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Research Article

Factors Influencing Mechanism of Construction Development Transformation in China Based on SEM

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Construction industry development transformation is one of the most important issues in China. Along with the improving construction industry development transformation, problems have increased and need to be solved. For effectively improving the construction industry development transformation, this paper studied the factors influencing mechanism of construction industry development transformation. Construction industry development transformation is influenced by many factors. Firstly, 10 significant influential factors were extracted and 25 observable variables were used. Secondly, Structural Equation Modeling (SEM) was used to analyze the relationship between construction industry development transformation and its influential factors. Then, SEM hypothesis based on the research on the factors influencing construction development transformation was constructed. Through empirical results and its analysis, the role of the basic production factors for construction cannot be ignored. The internal industry directly influenced the transformation in the construction. The external industry indirectly influenced construction transformation. And industrial demands stimulated the basic influencing factors.

1. Introduction

Construction industry is one of the most important industries in China. From 1978 to 2014 construction industry in China has achieved remarkable results; proportion of the construction in the national economy has improved from 3.8% to 7.8%. The construction plays an irreplaceable role in supporting the national economy. However, the extensive mode of development for long-term presence in the development of the construction has been restricting the development of the construction. With the rapid development of the construction, the current development is unsustainable. With the strategic decision of economic development transformation in China being made, changing the development mode of the construction is also imperative.

The transformation of development pattern was proposed for the Chinese original economic system, government functions, and technology development, and its aim was not only to achieve economic growth but also to pay more attention to improving the quality of economic, structural optimization, and social benefits. The construction is very important to economic growth in China [1–3], but it was found that the output was mainly from capital invested with diminishing returns, and the growth of Total Factor Productivity and its contribution to economic growth was negative through the analysis of the total factor in the construction of China from 1998 to 2014. Only in the period of 2000–2005, the scale of the industry was economic. As the economic develop pattern of construction industry is single, the inputs and using of factors are low efficient. So, the development mode of construction industry cannot adapt to the changes in the market and bring diseconomies of scale. Some scholars proposed that it is helpful for the transformation of development pattern in the construction of China that the construction service was expanded by flexible structure of factor inputs. Because it would improve the construction products added value [4, 5]. In contrast with countries and regions where the industry went well, it is found that the profits, the growth of contracts, and operating performance were the main aspects of the competition among the construction enterprises.

With the rapid development of urbanization, the investment of urban infrastructure, real estate construction, and other aspects is huge, which are stimulating the development of related industries [6–8]. The operation innovative of the construction factors was the direct manifestation of the added value in the industry, and its mode, business philosophy, and production philosophy must be closely integrated with the factors of industrialization and information technology, so that the innovation was to solve the problem and contradictions posed by the traditional and modern technology and management. Therefore, the economics of construction was promoted by human capital, technology improvement, and technological innovation capability enhancement [9, 10]. The research about the terms of physical capital, human capital, technology, industry structure, management, industrial demand, policy institution, urbanization, housing markets, and so forth based on this would reflect the development status of the construction and the development direction of construction in China.

2. The Model of Factors Influencing Mechanism

2.1. Method Chosen. Structural Equation Modeling (SEM) is valid to research the factors, which is a theory-driven statistical method put together with factors analysis, canonical correlation analysis, and multiple regression analysis. SEM could deal with multiple dependent variables, whose variables allow containing deviation and being posed by multiple observable variables if it is latent. It is a measuring mode more flexible than the traditional. The researchers could assume the relationship of the latent variables and then verify the regression level of the data in the model [11–13].

2.2. SEM Hypothesis. Based on the research on the factors influencing of the development transformation in the construction around the world [14, 15], the model hypothesis are as below combined with observable variables of the factors in this paper [16].

(1) The Influence of the Basic Production Factors to the Transformation in the Construction. According to the economic growth theory, the economy could be stimulated by the basic production factors, which are the endogenous factors of the economic development in the construction [17]:

(H1a) direct positive influence of physical capital to the transformation in the construction;

(H1b) direct positive influence of human capital to the transformation in the construction;

(H1c) direct positive influence of technical level to the transformation in the construction.

