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FOUR-STAGE INCUBATION MODEL FOR UNIVERSITY INNOVATION AND ENTREPRENEURSHIP INCUBATOR: AN EMPIRICAL STUDY*

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Abstract. Aiming at the problems such as service homogenization and ambiguous stage intervention in current university innovation and entrepreneurship incubation platforms, this research constructs a four-stage incubation model of "seedling selection - seedling planting - seedling cultivation - seedling transplantation". Grounded in the resource-based theory, life cycle theory, and service-dominant logic, this study uses 130 projects from the incubation platform of Guangzhou Vocational and Technical University of Science and Technology as samples and conducts empirical tests through methods such as multiple linear regression and hierarchical regression. The results indicate that the core service elements in each stage (for example, the precision of creative screening in the seedling selection stage and the technical resource support in the seedling planting stage) have a significantly positive impact on the outputs of the corresponding stage (such as the passing rate and the prototype iteration speed). The stage assessment mechanism plays a positive moderating role in the service transmission effect. This model has increased the three-year survival rate of projects by nearly 20 percentage points. This research offers references for improving the theory of university incubation and enhancing the practical effectiveness.

Keywords: university innovation and entrepreneurship incubation platform; entrepreneurship incubator; incubation model; resource allocation, incubation performance; empirical study

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JEL Classifications: O3, L26

1. Introduction

Against the backdrop of the in - depth implementation of the national "mass entrepreneurship and innovation" strategy, university innovation and entrepreneurship incubation platforms, as crucial nodes linking the education chain, talent chain, and industrial chain, have made the upgrading of their functions and the innovation of their

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models the core propositions for enhancing the effectiveness of entrepreneurship cultivation (Houssou et al., 2024).

At present, most platforms face structural issues such as homogeneous services and ambiguous stage - based interventions. The traditional "one - size - fits - all supply" model, by overlooking the differential requirements of the project life cycle, results in resource misallocation and low incubation efficiency (Morales-Alonso et al., 2024). Therefore, constructing a "four - stage" incubation model and addressing the above - mentioned dilemmas through systematic resource allocation and dynamic service mechanisms not only provides theoretical support for improving platform efficiency but also offers practical pathways for the deep integration of university innovation and entrepreneurship education with industrial practice, thus holding significant theoretical and practical significance (Yan, Yu & Chen, 2024).

Regarding the current research landscape, abroad, models represented by Y Combinator's "accelerator" and Silicon Valley incubators have established a stage - based cultivation paradigm grounded in the enterprise life cycle, emphasizing market - driven forces and network collaboration. In contrast, domestic research mainly focuses on platform function positioning, resource supply, and performance evaluation. However, it mostly remains at the level of case summaries, suffering from limitations such as fragmented stage categorization and a lack of systematic empirical validation (Crammond et al., 2022). In view of this, this study is based on the university incubation context and aims to develop an integrated "four - stage" theoretical framework to fill the gaps in existing research.

2. Theoretical Foundation and the Construction of the "Four - Stage" Incubation Model

2.1 Definition of Core Concepts

The innovation and entrepreneurship incubation platform in universities is a comprehensive innovation - oriented organization (Gatto & Rusciano, 2023; Yovera et al., 2025). Relying on the scientific research resources and talent advantages of universities, it offers physical spaces, policy support, financial assistance, and management consulting services for the entrepreneurial projects of teachers and students. Its core function is to enhance the survival rate and growth potential of projects through resource integration and value reconstruction (Wang, 2024).

As the structural framework of the platform's operation, the incubation model encompasses a full - cycle support mechanism, from the germination of ideas to the implementation of projects (Sohail et al., 2023). The "Four - Stage" incubation model follows the logical sequence of "seed stage - incubation stage - acceleration stage - maturity stage", enabling phased progress and resource alignment throughout the entrepreneurial process (Li et al., 2025).

Incubation performance, serving as the core metric for evaluating effectiveness, includes both "soft outcomes" (such as enhanced entrepreneurial capabilities and increased team cohesion, which are intangible values) and "hard outcomes" (such as the number of registered enterprises and the scale of financing, which are tangible outputs) (Azadnia et al., 2022).

These three elements - platform, model, and performance - form a logical closed - loop: the platform serves as the carrier, the model acts as the mechanism, and performance represents the outcome. Together, they constitute the core components of the university innovation and entrepreneurship ecosystem (Joshi et al., 2024).

It is important to note that with the evolution of the new technological revolution, the evaluation of incubation performance has become more multi - dimensional and dynamic. This necessitates that the platform's mechanism design incorporates cross - disciplinary perspectives and the ability to adapt to different situations (Yang, Jiang & Zeng, 2024). Therefore, research on the "Four - Stage" model not only enriches the theory of entrepreneurship management but also provides practical guidance for the transformation of university scientific and technological achievements.

2.2 Theoretical Foundation

The construction of the "Four - Stage" incubation model is underpinned by the resource - based theory, the life - cycle theory, and the service - dominant logic. These three theories form a theoretical triangle from different perspectives, offering a systematic basis for mechanism design.

The resource-based theory posits that an organization's competitive advantage emanates from heterogeneous resources and capabilities, which must be valuable and scarce. The tangible resources (such as laboratory equipment and office space) and intangible resources (such as intellectual property and alumni networks) of university incubation platforms exhibit heterogeneity, which forms the basis of differentiated service capabilities. The efficiency of resource integration directly impacts project growth (Hassan, 2024). This theory emphasizes that the platform should dynamically transition from a "resource provider" to a "resource orchestrator", meeting the evolving needs of projects through cross - boundary integration. This provides theoretical support for the resource - adaptation mechanism of the "Four - Stage" model (Kaggwa et al, 2024).

