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An Empirical Study on the Influencing Factors of ICT Application: A Large Scale Survey for Middle and Primary Schools in China

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Abstract: ICT application is the core driving force for optimizing the development of educational information system. In this paper, to explore the different influencing factors of ICT application in middle and primary schools, the following works have been done: Firstly, an exploratory factor analysis is used to classify ICT application into three dimensions. Secondly, a series of linear regression models are used to test whether ICT policy influences ICT application. Finally, by analyzing the different influencing effects in urban and rural areas, combined with the actual situation, the paper made a comparative analysis for influencing factors of ICT application between the urban and rural middle and primary schools. In this paper, we found that: 1. ICT application could be investigated from three aspects: digital educational resources, online learning and educational environment. 2. There was a certain degree of correlation between ICT application and ICT policy in schools of all regions, that is to say ICT policy can influence ICT application. 3. Because ICT application in urban and rural areas were at different stages, different school policies also affected them differently. In the conclusion, influencing factors on ICT application for schools in urban and rural areas were different, then we put forward some suggestions for ICT policy at the school-level respectively. We hope the way China coped with can provide the developing countries even underdeveloped areas, such as the African region with some feasible ideas.

Keywords: ICT application; influencing factors; middle and primary schools; exploratory factor analysis; linear regression; comparative analysis

1. Introduction

With ICT widely applied in the field of education, it has greatly promoted the innovation and development of educational philosophy, teaching mode and pedagogical methodology, so that the development of ICT in education is gradually changed from construction-driven to application-driven. In recent years, ICT application in education has received wide attentions. A study showed that the use of ICT in education is very important from the perspective of teachers (Trucano, 2005). In 2009, Education, Audiovisual and Cultural Executive Agency (EAECA) published an official report, which had established the indicators' framework of ICT application for middle and primary schools including the use intension from teachers, "Computer use" and "Internet use" from students (Pelgrum, 2009). British Educational Communications and Technology Agency (BECTA) published the self-review framework (SRF), which pointed out the item about 'ICT application in Curriculum' to evaluate the development and application of ICT in schools (BECTA, 2011).

In the literature, many studies on the factors influencing ICT application in education have been focused. According to the Technology Acceptance Model (TAM) used to predict application of ICT by agricultural students, authors explored direct and indirect effects on ICT application, and found that 'skill', 'support', and 'facilities' were the three factors that influenced ICT application by agricultural students (Pouratashi & Rezvanfar, 2010). Moreover, 'limitations of hardware', 'lack of in-service training' and 'lack of technical support' were the most important barriers for primary school teachers in the ICT integration (Goktas, 2013), which could be inferred that the improvement of hardware,

teachers' training and technical support were favor in ICT application. Research has shown that the success of the implementation of ICT is not dependent on the availability or absence of one individual factor, but is determined through a dynamic process involving a set of interrelated factors (Afshari, Bakar, Luan, Samah, & Fooi, 2009). Selecting some measurable indicators, Chun Lu conducted an empirical study and pointed out that ICT infrastructure had different influences on its application for schools in urban and rural areas based on stepwise regression analysis (Chun, Chin-Chung, & Di, 2015).

More previous studies have mainly focused on the influencing factors of ICT application. However, relatively fewer empirical studies have been conducted to explore the relationship between the ICT application and ICT policy (about infrastructure, teachers' training and technical support of ICT) in developing areas or even depressed areas on a nationwide scale. Therefore, this paper intended to study ICT application and to explore the correlation between ICT application and policy so as to identify the types of ICT policy to be constructed in cities and rural areas in national or provincial plans in education. We divided these variables into two groups: one is about ICT application: some variables related in the process of the classroom integration. The other is about ICT policy, based on infrastructure, teachers' training and technical support of ICT. Make the following assumptions:

- ICT application needs to be fully evaluated.
- ICT application is affected by ICT policy to a certain extent at the school-level.
- Influencing factors on ICT application for schools in urban and rural areas is different.

In this paper, we chose more different measurable indicators about ICT application, then developed and tested linear regression models for some factors that explained ICT application. Specially, try to explore the relationship between application and policy of ICT at the school-level. Firstly, an exploratory factor analysis was used to divide the indicators of ICT application into three dimensions: ICT application of digital educational resources, ICT application of online learning and ICT application of educational environment, then explored the relationship between application and policy of ICT in middle and primary schools, finally made a comparative analysis for influencing factors of ICT application between the middle and primary schools in urban and rural areas.