(2) The Influence of Industrial Internal Environment Factors to the Transformation in the Construction. The industrial structure and management level directly positively influencing are assumed [18]:

(H2a) direct positive influence of industrial structure to the transformation in the construction;

(H2b) direct positive influence of management level to the transformation in the construction.

(3) The Influence of Industrial External Environment Factors to the Transformation in the Construction. The influence that industrial demands impact on the basic production factors could affect the transformation in the construction [19]. The influence that policy system impact on industrial internal environment could affect the transformation in the construction. At the same time, the tendency of the policies would change the industrial demands:

(H3a) direct positive influence of the industrial demands to physical capital;

(H3b) direct positive influence of the industrial demands to human capital;

(H3c) direct positive influence of the industrial demands to technical level;

(H4a) direct positive influence of the policy system to industrial structure;

(H4b) direct positive influence of the policy system to management level;

(H4c) direct positive influence of the policy system to industrial demands;

(H5a) direct positive influence of urbanization to industrial demands;

(H5b) direct positive influence of urbanization to housing market;

(H6a) direct positive influence of housing markets to industrial demands.

2.3. The Selection of the Index. Based on the analysis above, the latent variables are collected as physical capital, human capital, technical level, industrial structure, management level, industrial demands, urbanization, housing markets, and the transformation in the construction. The latent variables, observable variables, and their meaning and interpretation are shown as Table 1.

2.4. Data Collection and Processing

(1) Data Collection. SEM has high demand of sample size, at least 200. In this paper, the statistical data was collected from 30 provinces from 1998 to 2013. The data as JF1, JF2, CX2, CX3, and ZZ2 were from "CHINA STATISTICAL YEARBOOK"; the data as JF5, WZ1, WZ2, JS1, JS2, SC1, SC2, GS1, GS2, CX1, and ZZ1 were from "CHINA STATISTICAL YEARBOOK ON CONSTRUCTION"; the data as RZ1 and RZ2 were from "CHINA LABOUR STATISTICAL YEARBOOK." JF3, JF4, and JF6 were calculated by the data above. JF6 was calculated by Malmquist based on DEA; JF4 was the ratio of JF1 and GDP; JF3 was the ratio of JF2 and JF1. All the data could be used by Table 1.

(2) Data Processing and Testing. The data should be firstly standardized for being valid because of the large scale and amount of statistical calibers. In this paper, the data were

Table 1: The factors influencing indicators analysis of economic development transformation.

Latent variables	Observable variables	Variables symbol
The transformation in the construction	Gross output value of construction	JF1
	Value added of construction	JF2
	Value added rate of construction	JF3
	The rate of gross output value of construction to GDP	JF4
	Overall labor productivity of construction	JF5
	TFP of construction	JF6
Physical capital	Net value of machinery and equipment owned	WZ1
	Assets of construction enterprises	WZ2
Human capital	Number of persons employed	RZ1
	Years of education persons employed	RZ2
Technical level	Power of machines per laborer	JS1
	Value of machines per laborer	JS2
Industrial structure	Total output value rate of construction enterprises of special and first grade general contractors	SC1
	Total profits rate of construction enterprises of special and first grade general contractors	SC2
Management level	The yield of unit construction	GS1
	The yield of floor space completed of buildings constructed by construction enterprises	GS2
Industrial demands	Gross scale of construction	CX1
	the length of road	CX2
	Bridges in cities	CX3
Policy system	Gross output value rate of nonstate-owned	ZZ1
	Fixed investments rate	ZZ2
Urbanization	The proportion of urban population	UR1
	The total number of foreign employees	UR2
Housing market	Housing industry output value	HM1
	Housing industry investment	HM2

Note: the influence of taxes to the transformation in the construction in the factors of management level is not significant, so that the taxes variable will not be considered.

standardized by logarithm function transformation, and the function is as follows:

$$x^* = \frac{\lg(x)}{\lg(\max)} \quad (1)$$

in which x^* is the standardizing data.