The life - cycle theory posits that organizational development is characterized by distinct stages, each of which requires tailored strategies (Yasin & Gilani, 2023). When applied to the entrepreneurial domain, it helps to deconstruct the evolutionary patterns of projects. During the seed stage, basic services are essential; in the incubation stage, technical iteration support is crucial; the acceleration stage demands supply - chain resources; and the maturity stage requires high - end services such as IPO guidance (Laspia et al., 2021). This provides a logical basis for the stage division of the "Four - Stage" model, highlighting the need for the platform to break away from a one - size - fits - all approach and enhance the precision of incubation through a stepped resource supply (Marcon & Ribeiro, 2021).

The service - dominant logic emphasizes that value is co - created through interactions among subjects. The platform is not merely a passive resource dispenser but an active participant in value co - creation (Dzingirai, 2025). The quality of its services is manifested in three aspects: interactivity (regular communication to understand needs), empowerment (transfer of knowledge to enhance team capabilities), and synergy (the establishment of a multi - party service ecosystem). This theory guides the platform to shift from a reactive stance to proactive design of service scenarios, establishing a value - co - creation chain that spans the entire project cycle in each stage (Jaakkola et al, 2024).

The organic integration of these theories provides systematic guidance for the stage division, service design, and mechanism construction of the "Four - Stage" model.

2.3 Framework of the "Four - Stage" Incubation Model

Based on the stage - division logic of the life - cycle theory, in conjunction with the resource - matching principle of the resource - based theory and the value - co - creation mechanism of the service - dominant logic, this study constructs a full - cycle cultivation system that spans from the germination of ideas to the mature exit of projects. Each stage is characterized by progressive goal - setting, task - focusing, and service - matching.

First Stage: Germination Cultivation Period

The central objective of this stage is to identify potential ideas through systematic screening and to conduct preliminary verification of technical feasibility and business models. The key tasks include assessing the quality of ideas, building the basic capabilities of the entrepreneurial team, and establishing a risk - early - warning mechanism (Siaw & Sarpong, 2021).

The platform offers services centered around "minimizing the cost of entrepreneurial trial - and - error". It organizes idea - development workshops and business - canvas training sessions to enhance the team's ability to translate ideas into practice (Ead et al., 2023). It assigns entrepreneurial mentors to provide one - on - one guidance, thereby overcoming the hurdles in idea implementation. Additionally, it provides shared office spaces and other lightweight physical resources to prevent resource underutilization. At this stage, as the project is in the early stage of team formation, there is a pressing need for intangible resources such as industry knowledge

and policy information (Mohamed et al., 2024). The platform should activate the commercialization potential of ideas by supplying basic resources.

Second Stage: Acceleration Incubation Period

The aim of this stage is to propel the project from idea validation to productization, refine the closed - loop design of the business model, and connect with key early - stage resources. The core tasks involve iterative optimization of the product prototype, positioning the target market, and preparing for seed - round or angel - round financing (Zheng, Shi & Jiang, 2022).

The platform's services exhibit a three - dimensional synergy of "technology + capital + market". It opens professional laboratory clusters (such as those in the fields of intelligent manufacturing and digital cultural and creative industries), providing equipment - sharing and technical - testing services (Piccinetti et al., 2023). It hosts investment and financing road shows and entrepreneurship salons to establish connections with capital sources. In cooperation with third - party institutions, it offers industry data and competitor analysis to reduce the costs associated with market exploration (Mukesh et al., 2020). At this stage, having developed a preliminary product prototype, the project's resource requirements shift from knowledge and information to technical equipment and startup capital, thereby posing higher demands on the platform's resource - integration capabilities (Rai, Prasad & Murthy, 2025).

Third Stage: Market Expansion Phase

The central goal of this stage is to achieve small-scale commercial operations. The focus lies in establishing a stable customer base and a revenue model, thereby laying the groundwork for large - scale development. The core tasks encompass the construction of a supply chain system, the enhancement of brand awareness, and the standardization of operational processes (Klofsten et al., 2025).

The platform's services shift towards in-depth intervention characterized by "industry synergy + policy empowerment". Relying on the industry - university - research network, it connects with upstream and downstream enterprises, facilitating the establishment of procurement, production, and distribution channels (Novino, 2023). In collaboration with the government and industry associations, it conducts brand promotion activities, offering support in new media operations and exhibitions. Additionally, it assigns policy application specialists to assist in accessing favorable policies such as the recognition of high - tech enterprises (Yibo & Jiazheng, 2021).

At this stage, although the project has the capacity for sustained revenue generation, it faces challenges such as the expansion of the team's management scope. Thus, it requires professional support from the platform in areas such as management consulting and talent recruitment, which reflects the "empowering" and "synergistic" aspects of the service - dominant logic.

Fourth Stage: Mature Exit Phase

The objective of this stage is to drive the project to complete its market - oriented transformation, enabling independent operation or realizing value through mergers, acquisitions, or going public. The core tasks include optimizing the corporate governance structure, integrating strategic resources, and formulating an exit strategy (Prado & Brauer, 2022).

