE and PQE were positive and significant, with confidence intervals excluding zero: CRIC ($\beta = 0.036$, 95% CI [0.018, 0.059]), SEA ($\beta = 0.030$, 95% CI [0.014, 0.050]), EO ($\beta = 0.029$, 95% CI [0.012, 0.050]),

DDE ($\beta = 0.027$, 95% CI [0.012, 0.046]), HCDC ($\beta = 0.019$, 95% CI [0.003, 0.038]) and SQG ($\beta = 0.019$, 95% CI [0.004, 0.036]), supporting H6. Taking both indirect routes into account (via DEIE $\rightarrow$ SEP and via DEIE $\rightarrow$ PQE $\rightarrow$ SEP), the largest total indirect effects on SEP belonged to CRIC (0.094), SEA (0.079) and EO (0.075). The magnitudes are modest because capabilities act through two successive links, but they show that capabilities influence sustainable performance mainly through integration and quality routines rather than in isolation.

Table 7. Indirect effects (5,000 bootstrap resamples)

Indirect path	β	Boot SE	t	p	95% CI
DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H5)	0.174	0.028	6.15	<0.001	[0.122, 0.232]
EO $\rightarrow$ DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H6)	0.029	0.010	3.00	0.003	[0.012, 0.050]
DDE $\rightarrow$ DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H6)	0.027	0.009	3.07	0.002	[0.012, 0.046]
HCDC $\rightarrow$ DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H6)	0.019	0.009	2.10	0.035	[0.003, 0.038]
SEA $\rightarrow$ DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H6)	0.030	0.009	3.26	0.001	[0.014, 0.050]
CRIC $\rightarrow$ DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H6)	0.036	0.011	3.42	<0.001	[0.018, 0.059]
SQG $\rightarrow$ DEIE $\rightarrow$ PQE $\rightarrow$ SEP (H6)	0.019	0.008	2.29	0.022	[0.004, 0.036]
EO $\rightarrow$ DEIE $\rightarrow$ SEP	0.046	0.015	3.00	0.003	[0.019, 0.078]
DDE $\rightarrow$ DEIE $\rightarrow$ SEP	0.043	0.016	2.76	0.006	[0.017, 0.078]
HCDC $\rightarrow$ DEIE $\rightarrow$ SEP	0.030	0.015	2.04	0.042	[0.004, 0.061]
SEA $\rightarrow$ DEIE $\rightarrow$ SEP	0.048	0.016	3.11	0.002	[0.022, 0.082]
CRIC $\rightarrow$ DEIE $\rightarrow$ SEP	0.058	0.016	3.51	<0.001	[0.028, 0.092]
SQG $\rightarrow$ DEIE $\rightarrow$ SEP	0.030	0.014	2.19	0.028	[0.006, 0.060]
EO: total indirect	0.075	0.022	3.39	<0.001	[0.035, 0.120]
DDE: total indirect	0.070	0.022	3.20	0.001	[0.030, 0.117]
HCDC: total indirect	0.048	0.022	2.19	0.028	[0.007, 0.094]
SEA: total indirect	0.079	0.022	3.64	<0.001	[0.039, 0.123]
CRIC: total indirect	0.094	0.023	4.08	<0.001	[0.051, 0.140]
SQG: total indirect	0.049	0.020	2.39	0.017	[0.010, 0.091]

4.6 Artificial neural network analysis

To examine non-linear predictive patterns, the six capabilities were used as input neurons to predict DEIE in ten MLP models (Table 8). Each run split the data into training ($n = 268$) and testing ($n = 116$) samples. Training RMSE ranged from 0.146 to 0.154 and testing RMSE from 0.155 to 0.171 (on min–max

normalised scores), and the similarity of the two indicates stable generalisation without overfitting. Table 9 and Figure 3 report normalised importance. Averaged across the ten models, CRIC was the most important predictor (95.2%), followed by SEA (72.9%), EO (64.9%) and DDE (64.6%), whereas SQG (31.1%) and HCDC (30.7%) were the least important.