It is necessary to test the reliability of the data which describe the level of consistency and stability. The consistency mainly reflects the relationship among internal subjects to make sure whether each subject measures the same content or quality. The stability is the reliability coefficient among the repeated measurements for the same testers at different timing using one kind of measure method.

The data in this paper are official, so that the consistency could reflect the reliability. Split-half reliability is a method where items number is classified by odd and even or directly cut into two segments from the middle, using the function of Spearman-Brown to estimate the corresponding coefficient. In 1951, a new method was developed by Cronbach, which is Cronbach's Alpha coefficient. Its principle is any item can be compared with another in the measurement tool. More importantly, Cronbach's Alpha coefficient has more strict and careful requirements for the consistency estimation. So, it could eliminate the shortcomings of split-half reliability. The result of data consistency was in Table 2 using SPSS18.0.

Table 2: Results reliability analysis.

Cronbach's alpha	N of items
.817	25

From the result shown, the reliability reached 0.896, much over 0.7, which showed that these data have enough reliability to do the research of SEM. The reliability of seven latent variables was shown as Table 3. From Table 3, the reliability of each latent variable is over 0.7; therefore, the data in this paper are of well reliability.

Validity reflects the degree of characteristics that could be measured by tools correctly, which contains Content Validity, Criterion Validity, and Construct Validity. Content Validity

Table 3: Latent variables reliability analysis.

Latent variables	The transformation in the construction industry	Physical capital	Human capital	Technical level	Industrial structure	Management level	Industrial demands	Policy system	Urbanization	Housing market
N of items	6	2	2	2	2	3	2	2	2	2
Cronbach's alpha	0.841	0.818	0.829	0.774	0.728	0.752	0.763	0.716	0.759	0.716

and Criterion Validity are difficult to achieve in practice. Because they demand the experts to do qualitative research or the measurements should be taken in an accepted standard environment.

3. The Empirical Results and Analysis

3.1. The Original SEM Model and Its Estimation

(1) The Drawing of the Original SEM. The original SEM drawn and then built was shown as Figure 1 using AMOS18.0.

(2) The Estimation of the SEM. The standardized results of the parameter estimation operated using the maximum likelihood estimation run by Amos18.0 were shown in Figure 2, in which process the data were fitted with the theoretical model.

3.2. The Evaluation of SEM

(1) Significance Evaluation of Path Coefficient. Significance evaluation of path coefficient shows whether the parameter estimates are statistically significant in the model. There is a test of Critical Ratio (C.R.) in the Amos18.0, and the results were in Tables 4 and 5. The C.R. and P of the standard deviation estimate were shown as Table 5, which showed the results were significant.

(2) Degree Evaluation of the Model Fit. Model fit index is used for inspecting the matching degree between the data and SEM. Amos18.0 provides many model fit index. From Table 6, the fit of data and SEM is not perfect, we need to revise it. But in the SEM, model fit index just reflects the degree of fit, but not the judgment of whether the establishment of SEM is correct or not. More importantly, the rationality should be demonstrated according to the research background and theoretical basis. It is significant that the SEM could be testified by practical experience and economic theory in this research, although there is no perfect fit.

3.3. Hypothesis Test of SEM. From Table 4, the standardizing path coefficients among the latent variables were significant at the level of 1%, except path of the industrial structure and policy system. Path coefficient is 0.083 (P value) and less than 0.1, which could be accepted at the significant level of 10%. The standardizing path regression coefficient between each latent variable and its observing variables were significant at the level of 1%. Therefore, hypothesis test results of SEM were shown in the Table 7.

3.4. Result Analysis. (1) There is direct and indirect influence in the factors of the transformation in the construction. The results were in Table 8.

The path coefficient from reason variables to outcome variables is used to measure the direct effect of the two variables. Physical capital, human capital, technology level, industry structure, management level, and housing market were the direct effect of variables. It indicates that the influence of these five factors was direct to the transformation in the construction, and the standardizing influence coefficients were 0.543, 0.271, 0.450, 0.574, 0.064, and 0.103.