2. Method

2.1 Sample

In this large-scale survey, the Departments of Education in each city were asked to nominate a provincial coordinator. All middle and primary schools in the sample districts were asked to complete the questionnaire. The leader and head teachers of each school completed the questionnaire according to the current situation of ICT at the whole-school level and sent it back to the provincial coordinator. Finally, the coordinators in each city sent back all the questionnaires to the research group.

There were about 10 thousands middle and primary schools in the Guangxi province of China. Samples gathered for this research were 8411 questionnaires of middle and primary schools over 14 cities. In this paper, 8380 questionnaires were used. These samples were selected randomly. In the questionnaire, we provided an individual choice question to know whether the school was in city or in rural areas. Among all the valid samples, 1642 were schools in cities, accounting for 19.59% of the total, and 6738 schools were in rural areas, making up 80.41% of the total. This study selected nine indicators of ICT application, as well as 6 indicators related to school ICT policy, as shown in Table 1.

Teachers' perceptions about what teaching and learning processes can be improved through the use of ICT (Sangrà, 2011). The teacher's role and the teaching processes are worth to be noticed. We used *"Means of ICT teaching processes", "Type of digital resources" and "Number of ICT-aided courses"* to indirectly examine teachers' application status of ICT. *"Proportion of ICT-aided teachers"* could directly reflect teachers' application ability of ICT. The use of a web-based "teaching-learning space" to facilitate asynchronous interaction between students and their supervisors (Jowallah, 2014). Teachers and students can use online learning space to achieve teaching and learning. Thus, *"Ratio of student online learning space"* and *"Ratio of teacher online learning space"* were considered. Multimedia classroom represents one of the basic ways of conventional e-learning implementation (Zhao & Jiang, 2010). The main places where teachers integrate IT into classroom teaching are the

computer classroom, multimedia classroom (Yeh, Chang & Chang, 2011). Therefore, "*Utilization rate of multi-media classrooms*" and "*Utilization rate of computer classrooms*" were considered in our indicators. Moreover, according to the Compendium of Chinese ICT course in Middle and Primary Schools, the ICT courses in those schools comprise no fewer than 68 class hours per academic year, and the courses performed on computer are no less than 70% of the total lessons (MOE, 2010). Thus, *"Time of ICT used in school per student"* in China could reflect the status of students' ICT utilization by multimedia classrooms and computer classrooms at the school level.

Table 1: The indicators of ICT application and policy.

ICT application	ICT policy
1. Means of ICT teaching processes	1.Proportion of Multi-media classrooms (P.M)
2. Type of digital resources	2.Number of Terminals per hundred students (N.T)
3. Number of ICT-aided courses	3.Proportion of Trained teachers (P.T)
4. Proportion of ICT-aided teachers	4.Proportion of ICT Full - time teachers (P.F)
5. Ratio of student online learning space	5.Proportion of ICT Supported teachers (P.S)
6. Ratio of teacher online learning space	6.Ratio of ICT Cost (R.C)
7. Utilization rate of multi-media classrooms	
8. Utilization rate of computer classrooms	
9. Time of ICT used in school per student	

To the creation of a safe and secure school environment for all learners, a national policy for school infrastructure called National Education Policy was developed (Marishane, 2014). In this paper, *"Proportion of Multi-media classrooms"* and *"Number of Terminals per hundred students"* were inspected the school infrastructure status. In order to bridge the gap and implement adequate ICT curricula, rigorous professional training in ICT teaching is essential for teachers (Tran, 2016). Thus, *"Proportion of Trained teachers"* was calculated trained teachers accounting for the proportion of all school teachers during one year, which reflected whether the school focused on teachers' training or not. *"Proportion of ICT Full - time teachers"* and *"Proportion of ICT Supported teachers"* were measured how many teachers could provide technical support, and reflected the teachers' professional level of ICT. What's more, *"Ratio of ICT Cost"* was ICT input accounting for the proportion of all school spending, reflecting the school's funding support of ICT.

