ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 1, January 2024

Analysis of Robotics and Process Automation Technology

Jing Lei [1], Jia-Qing Song [2], Hui Zhang [1]

School of Mathematics and Statistics, Taishan University, Tai'an 271000, China [1]
Office of Educational Administration, Taishan University, Tai'an 271000, China [2]

***Abstract*—Robotic process automation technology is a combination of robotics and process automation technology, which can effectively help enterprises achieve digital transformation, is one of the most influential technology trends in decades, and will play an even more important role in the future. Based on this, this paper briefly introduces the concept, technology, characteristics, development, application scenarios and application advantages of robotics and process automation technology, in order to enable more relevant practitioners to pay attention to, promote and apply robotics and process automation technology.**

***Index Terms*—Robotics; Process Automation; Robotic Process Automation; Artificial Intelligence**

I. INTRODUCTION

In this era of rapid technological change, robotics and process automation technology have become an indispensable part of modern enterprises. In order to better grasp these cutting-edge technologies and apply them to practical work, this article will briefly introduce robotics and process automation technologies and their applications.

II. ROBOTICS AND PROCESS AUTOMATION TECHNOLOGY

(1) Basic knowledge of robotics

The basics of robotics can be discussed in the following aspects: types, control systems, sensors, actuators, and programming languages.

1. Type

Robots can be divided into different types according to their application fields and working methods, such as industrial robots, service robots, medical robots, military robots, etc. Industrial robots are typically used in manufacturing, service robots can be used in cleaning, navigation, entertainment, and other fields, while medical robots are used in medical applications such as surgery.

2. Control system

The control system of a robot refers to the hardware and software systems used to control the robot's movement and perform tasks. It usually includes parts such as motion controllers, sensor interfaces, actuator interfaces, etc. Common control systems include PLC-based control systems, PC-based control systems, and specially designed robot controllers.

3. Sensors

Sensors play a vital role in robots, allowing them to perceive their surroundings and obtain the necessary information to make decisions accordingly. Common sensors include vision sensors, force sensors, contact sensors, lidar, etc. These sensors can help robots sense obstacles, measure force and pressure, locate and navigate, and more.

4. Actuators

Actuators are the power source of the robot, and they can make the robot perform various actions, such as moving, rotating, grabbing, etc. Common actuators include motors, hydraulic systems, pneumatic systems, etc.

5. Programming Languages

For the control and programming of robots, specific programming languages are usually used, such as C++, Python, ROS (robot operating system), etc. In addition, there are domain-specific languages dedicated to robot programming, such as URScript, a programming language specific to Universal Robots.

The above are some of the basics of robots, and understanding these knowledge can help us better understand how robots work and application scenarios.

(2) Process automation technology

Process automation technology refers to a technology that automates the management and execution of various processes within an enterprise through computer systems and software tools. In traditional business operations, many business processes need to be operated manually, such as approval processes, procurement processes, sales processes, etc., which usually require a lot of time and effort from human resources, and are prone to errors and bottlenecks. Process automation technology can improve the work efficiency of enterprises, reduce costs, reduce error rates, and improve data accuracy and standardization by using computer systems and software tools to automate the management and execution of enterprise processes. Specifically, process automation technologies typically include the following:

1. Process modeling

Process modeling refers to the presentation and description of various business processes within an enterprise in the form of diagrams. With process modeling, companies can gain a clearer picture of their business processes and be able to identify problems and bottlenecks that they didn't notice before. Process modeling typically uses standard modeling

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 1, January 2024

languages such as UML, BPMN, etc.

2. Workflow design

Workflow design is the design and optimization of specific business processes and turns them into automated execution processes. In workflow design, factors such as each node of the process, processing personnel, processing sequence, and process control need to be considered to ensure the efficient execution of the process.

3. Automate rule application

Automation rules refer to the transformation of some rules and conditions in a business process into code that can be understood by a computer, so that the computer can automatically execute the process according to these rules and conditions. Automation rule applications are typically implemented using technologies such as workflow engines.

4. Process monitoring

Process monitoring refers to the real-time monitoring and adjustment of the implementation of internal processes in an enterprise in order to find and deal with problems in a timely manner. Process monitoring can be displayed through dashboards, reports, etc.

