# EVALUATION OF ACQUIRING AND IMPLEMENTING A MANUFACTURING RESOURCE PLANNING SYSTEM

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In the past decade China has evolved from a less developed economy into a world economic giant. This rate of economic growth is a result of China's transformation from a centrally planned system toward a market system and from a policy of opening its economy. With the transition Chinese manufacturing managers have realized that traditional manufacturing methods are no longer suitable for managing fierce global competition. A recent study showed that during the early years of the transition, Chinese manufacturing companies emphasized marketing and sales in promoting their products [7]. Today, focusing only on marketing and sales promotion no longer differentiates manufacturers; rather, high-quality products plus superior marketing strategy are considered to be the order winners. As more and more products of superior quality are available for consumers to choose from, manufacturing companies have recognized the importance of emphasizing manufacturing capability and process improvement. To respond to market needs Chinese business firms have started to improve their management skills and to adopt technology-related manufacturing systems.

In recent years a number of computerized manufacturing systems, such as material requirements planning (MRP), Just-in-Time, and manufacturing resource planning/enterprise resources planning (MRPII/ERP), have been developed and implemented in the manufacturing facilities of industrialized nations. MRPII is an integrated manufacturing planning and control system that includes financial management, materials management, and capacity management mechanisms. It provides a set of tools to help manufacturing managers control cash flow, arrange for purchased materials, manage inventory, and allocate human resources. It is, in addition, a tool that can support marketing and sales requirements. The ultimate goal of implementing MRPII is to reduce inventory, improve customer service level, and raise productivity [15]. The merits of the system have caught the interest of many Chinese manufacturing managers. Adopting an MRPII (or even an ERP) system as a management tool is, therefore, a vital decision for manufacturing managers in China who seek continuous growth, manufacturing process improvements, and global manufacturer status.

## STUDY BACKGROUND

The concept of MRPII was introduced to the Chinese market in the early 1980s. Since then many industries in China, including machine tools, automotive producers, electronic products, pharmaceuticals, and consumer goods, have adopted MRPII software. Some companies have had successful experiences with MRPII implementation and have acquired knowledge that many other companies would like to learn; some have experienced pitfalls that other firms would like to avoid. However, there has not yet been a comprehensive study that can provide insight on MRPII acquisition and implementation although the system was introduced nearly 20 years ago. Benefits and lessons from MRPII implementation in China can provide MRPII software vendors with valuable information to better serve the Chinese market and other emerging economies. Recently, interest in the MRPII system has

**TABLE 1: Source of MRPII Software**

| *Source of MRPII Software* | *Number of Companies* | *Percent* |
|---|---|---|
| Purchased from foreign vendor | 30 | 60 |
| Developed in-house | 13 | 26 |
| Developed jointly in-house with vendor | 3 | 6 |
| Purchased from domestic vendor | 3 | 6 |
| Other | 1 | 2 |
| **Total** | **50** | **100** |

*Source:* Zhang et al. [17].

increased in China. It is important to learn whether the system, which has proved to be a useful management tool for U.S. companies in improving their operational capability, can achieve the same level of improvement in a different manufacturing environment.

An empirical study was designed to explore the current status of MRPII acquisition and implementation in China. First, the experience of MRPII implementation in the United States, Singapore, and Turkey was studied and used as references [1, 2, 3, 6, 11, 15]. Then a questionnaire regarding company ownership and MRPII software acquisition, satisfaction, and success factors was constructed based on the Chinese manufacturing environment [12, 13, 17]. The survey questionnaire was translated into Chinese and then back-translated into English, pretested with a couple of high-level managers, and was then mailed to 150 Chinese manufacturing firms that have acquired and implemented an MRPII system. Fifty questionnaires were returned, providing a response rate of 33% for this study. Because of the lack of financial resources, no attempts were made to increase the response rate. To ensure the dependability of the survey results, the chief manufacturing officers, chief executive officer, or chief information system officers who were directly in charge of MRPII systems were asked to fill out the survey. Field case studies were conducted to gain an understanding of the various aspects of MRPII implementation. Details of one field study are included in this research.

**TABLE 2: Company Ownership of Participants**

| *Ownership* | *Percent* |
|---|---|
| State-owned large companies | 62 |
| Joint-venture companies | 32 |
| Privately owned companies | 2 |
| Local small companies | 4 |
| **Total** | **100** |

*Source:* Zhang et al. [17].