2.2 Data Analysis

Data were analyzed inferentially using SPSS17.0. The inferential statistics included an exploratory factor analysis, a Pearson's correlation analysis and a series of regression analyses. Firstly, In order to reduce the data dimension of ICT application, exploratory factor analysis was conducted. Then a Pearson's correlation analysis was carried out to examine the relationships among the variables of interest. Finally, the ICT policy factors were considered as predictor variables, whereas the three dimensions of ICT application were processed as outcome variables, and the different important factors that influenced ICT application in education in schools of different regions were analyzed according to a series of linear regression analysis results.

3. Results and Discussion

3.1 Factor Analysis

Considering the possible existing correlation between all indicators of ICT application, as well as the purpose of data dimensionality reduction from the large amount of data used, an exploratory factor analysis was used.

3.1.1 The Appropriateness Test

To determine the appropriateness of data and measure the homogeneity of variables entered into the analysis, the Kaiser– Meyer–Olkin (KMO) and Bartlett's Test of Sphericity (BTS) were applied (Table 2). The KMO was 0.803, indicating that the sample was adequate for factor analysis (Kaiser, 1974). The BTS was 20100 ($p < 0.01$), indicating that the hypothesis variance and covariance matrix of variables as an identity matrix were rejected; therefore, the data were appropriate for factor analysis.

Table 2: Kaiser– Meyer–Olkin and Bartlett's Test.

Kaiser– Meyer–Olkin Measure of Sampling Adequacy	**Bartlett's Test of Sphericity**		
	Approx. Chi-Square	df	Sig
0.803	20100	36	.000

3.1.2 Factors Extraction

The Kaiser criterion was utilized to arrive at a specific number of factors to extract. Based on this criterion, only factors with eigenvalues greater than 1 were retained. Accordingly, three factors with eigenvalues over 1 were extracted, explaining a total of 63.84% of the variance. As shown in Table 3.

Table 3: Total Variance explained.

Factor	**Initial Eigenvalues**			**Rotation Sums of Square Loadings**		
	Total	%of Variance	Cumulative %	Total	%of Variance	Cumulative %
1	3.35	37.25	37.25	2.51	27.83	27.83
2	1.39	15.44	52.68	1.70	18.88	46.71
3	1.00	11.16	63.84	1.54	17.13	63.84

3.1.3 Factors Rotation

The varimax rotated factor analysis is shown in Table 4. The factors were named according to the contents of the relevant indicators. In the factor analysis, the percentage of the variance explained by each factor indicates the relative significance of the factor. The first factor explained 27.83% of the total variance, having a greater significance than the other two factors. This factor contains *"Means of ICT teaching processes"*, *"Type of digital resources"*, *"Number of ICT-aided courses"* and *"Proportion of ICT-aided teachers"*. These four indicators are based on educational resources to integrate ICT into education. Thus, a relevant name for the first factor on the loading pattern is *"ICT application of digital educational resources"*.

The second factor contains *"Ratio of student online learning space"* and *"Ratio of teacher online learning space"*. They are open proportion of student/teacher online learning space, which reflect the basic application of online learning for teachers and students to a certain extent. Therefore, according to these indicators a logical name that can be assigned to the factor is *"ICT application of online learning"*. This factor explained 18.88% of the total variance.

The last factor was associated mostly with variables related to *"Utilization rate of multi-media classrooms"*, *"Time of ICT used in school per student"* and *"Utilization rate of computer classrooms"*. The factor explains 17.13% of the total variance. *"Time of ICT used in school per student"* is the class time of students applied ICT every week, generally, in China multi-media classrooms and computer classrooms are places using ICT for students, so this factor can be named "*ICT application of educational environment*".

According to the proportion accounted for the ICT application in middle and primary schools, we can infer that the three factors are ranked as follows: ICT application of digital educational resources, ICT application of online learning and ICT application of educational environment, among which ICT application of digital educational resources is the largest, and the other two are relatively smaller.

Table 4: Indicators loaded in the factors of ICT application using varimax rotated factor analysis.

