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Article

Bodegus: A Serious Game Intervention to Shape Informal Business Practices

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Abstract

This study aimed to test whether a serious-game intervention (Bodegus) strengthens the relationship between the perceived usefulness of formal business practices and the intention to formalize these practices. Using a pre-experimental pre-test–post-test design, 38 Peruvian entrepreneurs played Bodegus as part of a workshop on formality and completed a questionnaire measuring the constructs' perceived usefulness and intention to formalize business practices. The constructs were modeled as second-order composites in the areas of governance/leadership, legal/tax, and accounting/finance. The analysis was conducted using a multi-group Structural Equation Model with the partial least-squares method. Although the group-difference tests were not statistically significant, the relationship between the two variables was stronger in the post-test model, showing higher explanatory and predictive metrics; therefore, the results were interpreted as exploratory. The originality of this study lies in presenting and detailing Bodegus as a serious-game intervention study that tests two opposing normative ethical approaches: virtue ethics and utilitarianism. Its impact consists of offering a replicable design and an analytical approach for ethical/behavioural education on informality, guiding course design, and micro-level policy initiatives aimed at fostering formal business practices.

1. Introduction

Informal business practices in emerging markets constitute a phenomenon that affects various aspects of organizations, such as organizational structure, as documented in the case of informal non-governmental organizations in India [1]. In addition, these practices influence business growth strategies, as shown in a study of a Cuban travel agency operating without formal accounting [2], and in an analysis of an Indian catering service seeking to become a formal restaurant [3].

The Peruvian case of informality stands out in emerging economies, with 70.9% of the workers being informal employees. Their labor relationships are not subject to national law,

lack social protection, and do not receive employment benefits. Informality in the country is more prevalent among women, with a rate of 73.3%, compared to 69.1% for men [4].

However, informality is often simplified as a binary issue defined mainly by whether a business is registered with tax authorities [5]. However, alternative perspectives offer a deeper understanding of the phenomenon by recognizing informality as a transitional phase in business life [6], seeing it as a spectrum within a dynamic process rather than a static state [7], and adopting a more advanced conceptualization from the perspective of informal business practices.

Dellevoet and Jones defined informal business practices as 'all those practices that, in contrast to formal rules, laws and regulations, and generally accepted principles of business ethics, grant business owners or managers maximum freedom to secure a competitive advantage, reduce costs, and increase profitability, as they deem appropriate' [8]. Under this definition, the authors maintain that informality can manifest in multiple areas of business, such as governance, legal and tax compliance, financial management, and human resource management.

According to Dellevoet and Jones, there is a contrast between businesses' ethical and economic perspectives. This contrast makes informal business practices suitable for inclusion in business training programs at all levels: undergraduate, postgraduate, and executive education. Such inclusion could provide a space to reflect on informality, encouraging participants to formalize both current and future businesses.

Informal business practices can be analyzed as behavioral phenomena among entrepreneurs. As a form of behavior, intentions toward formalization have been explored by several authors; for example, under the framework of the Theory of Planned Behavior (TPB) [9], through the development of a lifecycle model of informal entrepreneurship [10], and for informal female entrepreneurship within the TPB framework [11].

Ajzen's Theory of Planned Behavior (TPB) holds that behavioral intention is the most immediate and significant predictor of actual behavior; thus, influencing intention may influence behavior [12]. Therefore, using intention as a dependent variable in studies of informality allows for a precise assessment of entrepreneurs' possible transition from informal business practices to formal practices.

According to TPB, three antecedents shape a person's intention to perform a specific behavior: attitude, subjective norms, and perceived behavioral control. Attitude refers to an individual's overall evaluation of their behavior. Subjective norms capture the perceived social pressure to perform or avoid behavior, reflecting the influence of important reference groups such as peers, family, or colleagues. Perceived behavioral control represents an individual's perception of their ability to carry out their behavior. Within studies related to informality, Amésquita Cubillas uses the full TPB model as the theoretical and conceptual framework with Peruvian entrepreneurs [9].

On the other hand, Deterding defines serious games as fully developed games for educational purposes [13]. Prior research has documented the use of serious games to improve the effectiveness of business ethics education [14-18]. These games can help shape entrepreneurs' behaviors toward formalization, and TPB can serve as a theoretical framework to examine such behavioral changes.

Complementing TPB, the Technology Acceptance Model (TAM) proposed by Venkatesh and Bala extends the prediction of intention toward behavior by incorporating perceived usefulness, among other constructs, as an antecedent of intention [19]. Perceived usefulness reflects users' beliefs regarding the functional value and practical benefits of adopting a given technology. Although TAM was originally designed for technological systems, recent research has highlighted its relevance for studying educational interventions, ethical behavior modification, and informality.

Prior studies support the application of both TPB and TAM frameworks in serious games aimed at entrepreneurship education. For example, some studies have used TPB to validate serious games that target entrepreneurial learning outcomes [20,21]. Similarly, TAM has been applied in studies evaluating serious games [22-25]. Regarding informal business practices, one study examined the use of formal strategic planning from the perspective of its perceived usefulness among managers [26], while another used TAM to assess the adoption of digital formalization platforms by Indian entrepreneurs [27].