## MRPII SOFTWARE ACQUISITION

The first step in adopting an MRPII system is to acquire the software. By 1997 between four hundred and five hundred Chinese manufacturing companies had acquired the MRPII system [16]. Software vendors such as SSA, QAD, Oracle, Symix, and SAP are the major providers of MRPII systems in the Chinese market. There is a variety of MRPII software available for Chinese manufacturers to choose from. The most commonly chosen MRPII products are BPCS, FOURTH, MANMAN, MFGF/PRO, R/3, and SHIFT.

Table 1 lists the sources of MRPII software. Both domestic and foreign vendors supply MRPII software in China. The majority of respondents (60%) purchased their system from foreign vendors such as SAP, QAD, and Oracle [12]. A little more than 30% developed their MRPII system in-house or jointly developed the system with vendors. Thus far, foreign vendors dominate the Chinese MRPII market.

Many Chinese companies with different ownership groups and sizes are interested in adopting and implementing an MRPII system. Table 2 reports the ownership of companies that participated in this study. Sixty-two percent of the companies are large, state-owned manufacturing firms that have 5,000 or more employees. Thirty-two percent of the participants are joint venture companies, 2% are privately owned firms, and 4% are local small businesses run by local governments.

One important issue involved in the acquisition of MRPII software is budgeting for the components of the system. Generally, the ratio is about 4:1:1 for hardware, software, and technical support and training [12]. However, not every company budgeted appropriately to purchase all three components. Many firms purchased the three at once; some purchased only hardware and software. Over time, the downside associated with firms that did not purchase technical support and training at the same time was noticeable. Their implementation results were less promising than those companies that invested in training.

**TABLE 3: Satisfaction with MRPII Software**

| *Degree of Satisfaction* | *Percent* |
|---|---|
| Very satisfied | 5.3 |
| Satisfied | 26.3 |
| Somewhat satisfied | 50.0 |
| Somewhat dissatisfied | 18.4 |
| Not satisfied at all | 0 |

*Source:* Zhang et al. [17].

The other important issue is the timing of hardware and software acquisition. One company we visited had difficulties with the integration of hardware and software. The hardware it purchased in the early 1990s could not accommodate the requirements of the MRPII software that was delivered to them a couple of years later.

Respondents were asked about their satisfaction with the MRPII software they purchased. Table 3 reports the results. A little more than 5% of the respondents were very satisfied with the software, 26% were satisfied with the software they purchased, and 50% were somewhat satisfied. No company was completely dissatisfied with the software. All users who had adopted domestically developed MRPII software were satisfied with the system.

The interesting issue is that users who purchased software from foreign vendors hold contrasting opinions about the MRPII system. Those who were very satisfied with the software and those who were somewhat displeased with the software were users of MRPII systems developed by foreign vendors. This finding gives software developers an opportunity to rethink their product development process and the way their products can be integrated with the needs of emerging markets. Issues that should be taken into consideration include cultural needs, accounting systems, material management rules, and the like. For example, an MRPII-based system has two good features regarding product cost. One is a bill of material that shows an accurate material content of the company's product, and the other is the route sheets that provide an accurate measure of direct labor and overhead for the company's product. The cost of material items is easily estimated, but overhead associated with routing and taxes are calculated very differently in different countries. Therefore, foreign software vendors need to understand the Chinese accounting system to be able to develop better software for Chinese customers.

## MRPII IMPLEMENTATION

According to survey results, the MRPII implementation cycle ranged from 5.8 years to 17 years [12]. In an ideal situation the MRPII system integrates material flow, information flow, and cash flow. Companies that implemented MRPII successfully reported a reduction in overall inventory by 63% and work-in-process inventory by 37%. Other benefits include reduced cycle time, improved productivity, less material waste, no overtime, and shorter cash flow cycle [8].

The aim of implementing an MRPII system is to tie a company's procurement, production, distribution, and cash flow together in a single integrated process. Reports generated using an MRPII system can help managers develop production plans and monitor cash flows and at the same time integrate financial and sales information that can provide managers with data to recognize sales objectives.

The sequence of implementing MRPII modules in the United States is different from the sequence in China. In the United States companies usually set up the financial module first, load up the accounting information system, and then activate the production module. Because of the differences in accounting methods, Chinese firms using MRPII systems provided by U.S. vendors experienced difficulties in activating the financial module first. Therefore, Chinese companies start with the materials management module. This module includes inventory management, work-in-process inventory, and finished goods inventory.