Name of factor	Item	Factor loadings		
		Factor 1	Factor 2	Factor 3
digital educational resources	Means of ICT teaching processes	.856		
	Type of digital resources	.834		
	Number of ICT-aided courses	.785		
	Proportion of ICT-aided teachers	.588		
online learning	Ratio of student online learning space		.825	
	Ratio of teacher online learning space		.812	
educational environment	Utilization rate of multi-media classrooms			.767
	Time of ICT used in school per student			.748
	Utilization rate of computer classrooms			.570

3.2 Regression Analysis

3.2.1 ICT application in Middle and Primary schools

Based on the statistical analysis of all samples, the correlation between the schools' application of ICT and policy of ICT was presented in Table 5. For middle and primary schools, it was found that all indicators about ICT policy were significantly related to selected ICT application, such as *"Proportion of Multi-media classrooms"* and *"Proportion of ICT Full - time teachers"* ($r = 0.45$, $p < 0.01$, $r = 0.39$, $p < 0.01$, respectively).

Table 5: Correlation between ICT application and ICT policy in middle and primary schools.

	P.M	P.F	P.T	P.S	R.C	N.T
ICT application in middle and primary schools	.450*	.390*	.370*	.286*	.233*	.117*

* Correlation is significant at the 0.01 level (2 tailed).

As also shown in Table 6, the indicators that were highly predictive for ICT application included the following: "*Proportion of Multi-media classrooms*" ($t=24.68$, $p<0.001$), "*Proportion of Trained teachers*" ($t=18.35$, $p<0.001$), of which the overall prediction proportion reached 31.40%. And also all indicators about ICT policy were significantly in predicting ICT application in middle and primary schools. The results showed that ICT policy could influence ICT application in middle and primary schools to the extent.

In order to explore how the ICT policy influenced ICT application in middle and primary schools, this study established regression models based on the all indicators about ICT policy, and a series of comparative analyses in urban and rural areas were conducted.

Table 6: Regression between ICT application and ICT policy in middle and primary schools.

Dependent	Independent	B(*st.d*)	S.E	T	R^2
ICT application in middle and primary schools	P.M	.303	.007	24.68*	.314
	P.F	.167	.007	13.16*	
	P.T	.212	.006	18.35*	
	P.S	.122	.006	10.25*	
	R.C	.078	.006	6.90*	
	N.T	.033	.005	2.96*	
	(Constant)	.099	.006	15.94*	

*. Correlation is significant at the 0.01 level (2 tailed).

3.2.2 Analysis on the Influencing Factors of ICT Application's Dimensions of Urban and Rural Areas

For middle and primary schools in urban areas, it was found that "*Proportion of Trained teachers*" was significantly related to both online learning and educational environment ($r = 0.312$, $p < 0.01$, $r = 0.254$, $p < 0.01$, respectively) of ICT application. As for rural schools, ICT application with the highest degree of correlation to the ICT policy was "*Proportion of Multi-media classrooms*" ($r = 0.376$, $p < 0.01$). As shown in Table 7.

In short, there was a certain degree of correlation between ICT application and ICT policy in schools of all regions. We found that there was a correlation between *"Proportion of Multi-media classrooms"* and *"ICT application of digital educational resources"* no matter schools in urban area or rural area, and the former was less significant than the latter. However, compared with urban area, a correlation not only existed between *"Proportion of Multi-media classrooms"* and *"ICT application of digital educational resources"* in rural area but also significant.

Table 7: Correlation between ICT application and policy in the two regions.

Dependent	P.M	N.T	P.T	P.F	P.S	R.C
urban area						
ICT application of digital educational resources	.187**	.062*	.254**	.213**	.154**	
ICT application of online learning	.105**	.088**	.312**	.080**	.119**	.186**
ICT application of educational environment	.196**	.054**	.080**	.170**	.103**	.010**
rural area						
ICT application of digital educational resources	.376**	.074**	.225**	.179**	.139**	.222**
ICT application of online learning	.257**	.055**	.065**	.190**	.083**	
ICT application of educational environment	.145**	.089**	.223**	.100**	.131**	.164**

**. Correlation is significant at the 0.01 level (2 tailed). *.Correlation is significant at the 0.05 level (2 tailed).

As shown in Table 8, according to the results of the regression analysis, for schools in rural area, 20% of ICT application of digital educational resources were explained by ICT policy to the model significantly ($R^2 = .200$), and 8.8% of ICT application of educational environment were explained by ICT policy to the model significantly ($R^2 = .088$), which were both higher than those in urban area ($R^2 = .116$, $R^2 = .059$). However, for schools in urban area, 13.2% of ICT application of online learning was explained by ICT policy to the model significantly ($R^2 = .132$), which was higher than that in rural area ($R^2 = .082$). In fact, rural middle and primary schools faced a lot of difficulties. In the term of hardware of ICT, there were a small number of computers and multimedia facilities with low configuration. In the aspect of software use, no matter the quantity or quality, educational resources were difficult to meet the normal needs. In the aspect of teacher staff construction, many problems existed, such as: less ICT full-time teachers, the heavy workload, the low level of ICT application and the lack of opportunities participating in ICT training. In order to further find out the different influencing factors of ICT application in two regions, more comparative analyses were completed from the following three application dimensions:

