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Adaptation Design and Empirical Research of Lightweight ERP Systems for Small and Micro Enterprises

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Abstract

Against the global digital transformation of small and micro-enterprises (SMEs), the low adoption rate (<35% globally) and high failure rate (>60%) of traditional ERP systems have become bottlenecks for SME management upgrading. This study takes the "Qi Weijie" lightweight ERP system as the research object, conducts empirical analysis based on 15 SMEs across manufacturing, service, and retail sectors, and explores the influence mechanism of three core adaptation elements—scale adaptation, cost control, and ease of operation—on ERP application effects. A "Lightweight ERP Selection Scoring Model" with 10 quantitative indicators was constructed via Analytic Hierarchy Process (AHP), and its prediction accuracy was verified (in-sample $R^2 = 0.85$, out-of-sample $R^2 = 0.80$). Empirical results show that: (1) Scale adaptation has a significant positive impact on ERP application effect ($\beta = 0.65$, $p < 0.001$), with functional module customization and architectural flexibility explaining 42% of the variance; (2) Cost control presents a significant negative correlation with application effect ($\beta = -0.58$, $p < 0.001$), and every 10% reduction in implementation and maintenance costs leads to a 15% increase in user acceptance; (3) Ease of operation is the most influential factor ($\beta = 0.70$, $p < 0.001$), accounting for 49% of the variance, and intuitive interfaces and simplified processes increase system usage frequency by 2.3 times. This study enriches the theoretical framework of ERP adaptation research from the perspective of SME resource constraints and provides a scientific decision-making tool for SMEs. Validated in Beijing Mint Information Consulting Co., Ltd.'s practice, it helped 12 of 15 sample enterprises achieve a 45% average improvement in management efficiency and a 30% average reduction in operational costs.

Keywords: small and micro enterprises (SMEs), lightweight ERP system, adaptation design, empirical research, selection scoring model, digital transformation

1. Introduction

1.1 Research Background

SMEs contribute over 50% of global GDP and 60% of employment (World Bank, 2023), but face resource constraints: average annual IT expenditure accounts for only 1.2% of revenue (vs. 4.5% of large enterprises), and 78% of SMEs

have fewer than 2 full-time IT staff. Traditional ERP systems, with high implementation costs (> $150,000), long deployment cycles (18 months), and rigid modules, fail to meet SME needs, resulting in a 32.7% global adoption rate and 65% project failure.

Lightweight ERP systems, with modular design and cloud architecture, reduce costs by 60-70% and shorten deployment to 1-3 months (Xu et al., 2023). The "Qi Weijie" system has been applied in 200 + Chinese SMEs with 78% initial satisfaction, but existing research lacks in-depth empirical analysis of adaptation elements and quantitative research on matching SME characteristics. (Chen, Y., et al., 2022)

1.2 Research Purpose and Significance

1.2.1 Research Purpose

(1) Identify key adaptation elements of lightweight ERP for SMEs and clarify their impact paths; (2) Construct a quantitative "Lightweight ERP Selection Scoring Model" to solve blind selection; (3) Propose targeted strategies based on Beijing Mint Information Consulting Co., Ltd.'s practice.

1.2.2 Research Significance

- **Theoretical**: Integrate system adaptation theory, cost-benefit theory, and UTAUT2 model to construct a "adaptation elements-application effect" framework, filling the gap of quantitative verification.
- **Practical**: The model has over 80% accuracy, helping 8 SMEs avoid invalid investment ($80,000 on average) in pilots, and providing paths for ERP vendors and consulting institutions.

1.3 Research Framework and Methods

1.3.1 Research Framework

Adopt a "theoretical derivation-empirical verification-model construction-strategy proposal" framework: propose 3 core adaptation elements via literature review; put forward hypotheses and construct a conceptual model; collect data and verify hypotheses; construct a scoring model and propose strategies.

1.3.2 Research Methods

- **Literature Review**: Sort 128 studies on ERP and SME digital transformation (2018-2023) in Web of Science and CNKI.
- **Empirical Research**: Mix quantitative (225 questionnaire samples, system backend data) and qualitative (15 interviews, 1,200 minutes) methods.
- **Statistical Analysis**: Use SPSS 26.0 and AMOS 24.0 for reliability/validity analysis and regression; use AHP (10 experts) to determine indicator weights.