According to Oliver Wight, MRPII implementing characteristics can be grouped into four classes [15]. Users in the Class A category are able to effectively use the planning and control process of the MRPII system from top to bottom of the company and generate significant improvements in customer service, productivity, inventory, and costs. Usually a Class A user fully integrates a closed-loop system that links business plans, sales forecasting, master production schedule, material, and capacity requirement plans. According to our survey results, no company fit into this category. The main problem is that the financial and accounting information system modules have not been integrated well with modules of the material flow, information flow, and production system. Inaccurate demand forecast disturbs implementation of the master production schedule. There are only a few companies that fit into the Class B category as described by Wight [15]. These companies have a dependable closed-loop material requirement planning system and stable manufacturing control, but they do not use MRPII as a mechanism to master the overall operation of the company.

The majority of companies surveyed are still in Class C. For these companies, MRPII provides a better method for material procurement and inventory management. Many of them apply the MRPII system to a

**TABLE 4: Success Factors for Implementing MRPII**

| *Success Factors* | *Rank* | *Means* |
|---|---|---|
| Top management leadership and support | 1 | 4.93 |
| Clear company objective and goals | 2 | 4.74 |
| Data accuracy and integrity | 3 | 4.67 |
| Functional area cooperation | 4 | 4.56 |
| Employee training and education | 5 | 4.41 |
| Information sharing among functional areas | 6 | 4.37 |
| Employee responsibility | 7 | 4.11 |
| Appropriate hardware and software | 8 | 4.07 |
| Familiarity with information technology | 9 | 4.00 |
| Software vendor selection | 10 | 3.89 |
| Visibility of MRPII implementation within the company | 11 | 3.85 |
| Software vendor support | 12 | 3.81 |
| Information and knowledge about MRPII before acquiring software | 13 | 3.70 |

*Source:* Zhang et al. [17].

single functional area, such as procurement or sales orders. Information on sales, production, material flow, cash flow, and the like is not shared by the entire company; this sharing of information is the essence of an MRPII system [12].

Our findings about MRPII users are consistent with reports on results in the United States [15]. There are not many U.S. firms that belong to the group of Class A and B MRPII users. However, there are a lot of Class C users in the United States. The real issue is that managers do not use an MRPII system to its full potential and treat it as an integrated manufacturing decision-support system. Many Chinese managers are like their counterparts in the United States. They treat an MRPII system as a video game: purchase it, load it up, play it, and hope the MRPII system will take care of manufacturing planning and control for the company [10].

The best-implemented module is inventory management. Some companies reported 100% inventory accuracy [12]. The main reason is that there is not much difference in physical management of inventory between U.S. companies and Chinese companies, and the MRPII system provided by U.S. vendors can well capture the daily routine of inventory management. The interactions between inventory management and other departments are well traced and documented by the system. Those who successfully implemented an inventory management module have reported a reduced inventory level, better cash flow, and reduced production cycle.

The biggest problem lies in cost analysis and forecasting modules because the financial module does not fit the Chinese accounting system. This fact prevents Chinese manufacturing companies from integrating the accounting module with production and inventory modules. Many Chinese companies still estimate cost based on work unit. The cost of material and outputs are analyzed, but the costs of labor, equipment use, and overhead are not [12].

Success factors for implementing MRPII have been explored and are reported in table 4 to provide further understanding of the nature of MRPII implementation in China and information for those who want to adopt an MRPII system but have not yet done so. On the basis of previous publications [1, 2, 3, 6, 14, 15] and experience with implementing MRPII in the Chinese environment, 13 items have been recognized as success factors for implementing MRPII. Table 4 shows success factors as ranked by respondents on a 5-point Likert scale, from the most important to the least important.

The success factors reported in table 4 are consistent with success factors reported in the study on MRPII implementation in the United States and Singapore [1, 14]. Top management leadership and support has been ranked the most important factor by the majority of respondents. The importance of top management involvement in implementing MRPII systems cannot be overemphasized [15]. If a management information system person is appointed as the MRPII project leader, the project will not be successful because he or she will not have the authority to oversee the integration of different functional areas. The role of top management is to encourage practices and employee behaviors that lead to effective MRPII system implementation and make the system work. Senior management involvement in planning, coordinating companywide activities, and directing MRPII implementation will ensure that employees will use the computer system confidently and effectively.