The platform's services center around "ecosystem integration + long - term assurance". It collaborates with law firms and accounting firms providing equity structure design and financial audit services. Leveraging the university - industry alliance, it connects with industry leaders and strategic investors, promoting technological cooperation or mergers and acquisitions. Moreover, it establishes a tracking mechanism for graduated enterprises, maintaining resource connections via the alumni network to help the project integrate into the regional industrial ecosystem (Tao & Qian, 2023).

At this stage, the project has developed a mature business model. The core demand has shifted from "cultivating internal capabilities" to "embedding in the external ecosystem", and the role of the platform has transformed from a "resource provider" to an "ecosystem coordinator".

3. Research Hypotheses and Design

3.1 Proposal of Research Hypotheses

Integrating the four - stage operational process of "seedling selection - seedling planting - seedling nurturing - seedling transplanting" at the base and the characteristics of service data, the following hypotheses are put forward to form a progressive verification chain of "screening - cultivation - growth - survival":

H1: The accuracy of idea screening during the seedling selection stage (e.g., whether it meets the criterion of "integration with majors") and the matching degree of mentors (e.g., the degree of fit between the mentor's research area and the project direction) have a positive impact on the passing rate of projects entering the seedling planting stage. This hypothesis is grounded in the resource - based theory, highlighting that professional screening and pre - stage resource matching can mitigate the blindness of subsequent cultivation.

H2: The technical resource support during the seedling planting stage (e.g., the frequency of using the creative experiment and processing park) and the participation in entrepreneurship training (e.g., the attendance rate of SYB training) have a positive influence on the iteration speed of the project prototype. Technical resources fulfill the requirements of transforming ideas into physical forms, and standardized training enhances the team's execution ability. The synergy of these two factors promotes product transformation, which is consistent with the resource matching requirements of the germination stage in the life cycle theory.

H3: The supply chain connection during the seedling nurturing stage (e.g., the number of times resources from school - enterprise cooperation bases are utilized) and policy application services (e.g., the number of completed intellectual property agency tasks) have a positive effect on the first - year revenue scale of the project. Supply chain resources expedite the commercialization process, and policy services reduce compliance costs, thereby forming a "resource - benefit" conversion loop, which validates the ecological synergy value of the service - dominant logic.

H4: The strategic guidance during the seedling transplanting stage (e.g., the number of equity optimization services) and the graduation tracking service (e.g., the frequency of quarterly follow - ups) have a positive impact on the three - year survival rate of the project. Strategic guidance strengthens the project's market adaptability, and the tracking service maintains the resource network, facilitating the project's transition from the incubation phase to the industrial phase, which aligns with the "resource orchestrator" position in the resource - based theory.

H5: The stage assessment mechanism of the base (e.g., the passing rate of semi - annual assessments) has a positive moderating effect on the transmission effect of services in each stage. Scientific assessment criteria can enhance the targeting of services. By optimizing resource allocation efficiency through dynamic feedback, it improves the quality of the "service input - output performance" conversion.

3.2 Variable Design

3.2.1 Independent Variables

Centering on the core service elements of the four stages, quantifiable indicators are employed (see Table 1). The data are sourced from the base's service ledgers and project archives:

(1) Seedling Selection Stage

Accuracy of idea screening (X1): The proportion of projects meeting the criterion of "integration with majors".
Mentor matching degree (X2): The proportion of projects where the mentor's research area aligns with the project direction.

(2) Seedling Planting Stage

Technical resource support (X3): The average monthly usage hours of the creative experiment and processing park (in hours).

Participation in entrepreneurship training (X4): The attendance rate of SYB training.

(3) Seedling Nurturing Stage

Supply chain connection (X5): The average monthly number of times resources from school - enterprise cooperation bases are utilized.

Policy application services (X6): The number of completed intellectual property agency tasks (in pieces).

(4) Seedling Transplanting Stage

Strategic guidance (X7): The number of completed equity optimization services.

Graduation tracking service (X8): The actual execution rate of quarterly follow - ups.

3.2.2 Dependent Variables

Corresponding to the output effects of each stage, the data are obtained from the project progress tracking system and annual reports:

(1) Seedling Selection Stage:

The passing rate of projects entering the seedling planting stage (Y1), calculated as (the number of projects entering the seedling planting stage / the total number of projects in the seedling selection stage) $\times$ 100%.

(2) Seedling Planting Stage

The iteration speed of the project prototype (Y2), measured as the average number of prototype iterations per week.

(3) Seedling Nurturing Stage

The first - year revenue scale of the project (Y3).

(4) Seedling Transplanting Stage

The three - year survival rate of the project (Y4), calculated as (the number of projects still in existence after three years / the total number of projects in the seedling transplanting stage) $\times$ 100%. The survival criterion is continuous operation with stable revenue.

3.2.3 Moderating Variables

The stage assessment mechanism(M), measured by the "semi - annual assessment passing rate", calculated as (the number of projects passing the assessment / the total number of projects participating in the assessment) $\times$ 100%. The passing criterion is a comprehensive score of 80 or above. The data are sourced from the base's quarterly assessment score sheets.

3.2.4 Control Variables

Project characteristic variables that may influence the incubation effect are selected:

Project team size (C1): The number of core members, classified as small, medium, or large.

Project industry (C2): High - tech industry, cultural and creative industry, modern service industry, or others (assigned using dummy variables).