Evaluating the perceived usefulness of formal business practices across a firm's different functional areas contributes to academic knowledge given the theoretical and empirical assumption that formality contributes positively to entrepreneurship and entrepreneurial performance. From an empirical perspective, some studies identify access to public services and legal rights in courts as benefits of formality [28], report that legal registration increases profits and investment levels [29], and find that legal compliance is associated with greater business success in terms of sales and employment [30]. From a theoretical perspective and based on prior literature, Dellevoet and Jones highlight the additional benefits of formalization in various business areas, such as governance and leadership, by enabling better decision-making and greater transparency; legal and tax compliance by promoting contract fulfillment and enhancing the firm's legal reputation; financial management, by optimizing accounting systems and facilitating access to formal financing and insurance instruments; and human resource management, by providing better working conditions for employees [8].

Based on the construct intention toward a behavior from the TPB and the variable perceived usefulness from the TAM, we formulated our research question for a pre-experimental design involving the intervention of a serious game with informal entrepreneurs as follows:

> *Can playing the serious game Bodegus induce a change in the strength of the relationship between the perceived usefulness of formal business practices and the intention to formalize such practices among informal entrepreneurs?*

As an extension of the TPB, TAM proposes a relationship between perceived usefulness and intention toward a behavior such that an increase in perceived usefulness leads to a corresponding increase in behavioral intention [19]. Our research question focuses exclusively on these two constructs since antecedents such as perceived behavioral control and subjective norms cannot be meaningfully manipulated in an experimental setting involving a serious game such as Bodegus. Nevertheless, although attitude is a variable considered in both the TPB and TAM, we argue that assessing perceived usefulness provides a more direct criterion for evaluating the perceived benefits of formalization, as cost–benefit evaluations are a recurring subject in studies on informality [31-33]. In contrast, the design of Bodegus enables players to weigh ethical versus economic criteria when making formal or informal business decisions. Therefore, our experimental design focused on manipulating participants' perceived usefulness of formal versus informal business behaviors. Based on this theoretically supported relationship, our research hypotheses are as follows:

> Hypothesis 1 (H1): *Playing the serious game Bodegus positively and significantly influences the relationship between the perceived usefulness of formalization and intention to formalize business practices among informal entrepreneurs*.

2. Methods and Material

The study was conducted within the framework of a workshop on informal business practices targeting small shop owners (bodegueros) in the district of San Juan de Lurigancho, Lima, which is characterized by a high rate of informality [34]. Participation was voluntary and was determined through a non-probabilistic selection process, including only those bodegueros who accepted the invitation (40 bodegueros). The final sample consisted of 38 participants, two of whom withdrew from the workshop.

We employed a within-participants (pre–post) design, which increases statistical power by reducing intra-individual variance. In general, within-participant designs require fewer participants than between-participant designs to detect the same effect, especially when the correlation between repeated measures is positive [35]. With N = 38 paired observations, we conducted a sensitivity analysis using G*Power (paired samples t-test, two-tailed, $\alpha = .05$, $1–\beta = .80$) [36]. The analysis showed that the study had 80% power to detect a minimum within-subject effect of $dz = 0.467$ (non-centrality parameter $\delta = 2.026$, $df = 37$), that is, a medium-sized pre–post effect by conventional benchmarks. Accordingly, the sample size was adequate to detect medium effects, whereas smaller effects may remain undetected.

Consistent with current recommendations, we emphasized sensitivity and precision rather than post-hoc power and reported the paired pre–post change in the outcome with its confidence interval; for intention to formalize, the mean difference was $\Delta INT = -0.000$ ($SD = 1.115$), with a 95% CI [−0.367, 0.367] ($df = 37$, two-tailed). Therefore, with N = 38 pairs, the study was sufficiently powered for medium or larger within-subject effects ($dz \geq 0.47$), but not for small effects.

This study examined two research variables: the perceived usefulness of formal business practices and intentions toward business practice formalization. The authors developed these variables based on three business domains: governance and leadership, regulatory and tax compliance, and accounting and financial management, following the guidelines of several authors [8], [37], [38]. Human resource management was excluded from the study because not all participants employed staff members.

The variables were measured using a five-point Likert scale for the items listed in Table 1. To assess the perceived usefulness of formal business practices, participants were asked, ‘How useful can the following practices be for your business?’, with responses recorded on a scale ranging from "Very useful" to "Not useful at all." To assess intentions regarding business formalization, participants were asked, ‘What is your level of intention to implement the following practices in your business?’, with responses recorded on a scale ranging from "Very likely" to "Not likely at all." The post-test used the same questions and scales, preceded by the introductory phrase, Based on your experience in the Bodegus game.

Table 1. Indicators for the questionnaire

Business area / Items
Governance and Leadership
a) Make decisions with the advice of experts.
b) Plan every aspect of the business in detail for the year, and review and adjust plans every week.
d) Separate the roles of owner and manager.
Legal Compliance and Taxes
f) Have a Taxpayer Identification Number (RUC) in SUNAT.
g) Have an operating license granted by the municipality.
h) Pay all taxes fully and on time.
Accounting and Financial Management
i) Keep personal finances separate from business finances.
k) Have an automated accounting system.
t) Have an automated inventory control system fully integrated with the accounting system.

The research followed a pre-experimental pre-test-post-test design, as no control group was considered owing to the dynamics of the workshop and the sample size limitation. The pre-test was administered upon the participants’ arrival at the workshop, and the post-test was conducted after the game session. Informed consent was obtained from all participants, and

ethical approval was obtained from the University Ethics Committee (protocol number 069-2023-CEI-CCSSHHyAA/PUCP.