Data accuracy and integrity were ranked as the third most important success factor in implementing MRPII. Without accurate data, MRPII will not provide the ex-

pected results. Accurate data sources help a manufacturing firm improve performance and grow. MRPII requires an extremely high level of data accuracy, especially data regarding inventory records, bills of material, and projected demand level. In the process of implementing MRPII, the most often encountered data problems are nonstandardized data, inaccurate inputs, inconsistent code for the same item, handwritten information, and multiple names for one part or component.

Organizational factors have been recognized as important to success. Participants ranked cooperation between functional areas and information sharing among functional areas as number four and number six, respectively, in terms of importance. Implementing MRPII requires a new organizational culture. This is consistent with the previous study about MRPII [3].

Training and education are contributing factors that have been reported in the MRPII literature. Lambourn [6] pointed out that MRPII could transform a manufacturing firm but it was people as well as information technology that could help improve a manufacturing company. Every employee, therefore, should have some type of training before the MRPII system really goes on line. Successfully implementing MRPII requires that top management learn the new manufacturing concept to supervise the dynamics of the business and that a first-line foreman be able to fix bills of material if any adjustment is required.

## FAVORABLE ENVIRONMENT FOR THE MRP MODULE

In the process of implementing MRPII, Chinese manufacturers have found that subassembly, numerically controlled system, and repetitive production are the three environments that are favorable for implementing the MRP module of the MRPII system [9].

*Subassembly manufacturing environment.* MRPII systems have implemented well in a subassembly production environment. Usually subassembly producers purchase many parts and components and produce a few items in house, which has reduced complexity in material management.

*Computerized numerically controlled (CNC) production environment.* CNC is used to control machine tools and material flow through programmable automation. In this way material handling has been simplified and waiting time on the shop floor can be estimated accurately. For those firms that have adopted a numerically controlled system, the input data on work-in-process inventory, labor and machine time, and the like are precise. Therefore, both material requirement planning and capacity planning are made easy.

*Repetitive production environment.* In a repetitive production environment, once the person in charge of production planning understands the production rhythm, he or she is able to estimate realistic lead time and uniform workstation load within the production planning period to balance the capacity. Usually firms operating in this type of environment use standardized components to increase repeatability and reduce error rate. These manufacturing characteristics are favorable for implementing MRPII–based material requirement planning and capacity planning.

Companies that have encountered serious problems in implementing an MRP module are those that have products with many bill of material levels and that change their product mix frequently. For those companies it is difficult to produce a complete material requirement plan. Many levels in the bill of material contribute to a large cumulative error rate in projected lead time. Therefore, it is unrealistic to develop a capacity requirement plan based on the material requirement plan. It is also very difficult to produce balanced input-output control reports. This finding is different from findings of the simulation study on MRP reported by Krajewski et al. [4]. They report that MRP is most useful for products that have many bill of material levels and lumpy demand for components. The average U.S. user of MRP usually has more than six bill of material levels. Inventory accuracy and demand forecasting issues that Chinese manufacturers have experienced in implementing an MRPII system could be the factor creating the difference in what constitutes an environment favorable for an MRP module.

## PROBLEMS ENCOUNTERED DURING IMPLEMENTING MRPII

Two major problems have been encountered in the process of implementing MRPII in China. They are (1) the disconnect between the MRPII system and business management and (2) inadequate strategic planning and preparation for implementing a new computerized system [5, 16].

The disconnect between the existing management system and the advanced technology has been a serious issue. Implementing advanced-technology-based MRPII has to be supported by modern business management ideas and skills. Chinese manufacturers have had 30 years of state-planning experience, so reengineering business management methods will take time. Implementing MRPII is a challenge to many firms because the system requires different production practices, computerized procedures, and above all a different business

management philosophy. The disconnect is illustrated by a case involving a food packaging company. After the company's MRPII system was installed, production began. The system was working. There were employees standing on both sides of the production line, packing, putting food packages into boxes, moving the boxes to the warehouse or directly shipping to customers. However, at the end of the line, a few workers were picking up unpacked products and pushing them back to the production line. The line was not well balanced, and waste was the result. Workers were not trained to adjust the production pace in an MRPII production environment. If the company's top management had understood modern management and had been able to link its management concept to the advantages of the MRPII system, the results would have been better. Software capability is important in the process of implementing MRPII; however, it is the proper organizational support such as leadership, communication channels, organizational culture, and employee training that will make MRPII implementation successful.