2. Literature Review

2.1 Research on ERP Application in SMEs

ERP can improve SME management efficiency by 20-30%, but faces challenges: traditional ERP's TCO is 3-5 times SME IT budget, 28% of enterprises abandon systems within 1 year , 62% lack maintenance ability, and non-IT staff acceptance is only 55% (Xu et al., 2023). Lightweight ERP research stays qualitative, lacking quantitative analysis of element impact. (Liu, J., et al., 2021)

2.2 Research on ERP System Adaptation

ERP adaptability refers to system-enterprise matching (Zhang et al., 2021). Existing indicators are for large enterprises (e.g., Wang et al.'s 2020 18-indicator system), and "vendor-led modular adaptation" (Chen et al., 2022) lacks empirical verification.

2.3 Research on User Acceptance of ERP Systems

UTAUT2 model shows "performance expectation" and "effort expectation" affect acceptance (Venkatesh et al., 2012), but existing studies rarely quantify ease of operation's impact (e.g., Liu et al., 2021, no link between operation steps and usage rate). (McAfee, A., & Brynjolfsson, E., 2017)

2.4 Research Gaps

(1) Lack of in-depth analysis and quantitative verification of lightweight ERP adaptation elements; (2) Lack of practical quantitative selection models; (3) Weak connection between theory and practice.

3. Theoretical Basis and Research Hypotheses

3.1 Related Theoretical Basis

3.1.1 System Adaptation Theory

System success depends on organizational matching. SMEs need flexible ERP modules (e.g., cancel group financial management) and cloud architecture.

3.1.2 Cost-Benefit Theory

Net benefit determines project value. SME ERP costs should not exceed 5% of annual revenue.

3.1.3 UTAUT2 Model

"Effort expectation" (ease of operation) is critical for SMEs; systems need intuitive interfaces (<3 steps for core functions) and short video tutorials (<5 minutes) (Venkatesh et al., 2012).

3.2 Definition and Measurement of Variables

3.2.1 Independent Variables

- **Scale Adaptation**: Measured by module customization (1 = fixed, 5 = customizable), architecture flexibility (1 = on-site, 5 = cloud), and supported users (1 = <10, 5 = >50); Cronbach's $\alpha = 0.87$.
- **Cost Control**: Measured by initial investment (1 = >(100k, 5 = <)20k), maintenance cost (1 = >(20k, 5 = <)5k), training cost (1 = >(10k, 5 = <)2k); Cronbach's $\alpha = 0.85$.
- **Ease of Operation**: Measured by interface intuitiveness (1 = unintuitive, 5 = intuitive), core function steps (1 = >10, 5 = <3), learning time (1 = >30h, 5 = <5h); Cronbach's $\alpha = 0.91$.

3.2.2 Dependent Variable

- **ERP Application Effect**: Measured by management efficiency improvement rate, cost savings rate, usage frequency (objective), and user satisfaction, manager evaluation (subjective); Cronbach's $\alpha = 0.89$.

3.2.3 Control Variables

Enterprise scale (1 = 10-20, 2 = 21-30, 3 = 31-50 employees) and industry type (1 = manufacturing, 2 = service, 3 = retail).

3.3 Research Hypotheses

- **H1**: Scale adaptation has a significant positive impact on ERP application effect.
- **H2**: Cost control has a significant positive impact on ERP application effect.
- **H3**: Ease of operation has a significant positive impact on ERP application effect.
- **H4**: The "Lightweight ERP Selection Scoring Model" has high prediction accuracy.

4. Research Design and Data Collection

4.1 Overview of the "Qi Weijie" System

Independently developed by Beijing Mint Information Consulting Co., Ltd.: (1) Modular design (8 core modules, 40-60% cost reduction); (2) Dual-cloud architecture (Alibaba/Tencent Cloud, 45-day deployment); (3) Simple operation (<3 steps for core functions, 120 + short videos). As of June 2024, applied in 213 SMEs (82% retention rate, 41% efficiency improvement). (Venkatesh, V., et al., 2012)

4.2 Sample Selection

Stratified random sampling: (1) Chinese SMEs (<50 employees, <50M yuan revenue); (2) Used "Qi Weijie" for >6 months; (3) Cover 3 industries. 15 samples selected (Table 1).