For hypothesis validation, group structural equation modeling (SEM) was chosen instead of a t-test, as it allows for comparing the relationship between two variables before and after the intervention. SEM also enables the validation of latent variables, thereby providing greater reliability of the model's results. The Partial Least Squares (PLS) technique was selected because it does not require normally distributed data and performs effectively with small sample sizes [39]. All analyses were conducted using SmartPLS 4 software [40].

The multi-group SEM approach comprises three stages: validation of the measurement model, evaluation of the structural model, and assessment of the multi-group analysis [39]. Multi-group analysis (MGA) was performed using Henseler's MGA and the permutation test after verifying measurement invariance through the MICOM procedure [41].

1.1. Intervention

We created a serious game, Bodegus, for intervention in our experimental design. Bodegus aimed to influence participants' perceived usefulness of formal business practices against that of informal business practices. A preceding lecture on the national economy and informality, together with a technical session on Peru's online tax platforms, was included solely to provide a broader conceptual context for understanding informal business practices, which were carefully designed to avoid directly affecting participants' perceptions or intentions toward formalization.

1.1.1. Overview

Bodegus is a serious board game that simulates decision-making in small neighborhood stores, with a specific focus on choices between formal and informal business practices. The design draws on two competing ethical orientations—virtue ethics and utilitarianism [42-44]—to structure in-game trade-offs that make the perceived usefulness of formalization salient, and through repeated feedback and debriefing, aim to influence the intention toward formalization.

1.1.2. Mechanics

- Initial state and roles. Each player begins with an initial stock of merchandise and cash reserves. One participant acts as a banker, manages payments, and extends loans on request.
- Board structure. The board has two concentric circuits, a formal loop and an informal loop. All players start a formal loop and may switch loops during play (See Figure 1).
- Turn sequence. Players roll the dice to move. On landing, they execute the indicated action (e.g., purchasing or selling inventory) or resolve a "bodega dilemma."
- Decision points. Dilemma spaces explicitly present a formal option and an informal option framed to reflect virtue-ethical versus utilitarian reasoning about short-term gains versus longer-term rules-compliant stability.
- Payoff and feedback. Choice updates cash, inventory levels, and debt. The payoff structure generally rewards formal conduct and discourages informal shortcuts, while allowing some informal moves to yield short-term benefits to mirror real-world ambiguity.
- Winning condition. At the time cap, the winner is the player with the largest cash balance, minimal unsold stock, no outstanding debt, and a position on the formal track.

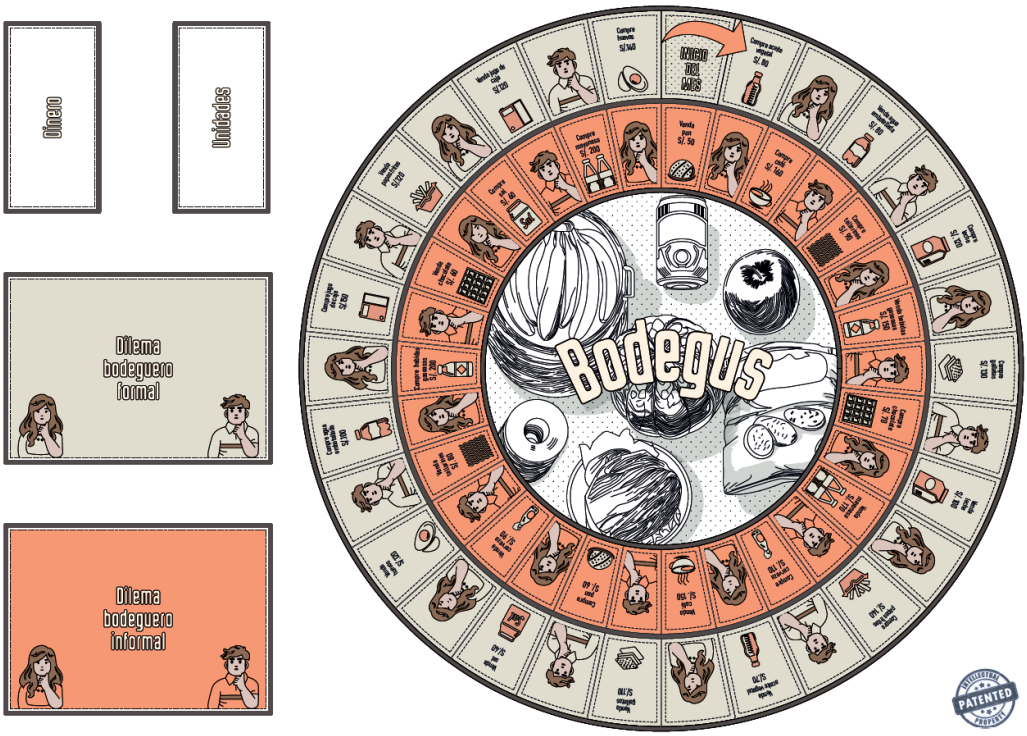

Figure 1. Bodegus Game Board ©. Bodegus is the intellectual property of Pontificia Universidad Católica del Perú, registration no. 1151-2025/DDA-INDECOPI, created by Luis Demetrio Gómez García and Gloria Maria Regina Zambrano Aranda, and protected by INDECOPI (Perú).

1.1.3. Dynamics

Across ≥4 rounds within a typical one-hour session (five players per table), players experienced the following:

- Liquidity–inventory cycles as purchases and sales affect cash flow and stock.
- Path switching between formal and informal loops, exposing different risk–reward profiles.
- Competitive pressure under common constraints invites a comparison between short-term informal payoffs and long-term formal stability.