Through process automation technology, process automation software can be used to optimize and improve the workflow of the enterprise, and the complex business process of the enterprise can be transformed into an automated execution process through process modeling, workflow design and the application of automation rules.

In short, process automation technology can help enterprises to standardize, normalize and automate business processes. Through the application of process automation technology, enterprises can improve work efficiency, reduce costs, reduce error rates, and improve the accuracy and standardization of data, so as to better adapt to market competition and changes in customer needs.

(3) Advantages and challenges of robotics and process automation

The combination of robotics and process automation technology can improve production efficiency, reduce error rates and reduce labor intensity, and realize the standardization, normalization and automation of processes. However, the application of robotics and process automation technology also needs to consider issues such as safety, stability and cost-effectiveness, and a full understanding of business processes and technical requirements to ensure the smooth implementation of automation.

(4) Robotics and process automation technology practice

1. Method

Robotics combined with process automation technology for hands-on operation. For example, let's practice an example of robotics and process automation technology to demonstrate how robotics and automation technology can be applied to manufacturing and manufacturing. Start by identifying areas where improvements can be made with robotics and process automation technologies. Then, write a robot program that enables it to complete tasks such as material handling, assembly, testing, and more. At the same time, the entire production process was modeled and optimized using process automation software, turning manual operations into automated execution. These include:

1. Analyze the production process and identify improvement options

We first need to analyze the entire production process to find out where we can improve with robotics and process automation technologies. For example, we have found that some repetitive tasks in the assembly process can be replaced by robots, such as material handling, assembly, testing, etc. At the same time, we also found that the parts of the approval process that require human intervention can be achieved through process automation.

2. Write a bot program

For the parts of the production process that need to be replaced by robots, we need to write robot programs that enable them to complete the relevant tasks. For example, we need to program robots that can automatically move materials, assemble parts into the correct position, perform tests and inspections, and so on. Writing a robot program requires an understanding of the robot's control system and programming languages, which are commonly used in Python, C++, and more.

3. Process modeling and workflow design

For the parts that need to be automated, we need to carry out process modeling and workflow design. First of all, we need to model the process that needs to be automated in order to better understand the execution of the entire process. Then, we need to design a workflow that transforms the various nodes in the process into an automated process. For example, we need to design an automated approval process, when a task needs to be approved, the system will automatically assign the approval task to the corresponding approver, and automatically move to the next node after the approval is passed.

4. Automated rule application

For the parts that need to be automated, we need to turn them into automated rule applications. For example, we need to write automation rules to automate the approval process. These rules can be written based on business rules and conditions, such as the order of approval processes, permissions, and so on.

5. Process monitoring

Throughout the production process, we need to monitor and adjust the execution of the entire process in real time, so that problems can be identified and dealt with in a timely manner. We can display it through dashboards, reports, etc., so that managers can know the execution of the production process at any time.

Through the combined application of robotics and process automation technology, we can greatly improve production efficiency, reduce error rates and reduce labor intensity. At the same time, through the automated management and execution of the entire production process,

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 1, January 2024

we can achieve standardization, normalization and automation of the process, so as to better adapt to market competition and changes in customer needs.

(2) Examples

For example, we want to practice robotics and process automation in an electronics manufacturing company to optimize production processes and improve efficiency.

1. Analyze the production process and identify improvement options

At this electronics manufacturing company, we found that some repetitive tasks on the assembly line, such as handling, assembling and testing parts, could be replaced by robots. At the same time, some aspects of the approval process can also be improved through process automation, such as the approval and release process of quality inspection reports.

2. Write a bot program

For tasks on the assembly line, we need to program robots that can automatically handle parts, assemble them in the correct position, and perform the necessary tests. We will use the programming interface provided by the robot control system, such as ROS (Robot Operating System), etc., to write the control program of the robot.

3. Process modeling and workflow design

For the approval and release process of quality inspection reports, we need to carry out process modeling and workflow design. First, we model the entire approval and release process to better understand the entire process. We then design workflows that transform individual points in the process into automated processes to ensure that the approval process runs smoothly.

4. Automated rule application

For the approval and release process, we need to write automation rules to automate the approval and release. These rules can be written based on conditions such as approval permissions, report content, etc., to ensure the accuracy and efficiency of the approval and release process.