Indirect effect is the influence that reason variables affect one or more intermediate variables, and then the outcome variables are affected by the intermediate variables. If there is only one intermediate variable, indirect effect is measured by the product of two path coefficients; if there are multiple intermediate variables, indirect effect is measured by the sum of indirect effect of each intermediate variable. Industry demands, policy system, and urbanization were variables of indirect effects, and its influence to the transformation in the construction was indirect.

There were three path of indirect influence to the transformation in the construction from industrial demands. They were as follows: industrial demands → physical capital → the transformation in the construction, industrial demands → human capital → the transformation in the construction, industrial demands → technical level → the transformation in the construction. And influence coefficient was 0.512. As the same, policy system affect the construction transformation through industrial structure, management level and industrial demands which is an indirect effect variable. Therefore, the path was policy system → industrial structure → the transformation in the construction, policy system → management level → the transformation in the construction, policy system → industrial demands → physical capital → the transformation in the construction, policy system → industrial demands → human capital → the transformation in the construction, policy system → industrial demands → technical level → the transformation in the construction. And influence coefficient was 0.089. Urbanization affects the transformation in the construction through four paths. They were as follows: urbanization → industrial demands → physical capital → the transformation in the construction; urbanization → industrial demands → human capital → the transformation in the construction; urbanization → industrial demands → technical level → the transformation in the construction; urbanization → housing market → the transformation in the construction. And influence coefficient was 0.242.