The one-hour duration was established through prior testing conducted by the research team, who first played the game themselves and later tested it with the undergraduate students. In these tests, one hour was sufficient to complete at least four rounds with a table of five participants. These dynamics provide repeated observable feedback that links choices to business outcomes.

Intended learning outcomes and alignment to study constructs:

- Perceived usefulness of formalization. Through the reward structure (profitability with lower risk, reduced indebtedness, and end-game requirement to be in the formal loop), players directly experience how formal practices can improve business outcomes. Dilemma framing (virtue-ethical versus utilitarian justifications) triggers a reflection on why formalization may be instrumentally advantageous, supporting changes in the perceived usefulness of formal business practices.
- Intention toward formalization. Repeated exposure to the comparative consequences of formal versus informal choices, reinforced in facilitator-led debrief, aims to strengthen the behavioral intention to adopt formal practices, consistent with the TPB and TAM pathways from usefulness to intention.

1.1.4. Implementation flow

1. Conceptual framing (15 min): Introduction to informality versus illegality, informal business practices, and ethical lenses that structure the dilemmas.

2. Rule briefing (15 min): printed rulebook and slides detailing objectives, turn structure, banking procedures, and dilemma resolution.
3. Game session (60 min): Teams 3–6 (one banker) completed at least four rounds.
4. Group debrief (20 min): Discussion links in-game experiences to ethical framing, and explicitly to the perceived usefulness of formal business practices and intentions to formalize.

3. Results

3.1. Measurement Model Validation

Given the formative nature of the constructs, both first-order and second-order models were designed and tested to validate the measurement model [39]. The estimation of the first-order model was performed using the total data with 10,000 bootstrap samples, the bias-corrected and accelerated (BCa) confidence interval method, a two-tailed test, and a significance level of 0.05. To validate these constructs, we applied a two-step approach [39]. Under this approach, the significance of the constructs' outer weights must first be examined. When the outer weights are non-significant, researchers can retain the indicators if the outer loadings are above 0.50, indicating a correlation between the indicator and the construct it seeks to explain. However, Hair emphasizes that before removing a formative indicator, researchers need to evaluate its relevance from a content validity point of view [39], leaving the decision to the theoretical conceptualization of the construct.

Table 2 shows that, according to the outer weights' criterion, several indicators were not significant. However, based on the outer loadings' criterion, all indicators were found significant; therefore, all of them were retained. The VIF results indicate the absence of significant collinearity, as all values remained below the maximum threshold of 5 [39].

Table 2. First-order formative measurement model validation

	Outer weights	T statistics	P values	Outer loadings	T statistics	P values	VIF
Ia -> INT_GobLead	0.491	2.014	0.044	0.803	5.843	0.000	1.293
Ib -> INT_GobLead	0.258	1.148	0.251	0.724	4.105	0.000	1.471
Id -> INT_GobLead	0.502	2.106	0.035	0.833	4.364	0.000	1.441
If -> INT_LegTax	0.199	0.742	0.458	0.831	7.359	0.000	2.337
Ig -> INT_LegTax	0.476	1.609	0.108	0.969	13.490	0.000	4.959
Ih -> INT_LegTax	0.395	1.363	0.173	0.947	10.398	0.000	4.186
Ii -> INT_Acc	0.125	0.621	0.534	0.543	3.071	0.002	1.251
Ik -> INT_Acc	0.735	4.444	0.000	0.964	14.754	0.000	1.735
It -> INT_Acc	0.292	1.381	0.167	0.767	5.595	0.000	1.551
Ua -> UP_GobLead	0.419	2.043	0.041	0.780	5.732	0.000	1.334
Ub -> UP_GobLead	0.407	1.849	0.064	0.805	5.211	0.000	1.458
Ud -> UP_GobLead	0.424	2.601	0.009	0.813	8.880	0.000	1.459
Uf -> UP_LegTax	0.358	1.076	0.282	0.871	9.017	0.000	2.453
Ug -> UP_LegTax	0.203	0.535	0.593	0.876	6.907	0.000	3.033
Uh -> UP_LegTax	0.548	1.841	0.066	0.932	8.184	0.000	2.291
Ui -> UP_Acc	0.120	0.577	0.564	0.666	4.287	0.000	1.562
Uk -> UP_Acc	0.533	2.419	0.016	0.921	12.601	0.000	2.119
Ut -> UP_Acc	0.480	2.480	0.013	0.892	9.507	0.000	1.825

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices; GobLead = Governance and Leadership; LegTax = Legal Compliance and Taxes; ACC = Accounting and Financial Management; VIF = Variance Inflation Indicator.

Based on these results, the second-order measurement model was constructed and validated by extracting the latent variables derived from the first-order model. The same bootstrap algorithm was used to validate the second-order measurement model. In this case, the outer weights, outer loadings, and VIF were calculated for both the total data and the segmented pre-test and post-test data (see Table 3).

Table 3 shows that, according to the outer weights' criterion, some indicators were not significant across the three models. However, under the outer loadings' criterion, all indicators were significant for the three models, except for the indicator INT_Acc in the pre-test model, with a p-value of 0.100. Since this indicator does not present collinearity (VIF = 2.348) and considering that a 90% significance level is regarded as more liberal but still acceptable in studies with smaller sample sizes, as well as the theoretical importance of this dimension in shaping the variable intention toward formalization, the indicator was retained (Hair et al., 2021). The remaining indicators across the three models did not exhibit collinearity issues, as their VIF values were below the maximum threshold of 5 in all cases, and below the more desirable threshold of 3.