5. Process monitoring

Throughout the production process, we need to monitor and adjust the tasks performed by the robot and the approval and release process in real time, so that problems can be detected and dealt with in a timely manner. We can display it through dashboards and reports, etc., so that managers can know how the production process is performing at any time.

Through the above practical operations, we have successfully applied robotics and process automation technology to the production process of an electronics manufacturing company, achieving the goals of improving production efficiency, reducing error rates and reducing labor costs.

III. Robotic Process Automation Technology

(1) Basic concepts

Robotic Process Automation (RPA) is a software technology that makes it easy to create, deploy, and manage RPA robots that simulate human behavior and interact with digital systems and software. RPA technology can enable RPA robots to work like humans, such as understanding the content on the screen, correctly completing keystrokes, system navigation, identifying and extracting data, and completing a series of established behaviors, but the work speed is faster and more stable than that of humans, and it can work 24 hours a day, replacing manual work in non-busy stages such as night, without affecting normal work, and can meet the efficiency requirements of special services in a very short time. In general, RPA technology has a variety of application advantages, such as high operational efficiency, high data accuracy, high security, scalability, and flexible deployment. The core technologies of RPA include screen capture, business process automation management, and artificial intelligence. Screen capture is mainly used to select specified objects in the web page or system interface to simulate human behavior to automatically complete mouse clicks, keyboard input and other operations; business process automation management combines Excel processing, email processing, logical judgment and other operations to form an automated process that can run stably according to the required fixed rules; artificial intelligence further expands the capability boundaries of RPA, using OCR recognition and NLP semantic analysis and other functions to make RPA Become smarter and complete complex, advanced tasks. RPA technology is ideal for handling repetitive and infrequently changing data handling tasks. Through a variety of encapsulated controls, users only need to drag and drop the controls to generate automated processes, regularly execute automatic mouse clicks and keyboard input operations of browsers and applications, data processing, database addition, deletion, modification and query, etc., and automatically generate interactive interfaces. RPA streamlines workflows and enables management to be more agile and responsive. Since RPA reduces monotonous routine tasks, it also improves employee satisfaction, engagement, and productivity. RPA technology is non-intrusive and can be implemented quickly, accelerating digital transformation. It is also ideal for automating workflows in legacy systems that lack APIs, Virtual Desktop Infrastructure (VDI), or database access. RPA can improve the level of data exchange and improve the efficiency of information systems in the medical industry. The core of RPA technology is to replace people with repetitive, low-value, and fixed process operations without manual decision-making through automation and intelligent technology, so as to effectively improve work efficiency and reduce errors. The introduction of RPA technology will bring changes to the integration of hospital informatization.

The architecture of RPA technology typically consists of three main components: the console, the runtime engine, and the bot.

(1) Console: The management center of RPA technology, which can be used to configure, schedule, and monitor automation tasks. The console typically includes a user interface for administrators and operators to use.

(2) Runtime Engine: The core component of RPA technology that is used to perform automated tasks. The runtime engine

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 1, January 2024

typically includes a task manager that assigns tasks to the robot and ensures that the tasks are executed in the correct order. In addition, the runtime engine includes a logging and reporting system for tracking and reporting on the execution of automated tasks.

(3) Robot: The execution unit of RPA technology that is used to automate various tasks. Bots can be implemented in different ways, such as script-based bots and AI-based bots. Script-based bots use scripting languages to perform tasks, while AI-based bots can autonomously learn and execute tasks based on task requirements.

These 3 components communicate and interact with each other via APIs for efficient automated task execution. In practice, the architecture of RPA technology may be adjusted and optimized according to specific needs and application scenarios.

(2) Technologies required for RPA technology development

(1) Programming languages. The development of RPA technology requires the use of programming languages, such as Python, Java, C#, etc., for writing automation scripts or bots.

(2) Automated tools. The development of RPA technology requires the use of automation tools, such as UiPath, Automation Anywhere, etc., for the creation of automated processes and bots.

(3) Database technology. RPA technology often requires interaction with databases, so developers need to master database technologies, such as SQL languages and database management systems.