In ICT application of digital educational resources, for schools in cities, the indicator "*Proportion of Trained teachers*" ($t=8.70$, $p<0.001$) related to school ICT policy was highly predictive. Urban schools could use rich digital educational resources, but resources updated faster, which gave teachers a big challenge about how to integrate ICT into classroom well. ICT training was an effective way to promote teacher professional development, and it could improve teachers' ICT ability (Sang, Valcke, van Braak, Tondeur, & Zhu, 2011). According to participate in ICT-related training, teachers could deepen the understanding, and applied it to the actual teaching process, so as to better promote the teaching and learning. For schools in rural areas, the indicators related to school ICT policy that were highly predictive for ICT application of digital educational resources included the following: "*Proportion of Multi-media classrooms*" ($t=26.59$, $p<0.001$) and *"Ratio of ICT Cost"* ($t= 13.62$, $p<0.001$). The hardware facilities of rural schools were not popular, research data showed that about 34.23% of the schools failed to build multimedia classrooms. Different from the schools in cities - the

use of mobile terminals and the future classroom had become increasingly popular, multimedia classroom was still the main place of digital teaching in rural schools. The hardware equipment and network building in rural schools have been relatively inferior, restricting the further application of digital educational resources (Jingtao, Yuanyuan, & Xiaoling, 2010).

In ICT application of online learning, for schools in cities, the indicator——*"Proportion of Trained teachers"* (t=11.78, p<0.001) related to ICT policy was highly predictive. With the innovation of classroom teaching, the teaching mode in the urban schools was gradually transformed from "teacher-centered" to "student-centered", requiring teachers to be provided with teaching skills, especially taking advantage of online learning space to promote teaching and learning. For schools in rural areas, the indicators related to school ICT policy that were highly predictive for ICT application of online learning include the following: *"Proportion of Multi-media classrooms"* (t=17.26, p<0.001) and *"Proportion of ICT full-time teachers"* (t=9.65, p<0.001). The limited number of multimedia classrooms, the lack of advanced terminals and the lack of targeted professional teachers were the main problems of ICT online learning in rural schools.

In ICT application of educational environment, for schools in cities, the indicators related to school ICT policy that were highly predictive include the following: *"Proportion of Multi-media classrooms"* (t=6.41, p<0.001) and *"Proportion of ICT full-time teachers"* (t=4.29, p<0.001). With the continuous education reform in urban school, the application of multimedia equipment has become the normalization of classroom, which put forward a high standard to the ICT use of teachers. With the rapid development of ICT in education, the ICT use of teachers has become more specialized, ICT full-time teachers could depend on professional knowledge about multi-medium, computers and other equipment. For schools in rural areas, the indicators related to school ICT policy that were highly predictive for ICT application of educational environment included the following: *"Proportion of Trained teachers"* (t=14.63, p<0.001) and *"Ratio of ICT Cost"* (t=9.01, p<0.001). Rural schools mainly faced with a lot of difficult issues, such as fewer ICT professional staff, the lack of teachers who owned awareness and less cost of ICT-related training.

Generally speaking, ICT application in urban and rural middle and primary schools were at different stages, and there were differences in ICT application respectively. Under the premise of the improvement of infrastructure, to keep up with the pace of ICT in education, urban areas were experiencing the change——from "how to use" to "how to make good use", which put forward a higher level of professional requirements for ICT towards teachers. In comparison with city schools, ICT in rural schools was starting from scratch, ICT application still depended on the complete degree of facilities. Lacking of ICT cost in rural areas, the investment in the introduction of advanced equipment and the construction of teaching staff were less than the city.

Table 8: Regression between ICT application and policy for middle and primary schools in two regions.