Table 3. Second-order formative measurement model validation

Model/relationships	Outer weights	T statistics	P values	Outer loadings	T statistics	P values	VIF
Complete							
INT_Acc -> Intention_Formalization	0.579	2.249	0.025	0.927	6.647	0.000	2.100
INT_GobLead -> Intention_Formalization	0.157	0.793	0.428	0.839	6.746	0.000	2.611
INT_LegTax -> Intention_Formalization	0.389	1.127	0.260	0.852	4.756	0.000	2.085
UP_Acc -> Utility_Perception	0.431	1.774	0.076	0.847	5.411	0.000	1.682
UP_GobLead -> Utility_Perception	0.503	1.907	0.057	0.845	6.305	0.000	1.409
UP_LegTax -> Utility_Perception	0.282	0.879	0.379	0.742	3.397	0.001	1.528
Pre-test							
INT_Acc -> Intention_Formalization	0.050	0.097	0.923	0.590	1.646	0.100	2.348
INT_GobLead -> Intention_Formalization	-0.042	0.120	0.905	0.640	2.202	0.028	2.712
INT_LegTax -> Intention_Formalization	0.998	1.512	0.130	0.999	2.556	0.011	1.772
UP_Acc -> Utility_Perception	0.155	0.390	0.696	0.666	2.102	0.036	1.596
UP_GobLead -> Utility_Perception	0.112	0.304	0.761	0.706	2.693	0.007	1.804
UP_LegTax -> Utility_Perception	0.832	1.198	0.231	0.984	2.221	0.026	1.758
Post-test							
INT_Acc -> Intention_Formalization	0.571	3.010	0.003	0.908	12.901	0.000	2.023
INT_GobLead -> Intention_Formalization	0.654	3.086	0.002	0.916	14.320	0.000	2.866
INT_LegTax -> Intention_Formalization	-0.165	0.696	0.486	0.716	5.249	0.000	2.701
UP_Acc -> Utility_Perception	0.427	1.893	0.058	0.786	3.872	0.000	1.853
UP_GobLead -> Utility_Perception	0.715	2.417	0.016	0.929	12.421	0.000	1.345
UP_LegTax -> Utility_Perception	-0.001	0.005	0.996	0.513	2.296	0.022	1.588

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices; GobLead = Governance and Leadership; LegTax = Legal Compliance and Taxes; ACC = Accounting and Financial Management; VIF = Variance Inflation Indicator.

3.2. Common Method Bias Analysis

Owing to the use of the same instrument for measuring both the dependent and independent variables, there is a potential risk of Common Method Bias (CMB). Two approaches were applied to assess the absence of CMB: the full collinearity VIFs approach [45] and the marker-path test using a random marker [46].

Its application consisted of creating a random marker in Microsoft Excel, which was added to the latent variable dataset as an item labeled CMB. For the full collinearity VIFs test, paths were drawn from all constructs to CMB (UP → CMB, INT → CMB), and PLS-SEM was estimated by group (Pre/Post). Subsequently, for verification, a marker-path test was performed by retaining the focal path UP → INT and adding CMB → INT (Tables 4 and 5).

Table 4. Full collinearity VIFs toward a random marker (CMB)

Path	Pre-test VIF	Post-test VIF
INT -> CMB	2.548	5.848
UP -> CMB	2.548	5.848

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

Table 4 presents the results of the full collinearity VIFs test [45]. The VIFs related to CMB indicated that, in the pre-test, the values were below the recommended threshold (3.3). However, in the post-test, the VIFs exceeded five, which is considered the maximum acceptable threshold. We interpret this pattern as substantive collinearity between perceived usefulness and intention toward formalization in a model with a single strong path rather than as evidence of common method bias [47].

In the marker-path test shown in Table 5, the path from CMB to INT was not significant in the pre-test ($\beta = 0.071$, $p = .573$) and weak/marginal in the post-test ($\beta = -0.136$, $p = .048$). In contrast, the relationship between UP and INT remained strong and stable in both the pre-test ($\beta = 0.766$) and post-test ($\beta = 0.939$). Based on these results, we conclude that there is no evidence of common method bias that threatens the validity of model outcomes.

Table 5. Marker-path test: path coefficient and significance

	Coefficient	T statistics	P values
Pre-test			
CMB -> INT	0.071	0.564	0.573
UP -> INT	0.766	6.794	0.000
Post-test			
CMB -> INT	-0.136	1.975	0.048
UP -> INT	0.939	31.546	0.000

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

3.3. Structural Model Assessment

The structural model assessment was first conducted with the full dataset and then separately for the pre-test and post-test data. In all three cases, three SmartPLS 4 algorithms were applied: first, the PLS-SEM algorithm; second, the PLSpredict algorithm; and third, the bootstrapping procedure with 10,000 samples using the bias-corrected and accelerated (BCa) confidence interval method, a two-tailed test, and a significance level of 0.05.

Model fit was evaluated using SRMR, d_ULS, and d_G. For the pre-test model, the indices were SRMR = 0.121, d_ULS = 0.305, and d_G = 0.174 (estimated model). For the post-test model, SRMR = 0.087, d_ULS = 0.158, and d_G = 0.200, respectively. The post-test SRMR indicates an acceptable fit (below .10 and close to the .08 guideline), whereas the pre-test SRMR is marginal (> .08 but < .10). Given the predictive orientation of composite-based SEM, subsequent inference focuses on R^2, Q^2, and PLSpredict, while these fit indices document overall model adequacy.

