A Case Study on Manufacturing Execution System Integration in Mergers and Acquisitions

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Abstract

With the increasing global competitions, a company should increase its competitiveness and productivity while facing rising of commodity prices and labor costs; and may therefore adopt Mergers and Acquistions as an option to address these problems. This study had several research objectives. First, its aim is to identify the key factors that affect MES integration. Second, it aims to clarify the effects of business mergers and information system integration, both of which influence relevant areas such as production, employees, shareholders, and the like. It is worth exploring these affected aspects because it may provide feedback that will impede or enables the merger and integration process. In this study, we adopted a system integration case study by conducting interviews, analyzing case data, and identifying key factors that affects the system integration. By conducting the case study, we identified the key factors affecting system integration and determined whether those factors would indeed affect the speed of the process, and from there finally drew conclusions and made suggestions.

Keywords: Manufacturing execution system, merger and acquisition, system integration, case study

1. Introduction

With the increasingly obvious trend of industry convergence, there have been more cases of synergies achieved via business consolidation or strategic alliances. Since the release of the Act of Business Mergers and Acquisitions on February 6, 2002, there has been a merger and acquisition (M&A) case every four days on average in Taiwan. According to statistics from the Department of Commerce - Ministry of Economic Affairs of Taiwan, there were up to 288 domestic M&A cases in the last three years; making a new record of 151.89 billion TND (Taiwan New Dollar) spent on M&As. Recently, an increasing number of Taiwan-based enterprises had undertaken M&A's, such as the merger of Chi Mei Optoelectronics with Hon Hai Precision Corporation, the acquisition of Thermaltake by TteSports, the merger of MOTOTECH with Accton, and the acquisition of Qwest Communications - a local phone company - by CenturyTel - an American regional telecommunication company. With increasing global competitions during the 21st century, a company should increase its competitiveness and productivity while facing rising of commodity prices and labor costs, and may therefore adopt M&As as an option to address these problems.

Employees facing M&A's will probably experience great anxiety and are not certain whether they may adjust to the new business culture. When experiencing a big organizational change, employees should adapt to new policies, regulations, and personnel changes in a merged company, and the degree of perceived procedural justice should be adjusted according to the work environment of the new organization. To date, few studies have explored organizational justice and organizational behav-

iors related to the employees that survive reorganization (Kernan & Hanges, 2002). Among the few studies, Kernan and Hanges (2002) developed a cause-and-effect model of organizational justice in a study of employees in an R&D department of a multinational pharmaceutical company after reorganization and demonstrated that procedural justice, informational justice, and interpersonal justice were all closely associated with organizational behavior variables; including organizational commitment, work satisfaction, turnover rate, and employees' trust in managers (Peng, Lin and Guo, 2004). Moreover, Yang (2006) investigated a single M&A case and pointed out that the dominant company should consider the situation of the merged or acquired company and adopts good integration management to achieve the expected business culture integration.

The Manufacturing Execution System (MES) is a core business system employed by many semiconductor industries. Wang (2007) pointed out that with an MES installment; a firm's production process may change from a manual operation process to an information-oriented process and improve the overall throughput and financial status of the company. Since the release of the first MES software in 1990, MES has increasingly drawn attention from manufacturers (Mourtzis et al. 2014). By continuously using the most cutting-edge software and computer technology, MES has rapidly improved and become suitable for a variety of manufacturing industries; such as for aerospace, automobiles, semiconductors, biochemicals, petrochemicals, steel, plastics, and medical devices. Enterprise information systems are often composed of several business applications such as Enterprise Resource Planning (ERP) systems, MES, and Product Lifecycle Management (PLM) systems (Ikbal et al., 2017). When conducting system integration, companies may have some problems with information system integration - such as workflow problems and other issues in the data creation process, which thus affects the integration speed (Gou et al., 2003). During these days, there are few studies of MES integration during mergers. To fill in the knowledge gap, this study investigates MES integration during a merger.

This study had several research objectives. First, its aim is to identify the key factors that affect MES integration. When enterprises are conducting merger or when multiple factories are integrating systems, there will be different data or data formats to handle; different factories have different regulations and policies, and need to use different data planes. Moreover, enterprises must complete all the merger steps very rapidly when they decide to conduct a merger. If the key factors in MES integration are identified, mergers or multi-factory integration may be achieved within the expected time. Second, it aims to clarify the effects of business mergers and information system integration, both of which influence relevant areas such as production, employees, shareholders, and so on. It is worth exploring which of these affected aspects may provide feedback that impedes or enables the merger and integration process.