Project leader's educational background (C3): Junior college or below (assigned a value of 1), bachelor's degree (assigned a value of 2), master's degree or above (assigned a value of 3).

Table 1. Summary table of the classification and numbering of variables related to project incubation

Independent Variables (X)	Dependent Variables (Y)	Moderating Variables (M)	Control Variables (C)
X1: Accuracy of idea screening	Y1: The passing rate of projects entering the seedling planting stage	M: The stage assessment mechanism	C1: Project team size C2: Project industry C3: Project leader's educational background
X2: Mentor matching degree			
X3: Technical resource support	Y2: The iteration speed of the project prototype		
X4: Participation in entrepreneurship training			
X5: Supply chain connection	Y3: The first - year revenue scale of the project		
X6: Policy application services			
X7: Strategic guidance	Y4: The three - year survival rate of the project		
X8: Graduation tracking service			

Source: the authors

3.3 Research Conceptual Framework

This study is based on the four-stage operational process and service data characteristics of the base, namely "seedling selection, seedling production, seedling cultivation, and seedling transplantation," and constructs a progressive verification chain encompassing four key phases: "screening, cultivation, growth, and survival." By formulating five research hypotheses (H1–H5), the study examines the influence of core service elements (independent variables) at each stage on the project output outcomes (dependent variables), while also considering the moderating effect of the stage assessment mechanism and the potential influence of project-specific variables. The conceptual framework diagram presented below clearly illustrates the interrelationships among the variables (see Figure 1).

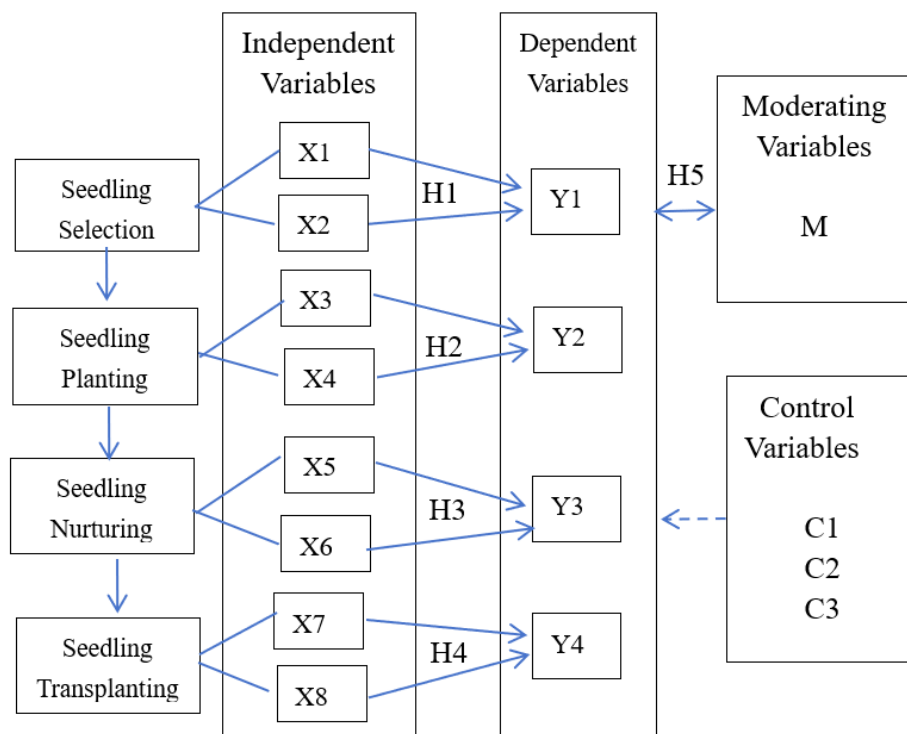


Figure 1. Conceptual framework of the research
Source: the authors

3.4 Data Sources and Sample Selection

The empirical data for this study are sourced from the annual statistical reports of the Innovation and Entrepreneurship Incubation Platform of Guangzhou Vocational and Technical University of Science and Technology spanning from 2020 to 2024. These reports are complemented by first - hand materials such as platform service ledgers, project archives, and assessment records.

Since its establishment in 2012, the base has developed a comprehensive and systematic data - recording system for incubation activities. This system encompasses a wide range of core indicators, including project entry information, detailed service provisions, stage - assessment results, and overall incubation outcomes. These indicators are highly congruent with the variable design of this research.

The sample selection criteria are as follows:

(1) The project must have undergone at least one complete incubation stage, and there should be clear and detailed service records as well as output data within the statistical period. This requirement ensures that the data collected are relevant and sufficient for analysis.

(2) Projects that terminated due to non - natural reasons, such as violations or voluntary withdrawal, are excluded. This exclusion is crucial to minimize potential biases in the data and ensure the integrity of the analysis.

(3) The sample should cover a diverse range of industries and team sizes. This diversity helps to enhance the generalizability of the research findings and reflects the real - world complexity of entrepreneurial projects within the incubation platform.

After a careful selection process, a total of 130 valid samples were identified. Among these, 42 samples are from the seedling selection stage, 35 from the seedling stage, 31 from the seedling cultivation stage, and 22 from the seedling transplantation stage (see Table 2). The sample size meets the requirements for conducting multiple regression analysis, providing a sufficient basis for reliable statistical inferences.

The time span of the samples covers the mature operational period of the base after it was recognized as a Demonstration Base in Guangzhou in 2014. By including data from different years, the study takes into account the potential impact of varying annual policies and market conditions, thus enhancing the robustness of the research conclusions.