Table 6 shows the analysis of the structural model, including the complete dataset as well as the pre-test and post-test groups. For the complete sample, the path from UP to INT was strong and highly significant ($\beta = 0.804$, $t = 11.899$, $p < .001$; 95% BCa CI [0.734, 0.896]). The model demonstrated high explanatory power ($R^2 = 0.646$; adjusted $R^2 = 0.642$) and substantial predictive relevance ($Q^2 = 0.512$). The effect size was also large ($f^2 = 1.828$), indicating that perceived usefulness explained a considerable portion of the variance in the intention to formalize.

Table 6. Structural model assessment

	Coefficient	T statistics	Confidence interval (95%)		P values	Variance explained R^2	R^2 adjusted	Predictive Relevance Q^2	Effect size f^2
Complete									
UP -> INT	0.804	11.899	0.734	0.896	0.000	0.646	0.642	0.512	1.828
Pre-test									
UP -> INT	0.781	2.361	-0.805	0.920	0.018	0.609	0.598	0.402	1.559
Post-test									
UP -> INT	0.913	31.083	0.883	0.973	0.000	0.833	0.829	0.555	5.003

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

When the model was estimated using the pre-test data, the path coefficient remained positive and statistically significant according to the p-value ($\beta = 0.781$, $t = 2.361$, $p = .018$). However, the 95% BCa confidence interval included zero (CI95% [−0.805, 0.920]), which suggests that the effect might not be robust given the small sample size ($n = 38$). Even so, the pre-test model showed acceptable explanatory power ($R^2 = 0.609$; adjusted $R^2 = 0.598$) and good predictive relevance ($Q^2 = 0.402$) with a large effect size ($f^2 = 1.559$).

In contrast, the post-test model produced a strong and stable relationship between UP and INT ($\beta = 0.913$, $t = 31.083$, $p < .001$; 95% BCa CI [0.883, 0.973]). Both explanatory power and predictive relevance were higher than in the pre-test ($R^2 = 0.833$; adjusted $R^2 = 0.829$; $Q^2 = 0.555$), and the effect size was larger ($f^2 = 5.003$). This pattern indicates that although the path was statistically significant in both groups, the association was stronger in the post-test, where the model explained more variance, achieved greater predictive accuracy, and showed a higher effect of perceived usefulness on intention to formalize.

3.4. Multi-group Analysis (MGA)

A multi-group analysis was conducted to test the hypotheses. This study aimed to verify the significance of the differences between the pre-test and post-test after using Bodegus as an intervention. Before carrying out the multi-group analysis, it is necessary to run a MICOM analysis to evaluate whether the differences between groups can be attributed solely to the latent variables of the structural model [41].

The MICOM procedure consists of three stages: (1) configural invariance, (2) compositional invariance, and (3) equality of composite means and variances (steps 3a and 3b) [41]. First, configural invariance was established given that the measurement and structural models were specified identically for the pre-test and post-test groups. Both groups included the same constructs, with the same indicators, measurement modes, and algorithm settings. The analysis was performed using a permutation algorithm with 10,000 samples, a significance level of 0.05, a two-tailed test, and a fixed seed to ensure replicability. Data treatment, resampling procedures, and software settings were consistently applied across groups. Therefore, the requirements for configural invariance are met.

The results of the permutation test in Table 7 indicate that compositional invariance was established for both the constructs (Step 2). For Intention toward formalization, the correlation between the composite scores of the pre-test and post-test groups was 0.636, with a permutation p-value of 0.101. Similarly, for Utility Perception, the correlation was 0.691 with a permutation p-value of 0.226. In both cases, the permutation p-values exceeded the significance level of 0.05, indicating that the null hypothesis of compositional invariance could not be rejected. Therefore, compositional invariance was supported for all constructs in the analysis.

Table 7. Compositional invariance (step 2)

	Original correlation	Permutation mean	5.00%	Permutation p value
INT	0.636	0.845	0.454	0.101
UP	0.691	0.776	0.426	0.226

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

The assessment of equality of the composite means showed no significant differences between the pre-test and post-test groups (Step 3a). As shown in Table 8, for intention toward formalization, the original mean difference was −0.199, with a permutation p-value of 0.392. For Utility Perception, the original mean difference was 0.094 with a permutation p-value of 0.697. In both cases, the permutation p-values exceeded the significance level of 0.05, and the confidence intervals were zero (−0.455 to 0.448 for INT; −0.454 to 0.455 for UP). Therefore, the equality of composite means was supported for all constructs.

Table 8. Equal mean assessment (step 3a)

	Original difference	Permutation mean difference	2.50%	97.50%	Permutation p value
INT	-0.199	0.000	-0.455	0.448	0.392
UP	0.094	0.002	-0.454	0.455	0.697

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

The assessment of equality of composite variances showed no significant differences between the pre-test and post-test groups (Step 3b). As presented in Table 9, for intention to formalize, the original variance difference was 0.092, with a permutation p-value of 0.740. For perceived usefulness, the original variance difference was −0.109, with a permutation p-value of 0.713. In both cases, the permutation p-values exceeded the 0.05 significance level, and the confidence intervals included zero (−0.568 to 0.544 for intention toward formalization; −0.579 to 0.542 for perceived usefulness). Therefore, the equality of composite variances was supported for all constructs.