(4) Application Programming Interface (API) and Web services. The development of RPA technology requires the use of APIs and web services so that robots can interact with other systems and exchange data.

(5) Machine learning and natural language processing. The future of RPA technology is intelligent and adaptive learning, so developers need to master machine learning and natural language processing techniques in order to automate tasks more intelligently.

(6) Data analysis and visualization techniques. RPA technology can automatically capture, process, and analyze data, so developers need to master data analysis and visualization techniques to better implement data-driven automation tasks.

(3) The development process of RPA technology

In the early 2000s, RPA technology began to emerge, mainly through simple automation through macro recording and replay. This approach lacks flexibility and can only be applied to simple, repetitive tasks. In the mid-2000s, RPA technology began to evolve with more advanced robotics and artificial intelligence technologies that could enable more complex tasks. At the same time, some open-source RPA platforms began to emerge, such as Sikuli and AutoIt, which provided the foundation for the popularization and application of RPA technology. [7] discussed that A robot is a machine that can automatically do a task or a series of tasks based on its programming and environment. They are artificially built machines or devices that can perform activities with utmost accuracy and precision minimizing time constraints. Service robots are technologically advanced machines deployed to service and maintain certain activities. Research findings convey the essential fact that serving robots are now being deployed worldwide. Social robotics is one such field that heavily involves an interaction between humans and an artificially built machine. These man-built machines interact with humans and can also understand social terms and words. Modernization has bought changes in design and mechanisms due to this ever-lasting growth in technology and innovation. Therefore, food industries are also dynamically adapting to the new changes in the field of automation to reduce human workload and increase the quality of service. Deployment of a robot in the food industries which help to aid deaf and mute people who face social constraints is an evergrowing challenge faced by engineers for the last few decades. Moreover, a contactless form of speedy service system which accomplishes its task with at most precision and reduced complexity is a feat yet to be perfected. Preservation of personal hygiene, a better quality of service, and reduced labour costs is achieved. In the early 2010s, RPA technology began to be widely used in finance, insurance, medical and other fields. At this time, there are already many commercially available RPA software on the market, such as UiPath, Automation Anywhere and Blue Prism, which provide more mature, stable and efficient automation solutions. In the mid-2010s, RPA technology evolved further and began to involve more complex tasks such as natural language processing, machine learning, and artificial intelligence. This trend has made RPA technology more intelligent and adaptive, automatically adapting to changes and adjustments in business processes. In the early 2020s, RPA technology has become one of the key technologies for enterprise digital transformation. With the development of technologies such as cloud computing, big data, and artificial intelligence, RPA technology will gradually become more intelligent, automated, and efficient.

and (4) the advantages and risks of RPA technology in the process of enterprise digital transformation

(1) The advantages of RPA technology in the process of enterprise digital transformation.

First of all, RPA technology can automate tedious and repetitive tasks, such as data entry, file conversion, mail processing, etc., which usually require a lot of time and manpower to complete, by using RPA technology, enterprises can save time and costs, replace employees' work with pre-programmed robot behaviors, liberate employees from tedious tasks, and focus more on high-value tasks. Second, RPA technology can reduce human error and improve accuracy and quality. Because the robot performs tasks without spelling mistakes, numeric errors, or other common errors, errors and error correction costs are avoided. In addition, RPA technology can automate operations 24 hours a day in the enterprise, thereby increasing productivity and efficiency. Robots do not require breaks or leave work and can perform tasks without interruption, helping businesses improve operational efficiency and flexibility. Finally, RPA technology can improve the security and compliance of enterprises. When bots perform tasks, they can avoid human