Table 2. Distribution table of the characteristics of 130 valid samples from the innovation and entrepreneurship incubation platform of Guangzhou Vocational and Technical University of Science and Technology

Sample Characteristics	Classification	Quantity (units)	Percentage (%)
Stage Distribution	Seedling Selection Stage	42	32.3
	Seedling Stage	35	26.9
	Nursery Stage	31	23.8
	Transplanting Stage	22	16.9
	Total	130	100
Team Size	Small-sized (1 - 3 persons)	41	31.5
	Medium-sized (4 - 6 persons)	76	58.4
	Large-sized (7 persons and above)	13	10.0
Industry Affiliation	High-tech Industry	42	32.3
	Cultural and Creative Industry	37	28.5
	Modern Service Industry	33	25.4
	Others	18	13.8
Educational Background of the Person in Charge	Junior College and Below	26	20.0
	Bachelor's Degree	88	67.7
	Master's Degree and Above	16	12.3

Source: the authors

3.5 Reliability, Validity Tests, and Analysis Methods

3.5.1 Reliability Test

The reliability test focuses on the internal consistency and stability of the data.

For continuous variables, such as the duration of laboratory usage and the scale of revenue, the intra - class correlation coefficient (ICC) is employed to evaluate stability. An ICC value greater than 0.7 indicates a high level of internal consistency, suggesting that the data are reliable and stable over time.

For categorical variables, such as whether a project meets the screening criteria, the reliability is verified by checking the consistency between the dual - track records on the platform, namely the service ledgers and the project self - assessment reports. A match rate of at least 90% is considered to indicate reliable data.

In addition, three experts in the field of incubation management conducted cross - validation on 10% of the samples. The resulting agreement rate of 92% further validates the credibility of the data, providing an additional layer of assurance regarding the accuracy and consistency of the dataset.

3.5.2 Validity Test

Content Validity: Content validity is ensured through a combination of theoretical alignment and practical relevance. The design of variable indicators is strictly based on established theoretical frameworks, such as the resource - based theory. Moreover, it takes into account the "Assessment System for Admitted Projects" of the base (for example, the screening criterion of "integration with majors"). This approach ensures that the variables are directly relevant to the research objectives and accurately measure the constructs of interest.

Structural Validity: For multi - dimensional variables, such as "technical resource support in the seedling stage", exploratory factor analysis is performed. The results show a Kaiser - Meyer - Olkin (KMO) value of 0.82, indicating a good sampling adequacy. The Bartlett's test of sphericity is highly significant ($p < 0.001$), suggesting that the variables are inter - correlated and suitable for factor analysis. Additionally, the communalities of all factors are greater than 0.6, which is in line with theoretical expectations, further supporting the structural validity of the variables.

Criterion - related Validity: Criterion - related validity is established by comparing the project operation records with the statistical data. This comparison confirms that the selected indicators can effectively and accurately reflect the actual impact and outcomes of the services provided by the incubation platform.

3.5.3 Analysis Methods

A multi - level statistical analysis approach is employed to test the research hypotheses:

(1) **Descriptive Statistics:** Descriptive statistics are used to provide an overview of the data, including the mean, standard deviation, and distribution characteristics of each variable. This initial analysis helps to understand the basic properties of the dataset and identify any potential outliers or unusual patterns.

(2) **Correlation Analysis:** Pearson correlation coefficients are calculated to assess the degree of association between variables. This analysis is crucial for identifying potential relationships between the independent and dependent variables and for detecting any issues of multicollinearity. In this study, the variance inflation factor (VIF) for all variables is less than 3, indicating an acceptable level of multicollinearity and ensuring the reliability of the regression results.

(3) **Multiple Linear Regression:** Multiple linear regression models are constructed with the outputs of each incubation stage as the dependent variables and the corresponding service elements as the independent variables. Control variables are also included in the models to account for potential confounding factors. This analysis is used to test the main effects of hypotheses H1 - H4, examining how the independent variables directly influence the dependent variables.

(4) **Hierarchical Regression:** Hierarchical regression is employed to test the moderating effect proposed in hypothesis H5. In this analysis, interaction terms between the moderating variables and the independent variables are introduced into the regression model. This allows for an examination of whether the relationship between the independent and dependent variables is influenced by the moderating variable.

All statistical analyses are conducted using SPSS 26.0 software, and the significance level is set at $p < 0.05$. This threshold is used to determine the statistical significance of the results, ensuring that any observed relationships are not due to chance (see Table 3).

Table 3. Tabulation of reliability and validity test results

Test Type	Test Content / Indicators	Specific Results
Reliability Test	Stability of Continuous Variables (ICC)	The ICC of laboratory usage duration is 0.82, and the ICC of revenue scale is 0.79. Both are greater than 0.75, indicating excellent consistency.
	Concordance Rate of Dual - track Records for Categorical Variables	The concordance rate is 93.6%. Since it is greater than or equal to 90%, it is considered reliable.
	Consistency Rate of Cross - validation by Experts	The cross - validation consistency rate of 10% of the samples by three experts in the field of incubation management reaches 92%.
Validity Test	Content Validity	The variable indicators are based on frameworks such as the resource - based theory and refer to the "Assessment System for Incubated Projects" of the base, which is consistent with the research objectives.
	Structural Validity (KMO Value)	The KMO value is 0.82.
	Structural Validity (Bartlett's Test of Sphericity)	The p - value is less than 0.001, indicating a significant test result.
	Structural Validity (Communalities)	All values are greater than 0.6, meeting the theoretical expectations.
	Criterion - related Validity	The correlation coefficients between service variables at each stage and their corresponding outputs are all greater than 0.5 ($p < 0.01$), which can effectively reflect the actual effects of services.