Table 9. Equal variance assessment (step 3b)

	Original difference	Permutation mean difference	2.50%	97.50%	Permutation p value
INT	0.092	-0.001	-0.568	0.544	0.740
UP	-0.109	-0.005	-0.579	0.542	0.713

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

Overall, the MICOM procedure confirmed full measurement invariance across the pre- and post-test groups. Configural invariance (Step 1) was established, compositional invariance (Step 2) was supported for all constructs, and no significant differences in composite means (Step 3a) or variances (Step 3b) were observed. Following the criteria proposed by Henseler,

these results demonstrate that the requirements for full measurement invariance were met, thereby allowing valid and meaningful comparisons of the structural model across groups [41].

To test group differences in the structural model, two nonparametric approaches were employed: permutation test and Henseler's MGA [41]. Permutation-based multi-group analysis showed that the path from perceived usefulness to intention toward formalization was stronger in the post-test group (0.913) than in the pre-test group (0.781), resulting in a difference of 0.132 (post-test minus pre-test). Using a two-tailed test, the permutation p-value was 0.100, and the 95% permutation confidence interval for the difference included zero (−0.155, 0.154), indicating that the improvement in the post-test group was not statistically significant (see Table 10).

Table 10. Permutation test

	Original (Pre-test)	Original (Post-test)	Original difference	Permutation mean difference	2.50%	97.50%	Permutation p value
UP -> INT	0.781	0.913	-0.132	-0.001	-0.155	0.154	0.100

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

Second, Henseler MGA (bootstrap-based multi-group analysis (MGA) was applied to compare the same path across groups (see Table 11). The path from perceived usefulness to intention to formalization again appeared stronger in the post-test group, but the observed difference of 0.132 (post-test minus pre-test) was not statistically significant (two-tailed p = 0.247). Likewise, Henseler's MGA provides no evidence of a significant difference between the groups for this path.

Table 11. Henseler's MGA

	Difference (Pre-test - Post-test)	1-tailed (Pre-test vs Post-test) p value	2-tailed (Pre-test vs Post-test) p value
UP -> INT	-0.132	0.876	0.247

Note. INT = Intention to formalize business practices; UP = Perceived usefulness of formal business practices

Although the explanatory power and predictive relevance were higher for the post-test model than for the pre-test model, and the path from perceived usefulness to intention toward formalization appeared stronger in both the permutation test and Henseler's MGA, as these group tests were not statistically significant, we conclude that Hypothesis 1 (H1) was not supported.

4. Discussion

4.1. Main results

Although the permutation test and Henseler's MGA did not reach statistical significance, and, consequently, we could not support the research hypothesis, the improvement observed in the post-test model relative to the pre-test model allows for an exploratory interpretation of our research question, suggesting that the serious game Bodegus can enhance perceptions of formal business practices and intentions toward formalization.

Despite this limitation, the results support our conceptual framework for examining the relationship between the perceived usefulness of formal business practices, operationalized from TAM, and the intention to formalize those practices, operationalized from TPB, in experimental designs that incorporate serious game intervention. Perceived usefulness, as a construct from the TAM, precedes behavioral intention. This finding orients to future research directions in which the perceived usefulness of individual and organizational behaviors, such

as informal business practices that have ethical and economic repercussions, should be evaluated in other business areas. This proposal aligns with the findings of Johnsen and is consistent with Ajzen, who warned against viewing TPB as static and explicitly allowed the incorporation of additional constructs that may explain behavior and behavioral intentions [39].

The findings from our Bodegus intervention indicate that informality is not only a macroeconomic phenomenon but also a behavioral one. Bodegus showed that informality is a broader concept from the perspective of informal business practices. The game design allowed this concept to be explored through the dilemmas and decisions that players faced, highlighting that the reality of formality/informality is more than a simple dichotomy.

At a theoretical level, our results support the need to conduct empirical research on ethics in decision making [42], in which normative approaches such as virtue ethics and utilitarianism maintain their relevance in the face of contemporary issues in developing economies, including informality. From a methodological perspective, our study suggests that serious games may be more effective when their design and implementation deliberately juxtapose different theoretical approaches— virtue ethics and utilitarianism–as in our case. In addition, Bodegus showed that in the context of complex and risky decision making, serious games can provide a safe environment to practice such decisions and model behavior before confronting real situations.

Another lesson derived from Bodegus is that, even without statistically significant results due to the small sample size, improvements were observed in the relationship analyzed. This suggests that participant-centered serious-game designs, based on players' realities, may have a greater potential to influence behavior than educational efforts that are more distant from that reality.

From an educational perspective, Bodegus also showed that serious games are not only useful in academic contexts but can also transcend the university classroom and generate changes among audiences with limited formal education, such as informal entrepreneurs [48]. However, an indirect practical implication of validating Bodegus with entrepreneurs is its potential use as a training tool in undergraduate and graduate courses related to business ethics [16,18]. The game reflects the realities of emerging economies and the phenomenon that graduates are likely to face in both private and public sectors.

As a practical implication, our results suggest that those responsible for educational policy should promote innovation and creativity among faculty, empowering them to develop and refine educational tools that continuously improve course content for both students and other participating audiences. At a broader level, a public policy implication is that in contexts with high rates of informality such as Peru, this phenomenon cannot be addressed solely through macro-level legal and tax mechanisms. At the micro level, education and the use of educational tools such as serious games can help transform this reality.