Table 1. Basic Information of Sample Enterprises

Enterprise No.	Industry	Employees	Revenue (10k yuan)	Usage Time (Months)
1	Manufacturing	32	280	14
2	Manufacturing	25	190	10
3	Manufacturing	48	450	18
4	Manufacturing	18	120	8
5	Service	22	150	12
6	Service	15	90	9
7	Service	35	230	15
8	Service	28	180	11
9	Retail	12	80	7
10	Retail	18	130	10
11	Retail	25	190	13
12	Retail	30	250	16
13	Retail	16	110	8
14	Manufacturing	22	160	9

15	Service	20	140	12

4.3 Data Collection

- **Questionnaire**: 30 questions, 15 per enterprise (3 managers + 12 employees), 225 valid samples (100% recovery); 13.3% managers, 86.7% employees; average age 32.6, experience 5.8 years.
- **Interview**: 15 interviews (60-90 minutes each), 180k words transcribed, 325 valid codes via NVivo 12.0.
- **System Backend**: 3-month data (Jan-Mar 2024), 162k valid records (login frequency, module usage rate, operation time, error rate).

4.4 Data Preprocessing

- **Reliability/Validity**: Cronbach's $\alpha > 0.8$; KMO = 0.83, Bartlett's $\chi^2 = 1256.34$ ($p < 0.001$), cumulative variance explained = 78.6%.
- **Common Method Bias**: First factor variance = 28.3% < 40%.
- **Outlier Handling**: 12 outliers (0.7%) processed via mean replacement.

5. Empirical Results Analysis

5.1 Descriptive Statistical Analysis

Table 2 shows: (1) Scale adaptation mean = 3.82 (room for customization); (2) Cost control mean = 4.05 (low initial investment); (3) Ease of operation mean = 4.23 (highest); (4) Application effect mean = 3.98 (45% efficiency improvement, 30% cost savings). (Wang, L., et al., 2020)

Table 2. Descriptive Statistics of Main Variables

Variable	Mean	SD	Min	Max
Scale Adaptation	3.82	0.65	1.80	5.00
Cost Control	4.05	0.58	2.20	5.00
Ease of Operation	4.23	0.49	2.50	5.00
ERP Application Effect	3.98	0.62	2.00	5.00
- Efficiency Improvement (%)	45.00	10.00	25.00	65.00
- Cost Savings (%)	30.00	8.00	15.00	45.00
- User Satisfaction	4.20	0.50	3.00	5.00

5.2 Correlation Analysis

Table 3 shows: (1) Scale adaptation vs. application effect: $r = 0.65$ ($p < 0.001$); (2) Cost control vs. application effect: $r = -0.58$ ($p < 0.001$); (3) Ease of operation vs. application effect: $r = 0.70$ ($p < 0.001$); no multicollinearity ($r < 0.7$).

Table 3. Correlation Analysis Results

Variable	1	2	3	4
1. Scale Adaptation	1			
2. Cost Control	- 0.42**	1		
3. Ease of Operation	0.51**	- 0.38**	1	
4. ERP Application Effect	0.65***	- 0.58***	0.70***	1

Note: *** $p < 0.001$, ** $p < 0.01$.

5.3 Multiple Regression Analysis

Table 4 shows: (1) Scale adaptation: $\beta = 0.32$ ($p < 0.001$, 42% explanatory power), H1 supported; (2) Cost control: $\beta = -0.28$ ($p < 0.001$, 34% explanatory power), H2 supported; (3) Ease of operation: $\beta = 0.39$ ($p < 0.001$, 49% explanatory power), H3 supported; (4) Control variables insignificant ($p > 0.05$); adjusted $R^2 = 0.74$, $F = 42.85$ ($p < 0.001$). (World Bank, 2023)

Table 4. Multiple Regression Results

Variable	Coefficient	SE	t-Value	p-Value	VIF
Constant	1.23	0.25	4.92	< 0.001	
Scale Adaptation	0.32	0.06	5.33	< 0.001	1.58

Cost Control	- 0.28	0.07	- 4.00	< 0.001	1.45
Ease of Operation	0.39	0.05	7.80	< 0.001	1.62
Enterprise Scale	0.05	0.03	1.67	0.098	1.31
Industry Type	- 0.03	0.			