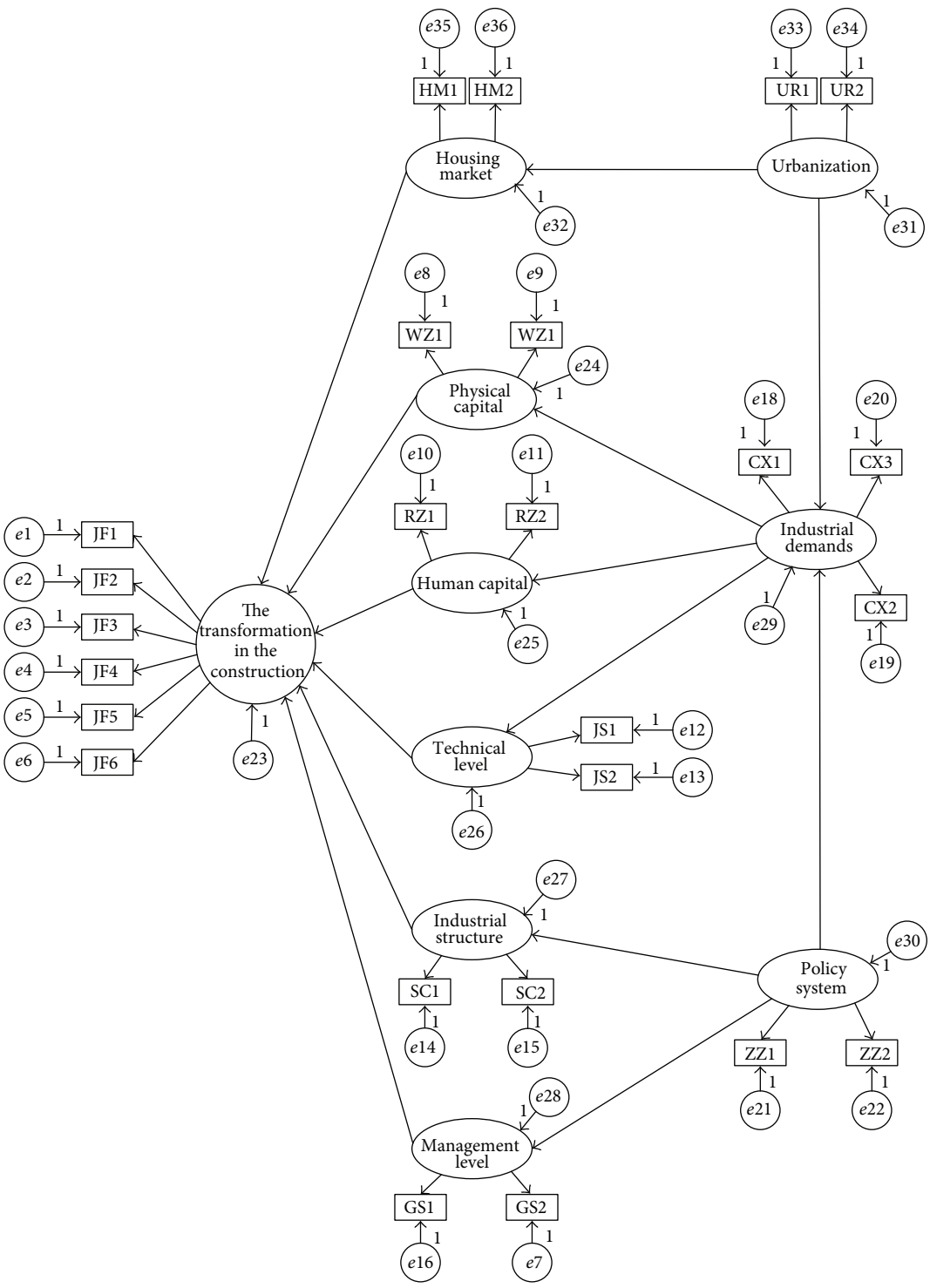

Figure 1: The initial set of structural equation model.

(2) Suppose (H1a), (H1b), and (H1c) were correct, which is the direct positive influence of physical capital, human capital, and technical level to the transformation in the construction, and their effects were technical level > physical capital > human capital, which is consistent with the theoretical analysis. It reflected that technology level in construction is the most critical factor for the transformation; but the influence of human capital is less than others. From the observing variables, RZ1 is the most reflection in the human capital, and the value of RZ2 is 0.26, which could not fully reflect the factor. It showed that the level of human capital in construction is low in China, and it is an entrance to promote