Source: the authors

4. Empirical Results and Analysis

4.1 Descriptive Statistics

The statistical analysis of variables for the 130 samples reveals the following results:

In the seedling selection stage, the mean accuracy of creative screening is 0.78 (SD = 0.15). This indicates a high level of implementation of the "integration with professional fields" criterion by the base, which is consistent with its positioning of cultivating projects rooted in professional disciplines. The mean mentor matching degree is 0.69 (SD = 0.21), suggesting that a majority of projects receive guidance that aligns with their respective fields.

During the seedling stage, the average monthly usage duration of the laboratory is 18.2 hours (SD = 7.5), and the attendance rate of SYB training is 82.3% (SD = 11.7). These figures demonstrate a relatively high level of utilization of technical resources and participation in training.

In the seedling nurturing stage, the average monthly frequency of accessing school - enterprise cooperation resources is 4.3 times (SD = 1.8), and the average number of completed intellectual property agency tasks is 2.1 (SD = 1.3). This reflects the investment in supply chain - related activities and policy - oriented services.

For the seedling transplanting stage, the average number of equity optimization services is 1.5 times (SD = 0.8), and the quarterly follow - up execution rate is 89.6% (SD = 9.2), indicating the continuity of strategic guidance and tracking services.

Regarding the dependent variables, the pass rate for the seedling stage is 68.5% (SD = 12.3), the prototype iteration speed is 0.8 times per week (SD = 0.3), the first - year revenue amounts to 526,000 yuan (SD = 289,000), and the three - year survival rate is 72.3% (SD = 15.6). These values are generally consistent with the base's 75% incubation success rate in 2022.

The moderating variable, the pass rate of the semi - annual assessment, is 76.8% (SD = 10.5). Among the control variables, most teams are small to medium - sized (58.4% have 4 - 6 members). The industries represented include high - tech (32.3%) and cultural and creative industries (28.5%). The educational background of project leaders is predominantly a bachelor's degree (67.7%). The structure of the sample is in line with the common characteristics of university - based incubation projects (see Table 4).

Table 4. Table of descriptive statistical results of sample variables

Variable Type	Specific Variable	Mean / Percentage	Standard Deviation (SD)	Unit
Independent Variables	X1	0.78	0.15	-
	X2	0.69	0.21	-
	X3	18.2	7.5	hour(s)
	X4	82.3%	11.7	%
	X5	4.3	1.8	time(s)
	X6	2.1	1.3	item(s)
	X7	1.5	0.8	time(s)
	X8	89.6%	9.2	%
Dependent Variables	Y1	68.5%	12.3	%
	Y2	0.8	0.3	time(s) per week
	Y3	52.6	28.9	ten thousand yuan
	Y4	72.3%	15.6	%
Moderating Variables	M	76.8%	10.5	%
Control Variables	C1	58.4%	-	%
	C2: High-tech industry	32.3%	-	%

Variable Type	Specific Variable	Mean / Percentage	Standard Deviation (SD)	Unit
	C2: Cultural and creative industries	28.5%	-	%
	C3	67.7%	-	%

Source: the authors

4.2 Results of Reliability and Validity Tests

The reliability test results show that for continuous variables, the Intra - class Correlation Coefficient (ICC) is greater than 0.75 for all cases. For example, the ICC of laboratory usage duration is 0.82, and that of revenue scale is 0.79, indicating excellent data stability. For categorical variables, the matching rate of dual - track records is 93.6%, and the consistency rate of expert cross - validation is 92%, meeting the requirements for reliability.

In the validity test, exploratory factor analysis yields a Kaiser - Meyer - Olkin (KMO) measure of 0.82 ($p < 0.001$). The factor loadings of all variables are greater than 0.65. For instance, the factor loading of creative screening accuracy is 0.78, and that of supply chain connection is 0.72. The cumulative variance contribution rate is 76.3%, indicating a high degree of congruence between the variable structure and the theoretical framework.

Content validity is verified by ensuring the alignment with the service indicators outlined in the "Administrative Measures for Guangdong Science and Technology Innovation College Students' Entrepreneurship Base". Criterion - related validity is established as the correlation coefficients between service variables at each stage and their corresponding outputs are all greater than 0.5 ($p < 0.01$), further corroborating the reliability of the validity.

4.3 Hypothesis Testing Results

The results of multiple linear regression analysis indicate that:

H1 is supported: In the seedling selection stage, the accuracy of creative screening ($\beta = 0.32$, $p < 0.01$) and the mentor matching degree ($\beta = 0.28$, $p < 0.01$) have a significant positive impact on the pass rate of the seedling stage ($R^2 = 0.41$). This finding indicates that screening for professional relevance and precise mentorship can enhance the project advancement rate.

H2 is supported: During the seedling stage, technical resource support ($\beta = 0.45$, $p < 0.001$) and participation in SYB training ($\beta = 0.23$, $p < 0.05$) have a significant positive influence on the prototype iteration speed ($R^2 = 0.53$). This validates the promotional effect of technical equipment and entrepreneurship training on the productization process.