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 1, January 2024

violations or security breaches, improving the security and compliance of the enterprise. RPA technology has many advantages in the enterprise, which can help enterprises improve efficiency, reduce costs, improve accuracy and quality, enable 24-hour automation, and improve enterprise security and compliance. [8] discussed about Intelligent Sensor Network for Vehicle Maintenance System. Modern automobiles are no longer mere mechanical devices; they are pervasively monitored through various sensor networks & using integrated circuits and microprocessor based design and control techniques while this transformation has driven major advancements in efficiency and safety. In the existing system the stress was given on the safety of the vehicle, modification in the physical structure of the vehicle but the proposed system introduces essential concept in the field of automobile industry. It is an interfacing of the advanced technologies like Embedded Systems and the Automobile world. This "Intelligent Sensor Network for Vehicle Maintenance System" is best suitable for vehicle security as well as for vehicle's maintenance. Further it also supports advanced feature of GSM module interfacing. Through this concept in case of any emergency or accident the system will automatically sense and records the different parameters like LPG gas level, Engine Temperature, present speed and etc. so that at the time of investigation this parameters may play important role to find out the possible reasons of the accident. Further, in case of accident & in case of stealing of vehicle GSM module will send SMS to the Police, insurance company as well as to the family members.

(2) The risks of RPA technology in the process of enterprise digital transformation.

While RPA technology brings many benefits to businesses, it also comes with some potential risks. First of all, RPA may have errors when performing repetitive tasks, especially when the objects of the target system change, such as page changes, domain name changes, account information changes, etc., and continuous manual maintenance of the RPA process is required to avoid similar problems. Second, because RPA is automated, without proper monitoring, control, and post-event checks, it can perform inappropriate actions, such as designing a faulty process in the RPA process, causing the bot to automatically delete important data or change important configurations, etc. In addition, RPA introduces new security risks, as attackers can exploit the operational privileges they must grant to implement automated processes to attack RPA itself, gain unauthorized access and carry out a series of dangerous activities. Finally, RPA can cause employees to lose their jobs or reduce their workload, which can raise some ethical or moral issues. Therefore, before implementing RPA technology, businesses need to carefully evaluate and plan to ensure that it is able to perform the required tasks correctly without raising some ethical or moral questions, and if necessary, take appropriate monitoring and control measures to minimize its risks.

(5) Discussion on the application scenarios of RPA technology in the process of enterprise digital transformation

(1) Application of RPA technology in the field of finance.

The application of RPA technology in the field of enterprise finance is becoming more and more common. It automates repetitive, high-risk, low-value tasks, improving productivity and accuracy, freeing up finance staff to focus more on strategic finance. For example, the day-to-day accounting work of a business often involves a lot of data entry and reconciliation. Using RPA technology, these tasks can be accomplished by writing automated processes, reducing the likelihood of errors and human intervention. In addition, RPA can also provide support in the process of financial statement preparation and analysis. Automated processes can collect and process data and generate reports, which can improve the speed and accuracy of report production and help finance professionals better understand the financial health of the business. Another application of RPA technology in the field of corporate finance is risk management. The types of risks that financial institutions need to deal with include credit risk, market risk, and operational risk. Automated processes can reduce your organization's risk exposure by providing real-time, accurate data and analytics to help identify and manage these risks. The application of RPA technology in the field of enterprise finance can greatly improve the efficiency and accuracy of financial work and provide better risk management support. As technology continues to evolve and innovate, one can expect more innovative applications to emerge that bring more value to business finances.

(2) Application of RPA technology in the office field.

In the field of enterprise office, RPA technology is widely used. For example, RPA can automate a series of daily office tasks such as data entry, report generation, order processing, and bill processing, thereby greatly improving the efficiency and accuracy of enterprise office. Specifically, RPA technology can simulate human operations on a computer and complete various office tasks by recognizing images and text on a computer screen. For example, when a business needs to process an order from a customer, an RPA bot can identify the information in the order and automatically fill it in into the company's order processing system. In this process, RPA can automatically verify the accuracy and completeness of the data, thus avoiding the occurrence of human error. RPA technology can not only improve office efficiency, but also greatly reduce the office cost of enterprises. Since RPA robots can replace part of the manpower, they can save labor costs, and at the same time, because some common human errors can be avoided in the automation process, it can also reduce the costs incurred by enterprises due to errors. RPA technology is widely used in the field of enterprise office, which can greatly improve office efficiency and accuracy, and can also save office costs.

(3) The application of RPA technology in the field of enterprise information operation and maintenance.