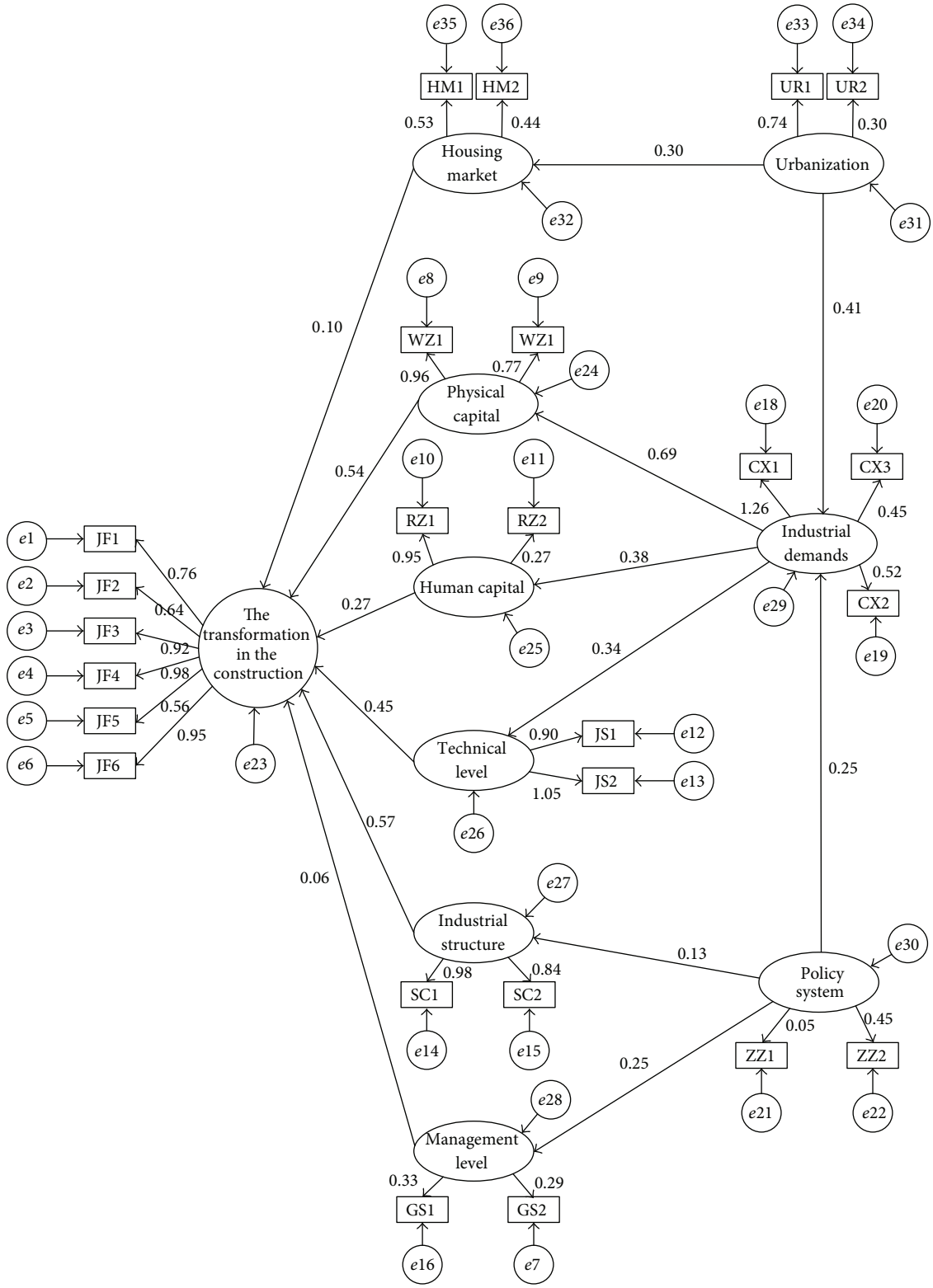

Figure 2: Structural equation model estimation results.

Table 4: Standardized regression weights.

The path of SEM	Estimate	S.E.	C.R.	P
The transformation in the construction ← physical capital	.543	.147	2.843	* * *
The transformation in the construction ← human capital	.271	.754	7.312	* * *
The transformation in the construction ← technical level	.450	.884	72.863	* * *
The transformation in the construction ← industrial structure	.574	.416	−15.251	* * *
The transformation in the construction ← management level	.064	.905	5.253	* * *
Physical capital ← industrial demands	.685	.001	16.933	* * *
Human capital ← industrial demands	.375	.029	24.479	* * *
Technical level ← industrial demands	.342	.162	10.753	* * *
Industrial structure ← policy system	.127	.970	1.422	.075
Management level ← policy system	.253	.049	20.735	* * *
Industrial demands ← policy system	.248	.008	71.146	* * *
Industrial demands ← urbanization	.413	.023	6.419	* * *
Housing market ← urbanization	.295	.062	23.483	* * *
The transformation in the construction ← housing market	.103	.952	2.842	* * *
JF1 ← the transformation in the construction	.764	.000	−5.943	* * *
JF2 ← the transformation in the construction	.636	.000	4.307	* * *
JF3 ← the transformation in the construction	.916	.063	26.846	* * *
JF4 ← the transformation in the construction	.982	1.030	25.431	* * *
JF5 ← the transformation in the construction	.562	.000	3.014	* * *
JF6 ← the transformation in the construction	.948	.000	16.138	* * *
WZ1 ← physical capital	.959	.215	8.846	* * *
WZ2 ← physical capital	.767	.437	9.835	* * *
RZ1 ← human capital	.954	.163	5.175	* * *
RZ2 ← human capital	.274	.257	35.436	* * *
JS1 ← technical level	.905	.000	13.063	* * *
JS2 ← technical level	1.052	.464	2.742	* * *
SC1 ← industrial structure	.983	1.873	14.962	* * *
SC2 ← industrial structure	.836	.034	8.772	* * *
GS1 ← management level	.334	1.743	8.346	* * *
GS2 ← management level	.291	.235	43.374	* * *
CX1 ← industrial demands	1.257	.007	.374	* * *
CX2 ← industrial demands	.516	.036	4.236	* * *
CX3 ← industrial demands	.451	.035	31.336	* * *
ZZ1 ← policy system	.052	.126	.141	* * *
ZZ2 ← policy system	.447	.914	2.746	* * *
UR1 ← urbanization	.735	.052	.244	* * *
UR2 ← urbanization	.301	.062	5.714	* * *
HM1 ← housing market	.529	.951	13.195	* * *
HM2 ← housing market	.436	.052	24.053	* * *