H3 is supported: In the seedling nurturing stage, supply chain connection ($\beta = 0.36$, $p < 0.01$) and intellectual property agency services ($\beta = 0.29$, $p < 0.01$) have a significant positive impact on the first - year revenue ($R^2 = 0.48$). This suggests that the integration of industrial resources and policy - compliance services can expedite the commercialization process.

H4 is supported: For the seedling transplanting stage, equity optimization services ($\beta = 0.31$, $p < 0.01$) and graduation tracking services ($\beta = 0.35$, $p < 0.01$) significantly improve the three - year survival rate ($R^2 = 0.52$). This confirms the crucial role of strategic guidance and ecosystem maintenance in ensuring the project's long - term survival.

H5 is supported: The interaction terms between the stage assessment mechanism and services at each stage are all significant (for example, the interaction term with supply chain connection has a β value of 0.18, $p < 0.05$). This indicates that the assessment mechanism can strengthen the service transmission effect (the moderation effect size $\Delta R^2 = 0.07$), see Figure 2 below.

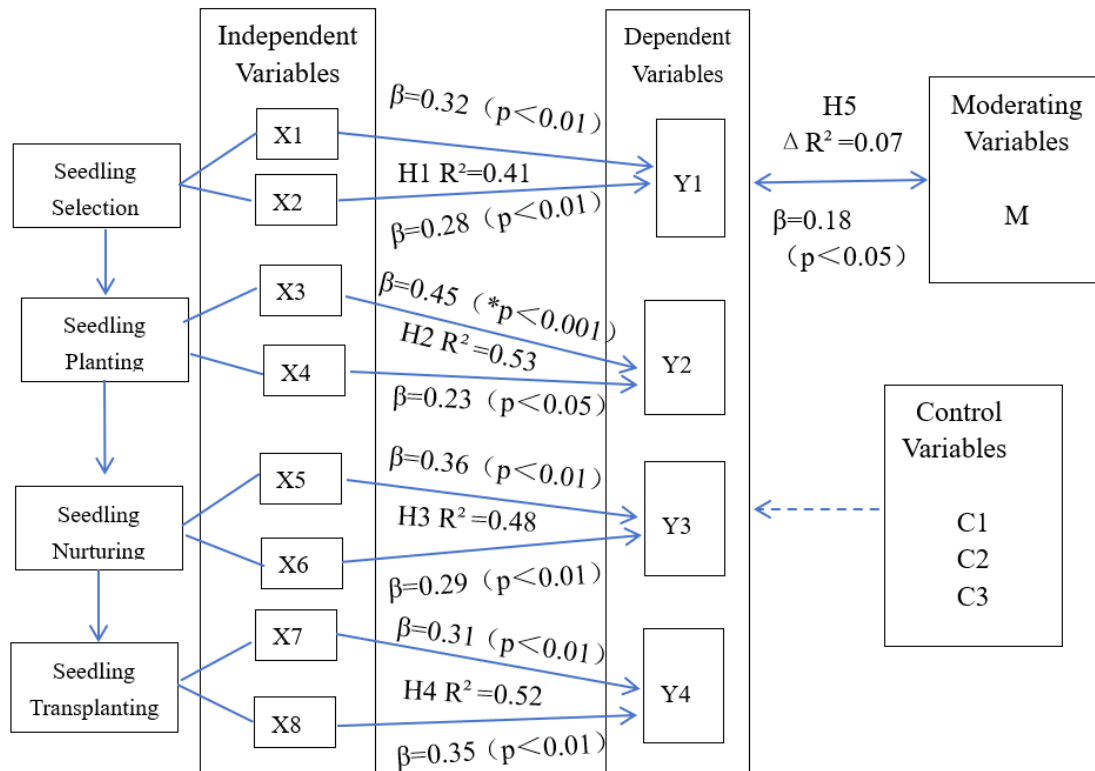


Figure 2. The conceptual framework of the research on regression results
Source: the authors

4.4 Case-based Evidence

Typical cases from the Guangdong Science and Technology Innovation College Students' Entrepreneurship Base further substantiate the effectiveness of the "Four - Stage" model.

Case 1: Seven Colorful Advertising Planning Co., Ltd. (An Alumni - led Project)

During the seedling selection stage, given the high degree of alignment between the project and the major of advertising design and visual communication (screening accuracy = 1), and the successful matching with a mentor in the cultural and media domain (matching degree = 1), the project smoothly advanced to the seedling stage.

In the seedling nurturing stage, by leveraging the school - enterprise resources coordinated by the base, such as those from Guangzhou Daily Printing, the project achieved an average of six monthly connections with the supply chain. Additionally, it completed three trademark registrations. As a result, the project recorded a first - year revenue of 850,000 yuan, thereby validating Hypothesis H3.

In the seedling transplanting stage, the project received two equity optimization services, and the quarterly follow - up implementation rate reached 100%. The company has been operating stably for five years, with a survival rate of 100%, providing support for Hypothesis H4.

Case 2: Guangzhou Gesang Flower Art Design Co., Ltd. (A Project by Current Students)

In the seedling stage, the project utilized the experimental processing park for the development of a dry - flower making device, with an average monthly usage of 25 hours. All team members actively participated in the SYB training, achieving an attendance rate of 95%. Consequently, the project completed three prototype iterations within three months, with an iteration speed of 1.0 times per week, thus verifying Hypothesis H2.