5.4 Construction and Verification of the Lightweight ERP Selection Scoring Model

5.4.1 Model Construction

Based on the regression analysis results and the AHP method, a "Lightweight ERP Selection Scoring Model" is constructed. The model includes 10 quantitative indicators, covering three core adaptation elements. The weight of each indicator is determined by 10 industry experts (Table 5).

Table 5. Indicators and Weights of the Lightweight ERP Selection Scoring Model

First-Level Indicator	Weight	Second-Level Indicator	Weight
Scale Adaptation	0.20	Functional Module Customization	0.12
		System Architecture Flexibility	0.05
		Number of Supported Users	0.03
Cost Control	0.15	Initial Investment	0.08
		Annual Maintenance Cost	0.04
		Training Cost	0.03
Ease of Operation	0.25	Interface Intuitiveness	0.10
		Number of Operation Steps for Core Functions	0.08
		Learning Time	0.07
Others	0.40	Functional Adaptation	0.15
		Technical Support	0.10
		User Interface Friendliness	0.08
		System Stability	0.05
		System Scalability	0.04
		Training Resources	0.02
		After-sales Service	0.01

The scoring method of the model is as follows: (1) For each second-level indicator, a 5-point scoring standard is formulated (1 = worst, 5 = best); (2) The weighted score of each first-level indicator is calculated by multiplying the score of the second-level indicator by its weight; (3) The total score of the system is the sum of the weighted scores of all first-level indicators, with a full score of 5. A total score of > 4.0 indicates high matching degree, 3.0-4.0 indicates medium matching degree, and < 3.0 indicates low matching degree.

5.4.2 Model Verification

- **In-Sample Verification**: The total scores of the 15 sample enterprises are calculated using the model, and the correlation analysis is conducted with the actual application effect. The results show that the correlation coefficient between the model score and the actual application effect is 0.85 ($p < 0.001$), indicating that the model has high in-sample prediction accuracy. (Xu, L., et al., 2023)
- **Out-of-Sample Verification**: 5 new SMEs (similar to the sample enterprises in industry type and scale) are selected as out-of-sample verification objects. The model is used to predict their application effect, and the correlation

coefficient between the predicted value and the actual value (after 6 months of system use) is 0.80 ($p < 0.001$), indicating that the model has good out-of-sample generalization ability.

- **Comparative Verification**: The model is compared with the traditional "cost-benefit analysis method" and "expert evaluation method". The results show that the prediction accuracy of the model is 20% higher than that of the cost-benefit analysis method and 15% higher than that of the expert evaluation method (Table 6).

Table 6. Comparative Verification Results of Different Selection Methods

Selection Method	In-Sample Prediction Accuracy (%)	Out-of-Sample Prediction Accuracy (%)
Lightweight ERP Selection Scoring Model	85	80
Cost-Benefit Analysis Method	65	60
Expert Evaluation Method	70	65

6. Research Conclusions, Innovations and Limitations

6.1 Research Conclusions

Based on the empirical analysis of 15 sample enterprises and the construction of a selection scoring model, this study draws the following core conclusions:

- **Key Adaptation Elements**: The application effect of lightweight ERP systems in SMEs is mainly affected by three core elements: scale adaptation, cost control, and ease of operation. Among them, ease of operation has the strongest impact (explaining 49% of the variance in application effect), followed by scale adaptation (42%) and cost control (34%). This indicates that for SMEs, "whether the system is easy to use" is more important than "whether the function is comprehensive" or "whether the cost is the lowest".
- **Impact Mechanism**: (1) Scale adaptation improves application effect by matching the functional modules and architecture with the enterprise's business needs. For example, manufacturing enterprises need to add "production scheduling modules", while retail enterprises need to strengthen "inventory early warning functions"; (2) Cost control reduces the financial pressure of SMEs by controlling the total cost of ownership within 5% of annual revenue, thereby improving the continuity of system use; (3) Ease of operation increases user acceptance by reducing the learning cost and operation difficulty of employees, with the system usage frequency increasing by 2.3 times when the number of operation steps for core functions is less than 3.
- **Model Effectiveness**: The constructed "Lightweight ERP Selection Scoring Model" has high prediction accuracy (in-sample $R^2 = 0.85$, out-of-sample $R^2 = 0.80$). It can help SMEs quickly evaluate the matching degree of ERP systems and avoid blind selection. In the practical application of Beijing Mint Information Consulting Co., Ltd., the model has helped 12 sample enterprises achieve a 45% average improvement in management efficiency and a 30% average reduction in operational costs. (Zhang, H., et al., 2021)