2. Literature Review

2.1 Merger and Acquisition

Mergers and acquisitions have attracted considerable interest in academic research since the 1980s. Ferdinand and Martin (2017) examined the long-term performance of German acquiring firms for M&A transactions that occur from 1981 to 2010. In contrast to many U.S. studies, the results do not find significant negative long-term performance for full sample. Baker and Niederman (2014) examine 22 mergers and acquisitions to investigate business-IS strategies employed. M&A outcomes are successful when strategies are aligned and not aligned based on alignment theory. Besides, M&A often uses emergent strategy formation, not normative strategy formation.

Siedschlag et al., (2014) indicates that foreign acquisitions had stronger effects on

firm performance in services than in manufacturing based on comparable firm-level data from six advanced small open economies over the period 2001–2009. Schiffbauer et al., (2017) examines the causal relationship between foreign acquisitions and firm productivity in the UK. The research finds that productivity gains are related to acquisitions by foreign firms operating in industries intensive in R&D. However, productivity gains had fewer possibilities when foreign acquirers conduct in marketing-intensive industries. Most research in the past focuses on firm performance and productivity and rarely discuss about information system, human resource and workflow integration.

2.2 Information System

When merging companies, information system integration issues are the most difficult. Accenture (2006) found that only 30% of managers involved in mergers and acquisitions believed that the combined companies had successfully integrated their IT systems. Lohrke et al. (2016) discussed four of the most critical IT integration issues within mergers and acquisitions summarized in Table 2-1: (1) Viewing IT as a key M&A consideration from the start; (2) Integrating disparate IT systems following the merger; (3) Reducing IT security vulnerabilities during and after M&As; (4) Using IT to enhance a merged firm's sustainable competitive advantage.

Pai (2009) proposes that companies have to face a lot of problems when implementing the information system as follow: (1) Business model change; (2) Work approach change; (3) Employee turnover; (4) Different capability of external consultants; (5) Work loading of key users; (6) System integration with work process; (7) Customization level; (8) technical ability. From these points of view, the study found the key factors that affect MES integration within mergers and acquisitions.

Table 2-1: Key Information Technology Issues within Mergers and Acquisitions (M&As)

Challenge	Solution	Illustrative Example
Viewing IT as a key M&A consideration from the start	Involve the two firms' Chief Information Officers very early in the M&A process	When Land O' Lakes considered acquiring GeoSys, a French company that used satellite data to inform farmers about crop health, its CIO assessed the age, scalability, and average downtime of GeoSys' IT systems to look for potential risks.
Integrating disparate IT systems following the merger	Carefully match one of three options-complete integration, partial integration, and coexistence-to the firm's internal capabilities	Oracle's consolidation of 70 internal IT systems into a single enterprise-resource-planning system helped it make more than 50 acquisitions from 2005 to 2009 and to integrate most of them within 6 months.
Reducing IT security vulnerabilities during and after M&As	Quickly align disparate IT security policies across the merged firm	20% of 761 major IT breaches in 2011 involved merging firms. Combining different IT systems often creates increased cybersecurity vulnerabilities in a newly merged firm.
Using IT to enhance a merged firm's sustainable competitive advantage	Please emphasis on building proprietary systems for data analytics that rivals will struggle to copy	United Healthcare acquisition of Humedica provided it access to electronic health records data to complement its hospitalization information, which, in turn, allowed it to develop new services for its client hospitals.

2.3 Human Resource

The employees in mergers and acquisitions will feel uncertain and have to adapt to the institution, regulations and personnel changes. Few studies discuss survivor reactions to reorganization. Kernan and Hanges (2002) conducted the study to all employees of the research and development facility of one division of a major multinational

pharmaceutical corporation. The division was responsible for innovation and new product development for consumer health products in both the United States and the United Kingdom. The results showed that procedural justice was strongly related to organizational commitment, job satisfaction, turnover intentions and management trust. Interpersonal and informational justice added unique variance to the prediction of management trust.