Table 8. RMSE values of the ANN models

Model	Training n	Testing n	Training RMSE	Testing RMSE
ANN1	268	116	0.146	0.171
ANN2	268	116	0.150	0.160
ANN3	268	116	0.152	0.158
ANN4	268	116	0.151	0.160
ANN5	268	116	0.154	0.155
ANN6	268	116	0.151	0.161
ANN7	268	116	0.149	0.169
ANN8	268	116	0.148	0.167
ANN9	268	116	0.152	0.159
ANN10	268	116	0.151	0.160
Mean			0.150	0.162

Table 9. Normalised importance of predictors of DEIE (%)

Predictor	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	Mean
EO	46.2	71.3	59.0	59.5	100.0	75.8	61.1	50.1	43.9	82.0	64.9
DDE	58.1	64.0	57.4	48.5	72.1	62.2	48.6	51.9	100.0	83.5	64.6
HCDC	44.3	19.5	29.8	19.7	27.3	62.1	3.0	50.8	20.8	29.4	30.7
SEA	88.2	71.1	41.4	83.5	54.9	100.0	16.9	93.5	79.4	100.0	72.9
CRIC	100.0	100.0	100.0	100.0	84.9	88.1	100.0	100.0	95.5	83.7	95.2
SQG	34.4	21.0	24.6	58.0	17.4	7.7	45.5	28.0	42.5	32.4	31.1

Note. A1–A10 = ANN1–ANN10; the most important predictor within each model is scaled to 100%.

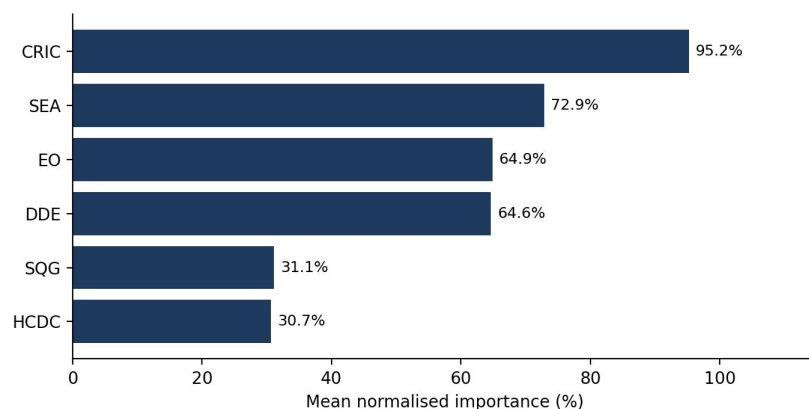


Figure 3. Mean normalized importance of capabilities in predicting DEIE

The ANN ranking reproduces the PLS-SEM ordering of the six capabilities (CRIC, SEA, EO, DDE, SQG, HCDC), which strengthens confidence in the relative importance of the predictors. The ANN also shows that the gap between the top four capabilities (64.6–95.2%) and the bottom two (31.1% and 30.7%) is wider than the linear path coefficients alone suggest. In other words, client and supplier integration, entrepreneurial orientation and digital design enablement carry the most predictive weight for integration, whereas people-centred competence and

governance have a more modest incremental predictive contribution once the other capabilities are taken into account. Because ANN does not test causal hypotheses, it is used as a complementary check on relative importance, not as a test of the hypotheses.

5. Discussion

5.1 Theoretical contributions

The findings support the proposition that quality and

sustainability outcomes in craft ventures are produced by an integrated capability system rather than by isolated resources. First, all six capabilities contributed to DEIE, consistent with RBV's claim that bundles of valuable, hard-to-imitate resources underlie performance differences (Barney, 1991; Peteraf, 1993). The prominence of client requirement integration and supplier alignment suggests that, for owner-managed ventures, external integration resources are especially consequential; this resonates with evidence that integration with customers and suppliers improves operational performance (Flynn et al., 2010; Koufteros et al., 2005).

Second, the significant effect of entrepreneurial orientation on integration extends entrepreneurship research. While EO is typically linked directly to firm performance (Rauch et al., 2009), our results show that its effect on sustainable performance is channelled through operational routines – integration and quality – offering a more granular explanation consistent with the view that EO's impact depends on complementary resources and capabilities (Wiklund & Shepherd, 2003, 2005). From a dynamic-capabilities perspective (Teece, 2007), EO supplies the sensing and seizing impetus, while integration and quality governance provide the reconfiguration and execution capacity that converts opportunity into dependable output.