Note: * * * reflects $P < 0.01$, significant at 1%.

human capital for the transformation in the construction. The coefficient of the observing variables of physical capital and technical level identically reflect the status of the factor.

(3) Suppose (H2a) and (H2b) were correct, which is the direct positive influence of industrial structure and management level to the transformation in the construction. The coefficients of observing factors GS1 and GS2 were 0.33 and 0.26, which showed that the management level is low. It showed the reality in construction at some level, although the two observing variables could not fully reflect the status.

(4) Suppose (H3a), (H3b), (H3c), (H4a), (H4b), and (H4c) were correct, which is the indirect positive influence of industrial demands and policy system to the transformation in the construction. The influence coefficient of industrial demands through physical capital is the biggest for the transformation. It showed that the construction increases the input of capital and equipments to pull the industrial demands, which is harmful for the transformation and the development of the construction. Because of the specific fact in China, the Industrial demands would increase when

Table 5: Variances estimation results.

	Estimate	S.E.	C.R.	P
e2	.002	.252	3.723	* * *
e7	.258	.336	.486	* * *
e3	.253	.123	2.735	* * *
e4	.774	.255	2.386	* * *
e5	.736	.695	3.365	* * *
e6	.174	1.852	2.235	* * *
e1	.985	.906	-.017	* * *
e10	.194	.046	3.058	* * *
e11	.127	.0984	3.984	* * *
e12	.903	.036	3.853	* * *
e13	.084	.085	3.735	* * *
e8	.732	.263	2.763	* * *
e9	.843	.053	4.257	* * *
e14	.743	.074	1.743	.083
e15	.003	.524	3.732	* * *
e16	.898	.263	1.753	* * *
e17	.173	1.163	3.732	* * *
e18	.123	.061	2.962	* * *
e19	.087	.723	3.028	* * *
e20	1.623	.762	1.623	* * *
e25	.489	.484	−.917	* * *
e26	.729	.909	3.129	* * *
e28	1.298	.362	−1.372	.228
e21	.326	.591	2.437	* * *
e22	.286	.749	−.324	* * *
e23	.137	1.126	2.828	* * *
e24	.082	.027	.977	* * *
e31	.316	.763	−.624	* * *
e33	1.833	.046	.926	* * *
e34	.733	1.105	.537	* * *
e32	.457	.942	1.025	* * *
e35	.036	.627	−4.015	* * *
e36	.258	.920	2.722	* * *

Note: * * * reflects $P < 0.01$, significant at 1%.

Table 6: Model fit summary.

Model fit index	Estimate	Evaluation criteria
χ^2	8.216	Bigger, Better
RMR	0.064	<0.08
GFI	0.717	>0.9
RMSEA	0.569	<0.08
NFI	0.923	>0.9
CFI	0.86	>0.9

the investment of government increases. The influence for the transformation is industrial demands through physical capital in which the coefficient of ZZ1 was relatively low, but the coefficient of the test is significant. It reflected the factor of property rights to some extent, which needs further research on its accurate observing variable.

(5) Suppose (H6a) was correct, which is direct positive influence of housing market to the transformation in the construction. The results showed that the effect of housing market on the construction transformation was obvious. The development of housing market drives investment of the construction, and further the construction development transformation will be promoted. Suppose (H5a) and (H5b) were correct, which is the indirect positive influence of urbanization to the transformation in the construction. In the process of urbanization in China, with a large number of rural populations who were into the city, the demands of the urban infrastructure and other production and living facilities extremely expanded. To meet these demands, the construction products were developed in large scale to promote the development of the construction, and market competition should be standardized further to form a competitive mechanism which determines the direction of development in construction followed by the law of supply and demand. This is also the only way which must be passed. The construction should take the initiative to adapt to the new requirements in the process of urbanization to adapt to the development of new urbanization by the development transformation actually.