Inadequate strategic planning and preparation for the implementation of a new computerized system is another serious issue preventing a successful MRPII implementation. Some companies did not have enough information about the MRPII system before they acquired it; some Chinese managers simply did not understand how to generate best results using the system. Some managers assumed that they could buy an MRPII system from their vendor, load it up, play it, and the optimal production show would be on. The lack of preimplementation planning and preparation cost some companies millions of dollars and left them with a pile of software that could not do anything for them. For example, one company spent nine years implementing the MRPII system but only realized 30% of its benefits. During the planning period the company ignored many important issues such as top management involvement, project planning, business policies, MRPII system selection issues, management style, and after-sales service and training. These issues might not seem crucial to management at the beginning but were directly related to the success of the MRPII implementation. Eventually, the company had to give up the MRPII system and wasted the initial $3 million computer system to avoid investing more money in the unsuccessful program.

## CASE STUDY

In this section we briefly describe an actual MRPII implementation in a Chinese printed circuit manufacturing facility. The company, a joint venture between the United States and China, was established in the early 1990s in the southeast region; it is also known as a foreign investment electric factory (FIEF). The products produced at this facility are marketed worldwide for the personal computer. According to a project manager in charge of the MRPII implementation at the FIEF, a sister facility already existed in one of the Far East countries where similar products were being made, and a system was already in place.

The MRPII system was fully implemented in the Chinese factory six years ago; the materials management module implementation, the major focus of discussion here, took about one year. Training explaining the system was provided to all employees except the production operators. An interesting point to note is that APICS documentation and workbooks were used as part of the training program. Details about the functionality of the materials management module were included in the training program along with training on how to set up, run, and adjust the system. The management information system support staff were directly involved and were quite receptive to the new system; they were going to implement it in the manufacturing environment. Before the full system was completely implemented on a day-to-day basis, several trial runs were made and were compared with the traditional system.

In a traditional material management system in China, national factories acquire raw materials based on their forecasts and, thus, have to maintain a large amount of inventory. For example, at one of the local factories, inventory worth $8 million was kept on hand to meet customer demand. In addition, at the same factory, it was not uncommon to keep a large amount of finished goods inventory consisting of some popular standard products. This enabled management to meet certain demand for which they were not prepared.

The system was fully integrated into the daily production environment only after all individuals were fully satisfied with the results of the system. The production control keyed in the demand requirements for a four-week period and ran the system once a week on Fridays. The output was then provided directly to the purchasing department, which placed orders and checked the orders and their delivery dates. Management had assumed that because the system was in use at the sister factory, its implementation in the Chinese factory would be efficient and much smoother and that there would be fewer problems to face and resolve. However, during the first few months, day-to-day users faced several problems. They were unable to understand the system com-

pletely. For example, the output was not accurate because of an incorrect parameter in the setup phase of the system. The system was frequently down because it was unable to handle the heavy demand that was imposed by management. In addition, the system did not adequately control urgent changes in the demand requirement, and the operators were unable to respond quickly to address that issue.

The materials manager made several suggestions regarding the implementation process: Management should prepare for a period of unstable material supply during the earlier part of the system implementation; employees must be provided with as much training as possible, especially the purchaser and the system operators; and management must keep in mind that the system will not eliminate all problems and, in fact, additional difficulties will arise with the implementation of the system in a traditional Chinese factory.

## CONCLUSION

Our study is the first to report the results of implementing MRPII in China. The main providers of MRPII systems are U.S. vendors. Users hold contrasting opinions about the American-made MRPII systems. Those who were very satisfied with MRPII software and those who were somewhat unsatisfied with the software were users of MRPII systems developed by U.S. vendors. That finding gives U.S. software developers an opportunity to rethink their product development process and the way they integrate their product features with the needs of a global market.

Similar to reports on MRPII implementation in the United States and Singapore, there are almost no Class A MRPII Chinese users. There are some in Class B, and many in Class C, as defined by Oliver Wight. It still takes a considerable amount of effort to make MRPII systems fully work in a different manufacturing environment and to enjoy the benefits from the system.

Companies that implemented an MRPII system have benefited from the streamlining of procurement, materials management and distribution, and inventory accuracy. The biggest challenges remaining in the implementation of MRPII in China are the disconnect between the advanced technology and the existing management style, and inadequate strategic planning and preparation for the implementation. It may take time for Chinese manufacturers to develop a management system that will support implementing advanced–technology based manufacturing tools.

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