From a practical perspective, Bodegus can also be used in family settings. Parents and children playing Bodegus together can help cultivate a shared ethical understanding that motivates parents to act ethically in business so as not to contradict the ethical reflection that the game may inspire in their children. Future research could examine this gameplay setting empirically, where future conceptual frameworks could incorporate the subjective norms construct from TPB to assess whether parental influence during the game further stimulates ethical reflection and decision-making.

Although Bodegus was developed to address informal business practices, the underlying design logic is transferable to serious games that aim to influence ethical or organizational behaviors in other domains. A core implication is the value of explicitly mapping theory-based constructs to game mechanics: the targeted belief (perceived usefulness) is operationalized through repeated choices, immediate and delayed feedback, and an end-state criterion that aligns winning conditions with desired behavior. This construct-to-mechanical mapping can be adapted to other settings where learners face short-term incentives to deviate from policies or

norms, such as safety compliance, responsible data handling, sustainability trade-offs, or anti-corruption decisions, because it focuses on how players experience the instrumental consequences of alternative courses of action rather than on a topic-specific narrative alone.

Another implication is the ethical architecture of serious games. Bodegus suggests that ethics-oriented games may be more effective when they do not rely on a single normative frame but instead structure decisions so that players can contrast competing ethical justifications. Deliberately juxtaposing virtue-based reasoning with consequence-based reasoning (utilitarianism) turns ethical conflict into a design resource, encouraging players to articulate which values are being prioritized, recognize trade-offs across stakeholders, and reflect on when rule-following, character-based duties, or outcome-based calculations lead to different decisions. This comparative approach is relevant to many areas of management education where "right action" is contested and context-dependent, and it can be readily translated into serious game design for management education.

4.2. Limitations and future research directions

This study had several limitations. The main limitation of this study was the small sample size used in the pre-experiment. Future research should implement Bodegus with a larger sample size that allows at least one control group—another limitation of this pre-experimental design— to strengthen causal inference. Accordingly, our results should be interpreted only as an exploratory approximation of the relationship between the perceived usefulness of formal business practices and the intention to formalize informal practices.

Regarding the research design, our pre-experiment was conducted as a part of a full workshop. Although we considered the introductory lecture necessary to situate participants in the context of informal business practices rather than informality per se, it may have introduced a potential confounding effect on the results of the serious-game intervention because this factor was not controlled. In contrast, the technical session on the use of online tax platforms was purely procedural and unlikely to have influenced participants' perceptions or intentions. Nevertheless, future studies should carefully consider this limitation when applying Bodegus to similar target groups.

Another limitation was the use of the same instrument for the pre-test and post-test, without a sufficient time interval to mitigate the recall of the pre-test responses. Although our analyses did not show common method bias, more robust designs could implement a split-sample strategy with separate groups for pre-test and post-test measurements.

An additional limitation is that not all research variables were evaluated across all business areas susceptible to informal practices, excluding important areas, such as human resource management. Because our sample consisted of bodegueros, who in many cases were self-employed, and because of the small sample size, we chose not to include this area. However, future research should incorporate this dimension for both variables, and ensure a representative sample of entrepreneurs who employ personnel.

Another limitation was the limited exposure time of the game. Although our design included prior instruction on the rules and facilitators that were available throughout the session, a single one-hour exposure may not be sufficient to prompt deeper reflection on the usefulness of formality and on the virtue–utilitarianism dichotomy proposed by the game. Future studies should consider prior orientation and trial sessions that are separate from experimental sessions. In addition, from a quantitative perspective, longitudinal designs with multiple exposures and corresponding follow-up measurements would allow for the use of techniques such as latent growth models to validate the improvement in the proposed relationship more robustly.

Finally, a necessary direction for future research is to explore players' perceptions using qualitative approaches, which would allow Bodegus to be situated within participants' real contexts, assess its impact more deeply, and improve game design based on player feedback.

5. Conclusions

This study examines whether playing Bodegus, a serious board-game intervention, strengthens the relationship between the perceived usefulness of formal business practices and the intention to formalize informal practices among Peruvian entrepreneurs. Using a within-participant pre–post design and a partial least squares structural equation model with full invariance verified through MICOM, it was found that the tested path was strong at both time points, and descriptively higher after the game. However, the differences between the two time points were not statistically significant in either permutation-based MGA or Henseler's MGA. These results suggest, in an exploratory manner, that a focused serious-game intervention can highlight the instrumental value of formalization and contribute to intention formation but also suggest the need for designs with greater statistical power to establish causal effects.

Beyond its methodological contribution—the use of a pre/post PLS model with invariance verification and multi-group analysis in the context of a serious game—the study offers a design logic that instructors can adapt to explore and discuss ethical dilemmas in informal business practices. Policymakers and curriculum designers can leverage this type of intervention to reinforce the legal and tax measures that they have already implemented to address informality at the micro level. Future research should employ larger samples, include a no-game control group or a staggered design, expand the business areas analyzed (for example, human resources, when relevant), and consider longitudinal exposures to validate the durability of the effects.

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Data availability. The dataset used in this study is available at: L. D. Gómez García, "Dataset for pretest posttest serious game evaluation through Structural Equation Model". Zenodo, nov. 02, 2025, https://doi.org/10.5281/zenodo.17504637.

Conflicts of interest

The authors report there are no competing interests to declare.

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