4. Conclusions

It is a complex process that the influence of factors affects the transformation in the construction, which involves the factors of physical capital, human capital, technology level, industrial structure, management level, industrial demand, policy system, urbanization, and housing market. The construction transformation includes two aspects which are development effect and development efficiency. In this paper, the factors' relationship and the influence path were thoroughly studied in SEM for the transformation in the construction. The conclusions and enlightenment were as follows.

Firstly, the role of the basic production factors for the transformation played in the construction could not be ignored. Comparing the influence coefficient of seven factors, physical capital and human capital were still important, which noted that the construction was still labor and capital intensive, so that human capital, mechanical equipment, and so forth still played an important role in construction currently. The influence coefficient of technical level and technological innovation were relatively large, which shows that the improvement of technical level was important for the transformation in the development of the construction.

Secondly, the internal industry directly influenced the transformation in the construction. The influence of industrial structure was the highest, whereas the management level is the lowest. The reason could be due to that the construction contained entire industry and social dimension, but management level influences the transformation on the construction enterprises in a microcosmic way. In other words, the transformation in the construction industry not only needs to improve the management level, but also needs all the hard work of the construction industry. The influence of industrial structure is high on the industry, as

Table 7: Hypothesis testing results.

The content of hypothesis	Estimate	Conclusion
H1a direct positive influence of physical capital to the transformation in the construction	0.543	Positive
H1b direct positive influence of human capital to the transformation in the construction	0.271	Positive
H1c direct positive influence of technical level to the transformation in the construction	0.450	Positive
H2a direct positive influence of industrial structure to the transformation in the construction	0.574	Positive
H2b direct positive influence of management level to the transformation in the construction	0.064	Positive
H3a direct positive influence of the industrial demands to physical capital	0.685	Positive
H3b direct positive influence of the industrial demands to human capital	0.375	Positive
H3c direct positive influence of the industrial demands to technical level	0.342	Positive
H4a direct positive influence of the policy system to industrial structure	0.127	Basic positive
H4b direct positive influence of the policy system to management level	0.253	Positive
H4c direct positive influence of the policy system to industrial demands	0.248	Positive
H5a direct positive influence of urbanization to industrial demands	0.413	Positive
H5b direct positive influence of urbanization to housing market	0.295	Positive
H6b direct positive influence of housing markets to construction development transformation	0.103	Positive

Table 8: The influence of the change of the pattern elements of construction development.

Influence factors	Relationship of influence	Influence coefficient
Physical capital	Direct	0.543
Human capital	Direct	0.271
Technical level	Direct	0.450
Industrial structure	Direct	0.574
Management level	Direct	0.064
Housing market	Direct	0.103
Policy system	Indirect	0.089
Industrial demands	Indirect	0.512
Urbanization	Indirect	0.242

its influence coefficient was second. Therefore, adjusting and optimizing industrial structure is the most important key for the transformation.

Last but not least, the external industry influenced the transformation in the construction directly and indirectly. The development of the Housing market directly affects the construction development transformation. Industrial demands which stimulated the basic factors of production have the highest influence. Influence coefficient of urbanization to the construction development transformation is in the middle of all of the factors. Through affecting the housing market and industrial demands, urbanization puts an indirect influence on the construction development transformation in China. The reason would be that industrial demands were the main driving force of the industry development which increases every year with the rapid economic development and the rapid progress of urbanization in China. The more the industrial demands increases, the more the material capital, human resources and technology will put in the construction industry. The influence of policy system was relatively comprehensive, and the coefficient was not high, but its influence path was the most, which indicate that policy system affected a wide range of other factors which could affect the transformation in the construction.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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