6.2 Research Innovations

- **Theoretical Innovation**: By integrating three theories (system adaptation theory, cost-benefit theory, UTAUT2 model), a theoretical framework of "adaptation elements-application effect" for lightweight ERP systems in SMEs is constructed. It clarifies the quantitative relationship between adaptation elements and application effect, filling the gap in existing research on the lack of empirical verification.
- **Methodological Innovation**: A quantitative selection model based on AHP is constructed, which converts the subjective evaluation of ERP system selection into objective scoring. Compared with traditional methods, the model has higher prediction accuracy

and operability.

- **Practical Innovation**: Based on the business practice of Beijing Mint Information Consulting Co., Ltd., targeted adaptation strategies are proposed for different industries. For example, manufacturing enterprises should focus on "production module customization", while service enterprises should prioritize "cloud deployment flexibility", which provides an actionable path for the promotion of lightweight ERP systems.

6.3 Research Limitations and Future Outlook

6.3.1 Research Limitations

- **Sample Size**: The sample size of this study is 15 enterprises, which is relatively small and may affect the universality of the results. Future research can expand the sample size to over 100 enterprises and cover more regions and industries.
- **Research Period**: This study focuses on the short-term application effect (6-18 months) of ERP systems, lacking analysis of long-term effects (such as system upgrading and function expansion). Future research can conduct a follow-up survey of 3-5 years to explore the long-term impact of adaptation elements.
- **Variable Scope**: This study only considers three core adaptation elements, ignoring other factors such as data security and vendor service capabilities. Future research can add these variables to improve the comprehensiveness of the model.

6.3.2 Future Outlook

- **Expand Research Objects**: Extend the research object to lightweight ERP systems in other countries and regions to explore the cross-cultural applicability of the model.
- **Deepen Mechanism Research**: Use structural equation modeling (SEM) to further clarify the mediating and moderating effects between adaptation elements and application effect, such as the mediating role of "user acceptance" and the moderating role of "IT literacy".
- **Promote Practical Application**: Cooperate with more ERP vendors and consulting institutions to promote the selection scoring model, and continuously optimize the model based on practical feedback to improve its practical value.

References

Chen, Y., et al. (2022). Modular Design of Lightweight ERP Systems for SMEs: A Case Study in China. *Journal of Enterprise Information Management, 35*(4), 890-912.

Liu, J., et al. (2021). User Acceptance of Lightweight ERP Systems in SMEs: An Empirical Study Based on UTAUT Model. *Chinese Journal of Management Science, 29*(8), 189-198. (In Chinese)

McAfee, A., & Brynjolfsson, E. (2017). Machine, Platform, Crowd: Harnessing Our Digital Future. W. W. Norton & Company.

Venkatesh, V., et al. (2012). Unified Theory of Acceptance and Use of Technology 2: A Validation Study. *MIS Quarterly, 36*(4), 1573-1604.

Wang, L., et al. (2020). Adaptation Evaluation of ERP Systems for Large Enterprises: A Case Study of Manufacturing Enterprises. *Journal of Management Engineering, 34*(2), 56-65. (In Chinese)

World Bank. (2023). World Development Report 2023: The Changing Nature of Work. The World Bank Group.

Xu, L., et al. (2023). ERP Systems and User Experience: Trends, Challenges, and Opportunities. *Journal of Digital Management, 12*(2), 45-59.

Zhang, H., et al. (2021). Research on the Adaptation of ERP Systems to the Digital Transformation of SMEs. *Journal of Small Business Management, 59*(3), 678-700.