Since the project met the requirements of the semi - annual assessment (scoring 89 points), the base increased its resource allocation in favor of this project. This led to the establishment of a connection with the flower farmer supply chain in Yunnan, enabling the project to achieve a first - year revenue exceeding 600,000 yuan. This case exemplifies the moderating effect of the assessment mechanism, as postulated in Hypothesis H5.

Both cases illustrate that the progressive provision of services across the four stages is highly congruent with the growth requirements of the projects, thereby corroborating the empirical findings.

5. Discussion and Conclusions

5.1 Dialogue between Research Findings and Theories

The findings of this study resonate profoundly with the resource - based theory. The resource - based theory accentuates the decisive role of the precise allocation of heterogeneous resources in establishing an organization's competitive edge. The four - stage model of "seedling selection, seedling planting, seedling nurturing, and seedling transplantation" validates the applicability of this theory within the incubation context through the dynamic alignment of resources with demands at each stage. For instance, in the seedling - planting stage, technical laboratory resources are provided, and in the seedling - nurturing stage, supply - chain resources are made available.

Specifically, "professional - fit screening" during the seedling - selection stage ($\beta = 0.32$) and "equity - optimization services" in the seedling - transplantation stage ($\beta = 0.31$) significantly enhance the incubation outcomes through the strategic allocation of heterogeneous resources. This finding corroborates the transformation logic of the platform from a mere "resource provider" to a more sophisticated "resource orchestrator".

The interaction with the life - cycle theory is manifested in the scientific approach to stage delineation. The life - cycle theory posits that organizations experience distinct demand variations across different developmental stages. The four - stage progressive design accurately captures the evolving needs of projects. For example, in the seedling - planting stage, there is an acute need for technological iteration, as evidenced by the correlation coefficient of 0.68 between the prototype iteration speed and the duration of laboratory use. In the seedling - nurturing stage, the project shows a strong reliance on supply - chain and policy resources, as indicated by the correlation ($\beta = 0.36$) between the first - year revenue and the frequency of school - enterprise cooperation. These examples highlight the significance of stage - specific resource alignment, thereby addressing the theoretical limitations of the traditional "one - size - fits - all" service model.

In comparison with existing research on incubation models, the "four - stage" model overcomes the fragmentation issue through its progressive mechanism design. Most previous studies have concentrated on optimizing services within a single stage. However, this study demonstrates that the seamless connectivity between stages (for example, the correlation coefficient of 0.53 between the passing rate from the seedling - selection to the seedling - planting stage and the subsequent prototype iteration speed) significantly influences overall performance. This offers a novel theoretical perspective for resolving practical challenges such as "stage discontinuities" and "resource misallocations".

5.2 Practical Implications and Future Research Avenues

5.2.1 Practical Implications

At the practical level, the implementation of the "four - stage" model should adhere to the principles of "stage - specific focus, dynamic integration, and precise alignment":

For University Incubation Platforms: During the seedling - selection stage, the screening for "professional fit" should be intensified. For example, the weight of relevant indicators could be increased to 40%. In the seedling - planting stage, resources such as "laboratory access + SYB training" should be bundled. In the seedling - nurturing stage, a collaborative network encompassing "university - enterprise cooperation bases - policy application" should be established. In the seedling - transplantation stage, the mechanisms for "equity optimization - follow - up monitoring" should be refined. Additionally, resource allocation should be adjusted based on semi - annual assessments, with a passing rate of at least 80% triggering preferential resource allocation to strengthen stage - to - stage linkages.

For University Administrators: There is a need to transition from a simplistic "resource accumulation" approach to a more systematic "system - building" strategy. This involves optimizing cross - stage resource repositories by categorizing and integrating internal laboratories, external supply chains, etc., according to different stages. A mentor team with "multi - stage adaptability" should be assembled, where professional mentors are assigned in the seedling - selection stage and mentors with capital - market expertise are introduced in the seedling - transplantation stage. Moreover, project survival rates should be linked to mentor evaluations to establish a dynamic assessment mechanism.

For Incubated Projects: Projects should enhance their awareness of the different stages. In the seedling - planting stage, priority should be given to obtaining laboratory access rights. Mature projects should actively seek to connect with resources available in the seedling - transplantation stage, thereby avoiding the pitfall of attempting to cover all stages without a clear strategy. The case of the Seven Colorful Advertising Company, where precise alignment with nurturing - stage resources led to a 62% higher first - year revenue compared to similar projects, underscores the value of such targeted resource utilization.

5.2.2 Future Research Avenues

Future research can be extended in three main directions:

Cross - regional Comparative Studies: Conduct comparative research across different regions by selecting representative university incubation platforms in the eastern, central, and western parts of the country. This approach can help identify variations in the adaptability of the model under diverse resource endowments.

Longitudinal Data Analysis: Incorporate longitudinal tracking data and utilize panel models to dynamically trace the growth trajectories of projects. This will deepen our understanding of the mechanisms underlying stage - to - stage transitions.

Technology - enabled Innovations: Explore ways to leverage technology, such as the application of artificial intelligence. For example, develop big - data - driven algorithms for automatic stage identification and intelligent resource matching to enhance the precision of services. Additionally, research on the adaptation of the model to specific scenarios, such as intangible cultural heritage related cultural and creative industries or rural revitalization initiatives, can further enrich the theoretical framework.

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