With the deepening of digital transformation, enterprises have higher and higher requirements for IT operation and maintenance, and traditional IT operation and maintenance methods can no longer meet the needs of enterprises. As an automation technology, RPA technology can help enterprises achieve efficient and intelligent IT operation and maintenance management. RPA technology can use

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 10, Issue 1, January 2024

automated bots to perform repetitive, low-value, and high-risk tasks in IT operations, such as log monitoring, database backup, and security vulnerability scanning. The automated robot can work uninterrupted for 24 hours, which greatly improves the efficiency and accuracy of IT operation and maintenance, and can also save labor costs. In the field of IT operation and maintenance, RPA technology can also be combined with other technologies, such as artificial intelligence (AI) and machine learning (ML), to further improve the intelligence and adaptability of automated robots. For example, automated bots can predict potential IT issues by learning from historical data and operational staff behavior patterns, and automatically alert and address problems before they occur. In addition, RPA technology can help enterprises achieve standardization and sustainability of IT operations. Automated robots can operate in accordance with standard processes and specifications, reducing the occurrence of human error and deviations, thereby improving the quality and stability of IT operation and maintenance. At the same time, automated robots can also monitor the operation of the system in real time, find and solve problems in time, so as to achieve continuous improvement of IT operation and maintenance. The application of RPA technology in the field of IT operation and maintenance has been widely recognized and applied. In the future, with the continuous development and innovation of technology, RPA technology will play a more important role in the field of IT operation and maintenance, helping enterprises achieve digital transformation and improve business value.

IV. Conclusion

The knowledge in this article can deepen students' in-depth understanding of robotics and process automation technology, and more importantly, cultivate students' practical ability and innovative thinking. Through continuous learning and practice, robotics and process automation technology will play an increasingly important role in various industries, bringing more efficient and intelligent production methods to enterprises.

Acknowledgment

This work was supported by Teaching Reform and Research Project of Taishan University (JG202156).

References

[1] Li Zheqing, Zhao Yu, Yu Zhen, et al. Robotic process automation technology to improve the application value of medical data [J]. China Informatization, 2023, (12): 44-47.

[2] Huang Yuexin, Chen Bing, Wang Yaodong, et al. Application Path of Robotic Process Automation Technology to Drive Digital Innovation and Development of Science and Technology Journals: A Perspective of Publishing Process Transformation and Upgrading [J]. Science and Technology Management Research, 2023, 43(23): 241-246.)

[3] Yang Lijun, Wang Yuyang, Meng Di. Application of robotic process automation in power dispatching [J]. Electronic Technology, 2023, 52(11): 226-227.

[4] Li Baqun. Application of robotic process automation in enterprise financial sharing system [J]. Electronic Technology, 2023, 52(09): 36-38.

[5] Chen Y, Wu Qiupeng, Zeng Dewei et al. Opportunities and challenges faced by robotic process automation in the medical field[J]. Journal of Medical Informatics, 2023, 44(03): 69-73+84.

[6] Liu Hong. Research on the application of process automation robots in financial sharing [J]. Economic Research Guide, 2022, (12):104-106.

[7] Christo Ananth, D. Jessintha, P. Praveen kumar, S. Jaisiva, T. Ananth kumar, "Social Service Robot using Gesture recognition technique", 4th National Conference on Communication Systems (NCOCS 2022), Journal of Physics: Conference Series, IOP Publishing, 2466(2023), 012020, DOI: 10.1088/1742-6596/2466/1/012020

[8] Christo Ananth, C.Sudalai@UtchiMahali, N.Ebenesar Jebadurai, S.Sankari@Saranya, T.Archana, "Intelligent sensor Network for Vehicle Maintenance system", International Journal of Emerging Trends in Engineering and Development (IJETED), Vol.3, Issue 4, May 2014, pp-361-369.

Jia-Qing Song received the Bachelor from Shanghai University of International Business and Economics in 1991. He is an experimenter at Taishan University. His research interests include educational administration, teaching management. Email: jiaqing_song@126.com.

Jing Lei (corresponding author) received the B.S., M.S., and Ph.D. degrees from Ocean University of China, in 2003, 2007, and 2010, respectively. She is a professor at Taishan University. Her research interests include educational administration, teaching management. Email: elizabethia@126.com.

Hui Zhang received the Master of Economics in Statistics from Beijing Forestry University in 2019. She is now an assistant at Taishan University. Her research interests include educational administration, teaching management. Email: zh17864810604@163.com.