Third, the strong DEIE → PQE → SEP chain connects the quality management literature (Kaynak, 2003; Zeng et al., 2015) with sustainable entrepreneurship (Shepherd & Patzelt, 2011; Hall et al., 2010). It indicates that, in craft enterprises, the route to triple-bottom-line outcomes runs substantially through everyday operational excellence – reducing defects, waste and rework, and securing repeat business – rather than solely through explicit green or social initiatives. This is a contribution to the “how” of sustainable entrepreneurship that has been called for in recent reviews (Muñoz & Cohen, 2018; Kraus et al., 2018).

Fourth, the study supports the socio-technical argument (Trist & Bamforth, 1951; Mumford, 2006) that technology and social capabilities must be jointly developed: digital design enablement and human capital design competence both mattered, and neither can be expected to deliver integration alone. Finally, the combined use of PLS-SEM and ANN adds methodological value: whereas PLS-SEM tested hypothesized paths, ANN confirmed the ranking of predictors and showed that the predictive weight is concentrated in client, supplier, entrepreneurial and digital capabilities, illustrating the benefit of multi-method triangulation (Leong et al., 2020).

5.2 Implications for entrepreneurs

- **Make client integration a routine.**

Structured briefs, sample approvals, visual mock-ups and change-control logs reduce ambiguity between what clients expect and what is produced. Given the strong role of client requirement integration in this study, it offers the best return on small investments.

- **Treat key suppliers as partners.** Shared specifications, joint quality checks for timber and hardware and agreed lead times improve the stability of inputs and reduce rejections.

- **Adopt digital design tools incrementally.** Simple CAD drawings, cutting lists and photo-based finish standards can be introduced without displacing artisan judgement, consistent with joint optimisation of social and technical systems.

- **Build design competence among artisans and supervisors.** Training that links design intent with joinery, finishing and material properties strengthens the human capital on which integration depends.

- **Embed sustainability in the quality system.** Track material yield, rework rates, safe-working practices and certified or legal timber sourcing as quality indicators so that sustainability and quality reinforce each other.

5.3 Implications for policy and support institutions

Cluster-development agencies, export promotion bodies, MSME facilitation centres and skill-development institutions can use these findings to design capability-based support rather than generic subsidies. Priority areas include shared digital design and prototyping facilities, supplier-development programmes at cluster level, design-to-production training for artisans, and quality-and-sustainability certification pathways that are scaled to micro and informal units. Given the modest representation of women entrepreneurs in the sample, targeted outreach and support may broaden participation and inclusiveness – an objective consistent with the social dimension of sustainability and the 2030 Agenda (United Nations, 2015).

6. Conclusion, Limitations and Future Research

This study shows that in Indian furniture handicraft ventures, entrepreneurial orientation and five strategic capabilities enhance design–execution integration, which improves product quality and, through it, sustainable entrepreneurial performance. Client requirement integration and supplier alignment emerged as particularly influential, and the sequential mediation results indicate that capabilities create sustainable value largely by being embedded in integration and quality routines. For entrepreneurs and support institutions, the message

is that sustainable craft enterprise is built through integration of people, technology, suppliers and clients under a quality governance system that also embeds sustainability.

Several limitations suggest avenues for future work. First, the cross-sectional design limits causal inference; longitudinal or experimental designs could trace how capabilities, integration and performance co-evolve. Second, the data are self-reported by owner-entrepreneurs; future studies could triangulate with objective indicators (defect rates, returns, material yield, export value) and with multi-respondent data from designers, artisans and clients. Third, the study is restricted to furniture handicraft clusters in India; replication in other crafts and Asian economies would test generalizability. Fourth, sustainable performance was modelled as a single reflective construct; future research could examine economic, environmental and social dimensions separately, and could add moderators such as institutional support, cluster membership, gender of the entrepreneur, or market uncertainty. Fifth, qualitative or mixed-methods work could illuminate how entrepreneurs experience and negotiate tensions between artisanal autonomy and standardization. Finally, emerging technologies such as AI-assisted design and digital product passports offer promising extensions of the framework.

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