Yang (2006) proposed that the dominating company in the merging and acquisition should consider the status of the company being consolidated and make integration management well to achieve the expected influence of business culture integration. Most studies focus on how acquirers use their power to change practices at the acquired company during the integration process. Weber and Tarba (2010) argues that the changes in acquirer's HR practices, including training methods, communication, and increased autonomy of HR managers can contribute to M&A performance. The study suggest that to enhance M&A performance. acquirers have to use human resources (HR) practices that develop integration capabilities during post-merger integration from a knowledge-based view of acquisitions.

Jordão et al., (2014) analyzed the influence of organizational culture on the post-acquisition management control system (MCS) of the Brazilian company and provide two suggestions: (1) The changes in the acquired company's management control system were derived from the new financial results-oriented culture introduced by the acquirer. (2) The culture implementation implied modifications in production, financial and quality controls. Companies have to provide some incentives, including financial and job guarantee etc., will not lose their talents after the mergers and acquisitions and influence their future operations (Xue, 2000).

2.4 Workflow

The MRP system records product usages, customer orders, and materials required; and sends requests to the manufacture execution system layer to build more products to satisfy these needs. The MES systems are responsible for product manufacturing, and all operations associated with the creation of those products (Mehta and Reddy, 2015). Integration can be seen as a process including high levels of interaction between people, machines and applications, which enhances the synergy within a company (Vernadat, 1996)

Gou et al., (2003) proposed that the virtual enterprise integration can be hierarchically classified into three levels: (1) Physical system integration; (2) Application integration; (3) business integration. The study presents several definitions about general business processes: (1) Business process: one or more linked procedures or activities; (2) Activity: a piece of work that forms one logical step within a process; (3) Resource: an entity that actually performs activities of a business process. According to Bordeianu et al. (1998), the departments' mergers enable libraries to centralize activities and streamline workflow which often results in increased efficiency and productivity.

2.5 The Research Model

Based on previous literature reviews, the proposed research model drawn from the constructs of information system, workflow, human resource and MES integration is shown in Figure 2-1.

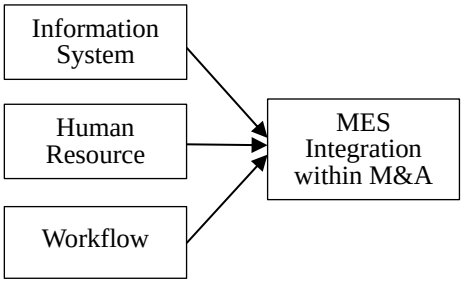

Figure 2-1: The Research Model

3. Research Method

In this study, we adopted a system integration case study by conducting interviews, analyzing case data, and identifying

key factors that affect system integration. By conducting the case study, we identified the key factors affecting system integrations and determined whether those factors would indeed affect the speed of the integration process, and from there finally draw conclusions and make suggestions.

3.1 Research Subject

The case company was founded in 1997 and listed in the Gre Tai Securities Market (OTC market) in January 2002. Their corporate office is located in the Hsinchu Science Park. This company is a professional semiconductor bump manufacturer within the downstream semiconductor packaging and testing industry. It is the only domestic company that has mobile devices for the whole process of IC packaging and testing, and is the largest contract manufacturer for packaging and testing globally. This business line primarily includes producing and selling bumps (e.g., gold, tin and lead) and providing posterior segment tape carrier packaging (TCP), chip-on-film (COF) packaging, and chip-on-glass (COG) packaging, and its products were mainly used in LCDs to drive IC. Bumps are an important part of the semiconductor production process. Metal bumps on wafers have protruded points that can be used as IC signal contact points; metal bumps are classified into gold bumps, eutectic sold bumps, high lead solder bumps, and others. The case company employed 1,974 people in 2009, of which 66.21% of all employees had junior college degrees. And after the merging, the company grew to 3,657 employees. The product and revenue ratio of the case company are gold bumps (35%), carrier packaging (10%), chip-on-glass (14%), tap carrier packaging and chip-on-film (41%).

In this study, we interviewed the core staff involved in the merger, including IT professionals and other regular engineers alongside production line staff in the production team. From the interviews, we found out the factors and analyzed them. Especially the main factors that affects the system integration and merger.