Dependent variables	**Predicting variables**	**Urban areas**				**Rural areas**			
		B (*st.d*)	S.E	T	R^2	B (*st.d*)	S.E	T	R^2
ICT application of digital educational resources	P.M	.115	.024	4.75	.116	.310	.012	26.59	.200
	P.T	.209	.013	8.70		.130	.011	11.57	
	P.F	.121	.014	4.80		.057	.012	4.90	
	P.S	.095	.013	3.92		.066	.011	5.92	
	R.C					.153	.011	13.62	
ICT application of online learning	P.M				.132	.215	.012	17.26	.082
	N.T	.052	.023	2.22		.020	.012	1.65	
	P.T	.281	.024	11.78					
	P.F					.120	.012	9.65	
	P.S	.096	.024	4.00		.028	.012	2.30	
	R.C	.138	.023	5.90					
ICT application of educational environment	P.M	.160	.025	6.41	.059	.073	.012	5.90	.088
	N.T					.055	.012	4.63	
	P.T					.176	.012	14.63	
	P.F	.111	.026	4.29		.035	.012	2.82	
	P.S	.051	.025	2.03		.091	.012	7.59	
	R.C					.108	.012	9.01	

4. Conclusion

The present study focused on the influencing factors of ICT application in middle and primary schools. It was important to stress that the study was set up in the Chinese context. Our findings suggested that the influencing effect of school ICT policy to ICT application was different in urban and rural areas. The results underpin the importance to consider linear regression models to explain the influencing factors and predict ICT application.

Using a large representative dataset of 8380 schools in the Guangxi province of China, a series of regression prediction models were constructed to analyze the influence that ICT policy may exert on ICT application. Based on the prediction results of the models and the comparison in two religions, suggestions for the policy of ICT in the two regions were provided for further popularizing ICT application in schools. In order to speed up the process of ICT application in schools, taking the gap in the development and application of ICT between two religions into account, combined with the different stages of ICT application respectively, our suggestions for ICT policy in different regions were as follows:

For urban schools, it's necessary to strengthen the construction of teachers and enhance the information literacy of teachers (Álvarez & Gisbert-Cervera, 2015). The construction of teachers was the basic guarantee for the sustainable ICT development in education, and the ICT application ability was the necessary professional ability for teachers in modern society. Teachers' ICT status and ICT training were the relevant contents of the teacher staff construction, with the continuous emergence of high-quality digital educational resources, schools in cities should strengthen teacher training (Tsitouridou & Vryzas, 2004) related ICT, and constantly improve the ICT application level of teachers to help them integrate ICT into classroom perfectly, achieving a wide range of digital teaching methods, so as to promote teaching and learning.

For rural schools, due to lack of ICT cost in middle and primary schools, ICT infrastructure was seriously lagging behind developed areas such as schools in cities. Therefore, rural schools needed to increase the following three aspects of ICT investment:

- In the development of ICT in middle and primary schools, infrastructure construction was the prerequisite for ICT application, so it's necessary to improve infrastructure construction, such as build enough multimedia classrooms and provide better ICT equipment, so as to satisfy the normal teaching needs.
- Considering ICT in education centering on its application, to realize ICT application needed to have a better hardware environment as a support. More importantly, there must be rich to meet the needs of high-quality digital education resources. To achieve the purpose of resource sharing, more high-quality digital educational resources should be purchased, so as to bridge the "digital divide" with urban areas.
- Finally, organize the ICT training actively, encourage teachers to participate in it, provide teachers with the opportunities of ICT application and develop more ICT full-time staff, so as to provide technical guidance (Papanastasiou, 2008) for the future.

In recent years, ICT in education of China has been rapidly developed. Infrastructure construction was generally completed in urban areas, rural areas still remained at a fairly junior level. Shortage of ICT cost were usually in resource construction and teachers' training. Most teachers paid attention to the latest development of technology and had a certain degree of computer application ability. However, there were many problems, such as the heavy task, the lack of a large number of outstanding professional teachers and lagging teaching mode. At present, ICT in education of China is in the initial stage. As a developing country of the Third World, although there are many difficulties in the process of ICT, China is still drawing on the ICT system put forward by developed countries, continues to vigorously promote ICT application combined with own actual situation as well. We hope the way China coped with can provide the developing countries even underdeveloped areas, such as the African region with some feasible ideas.

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