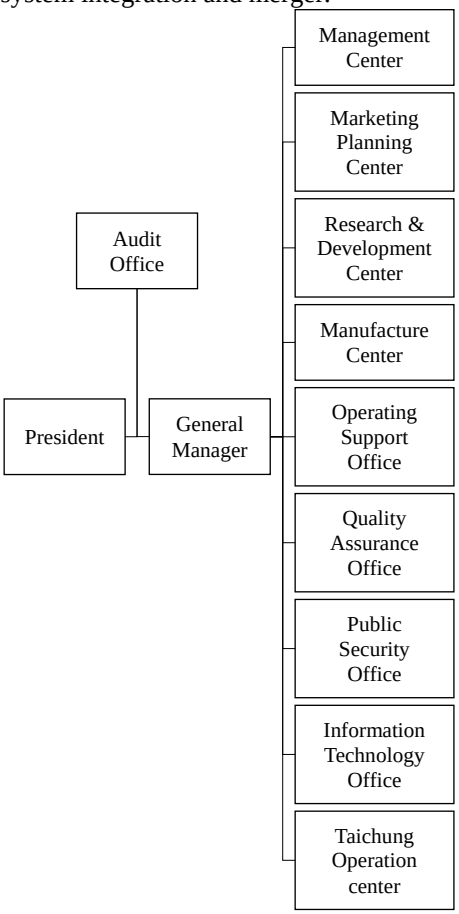

Figure 3-1: The Organization Chart of Case Company

Table 3-1: Outline of the Interviewees

Staff	Factory category	Technical title	Yearly salary	Role in the merger
A	Merging company	Project manager	7.7 Y	IT Leader
B	Merging company	Engineer	8 Y	Project integration
C	Merging company	Senior engineer	12 Y	Production line representative
D	Merged company	Manager	7.79 Y	Product department representative
E	Merged company	Engineer	2.67 Y	Product offline representative

3.2 Manufacturing Execution System

MES can, at any time, monitor the operating status of the bottom devices and collect the status parameters of the devices and equipment. After analyzing, computing, and processing data; MES triggers new events instantaneously and reliably integrates the control system with the information system. Also, sends production status data back to the managers in a timely manner. Figure 3-2 illustrates the MES architecture. The case company had 12 types of MES sub-systems, including: basic data creation; product-parameter; cargo arrangement; mask management; recipe management; environmental EDC management; product EDC management; equipment EDC management; control wafer management; abnormality management; real-time abnormality reporting; real-time equipment monitoring system.

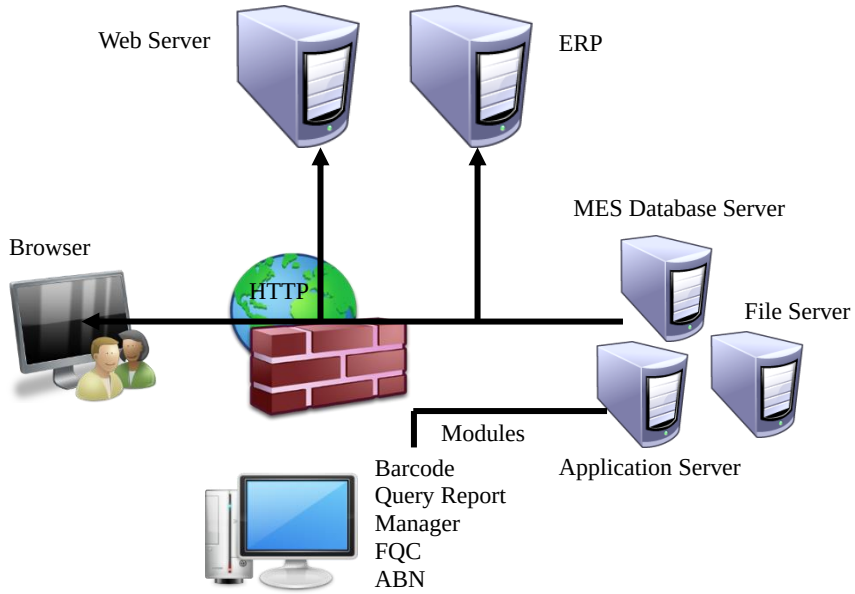

Figure 3-2: The MES Architecture of the Case Company

According to the MES data architecture prior to the business merger, the product part number (PPN) was the main part of the control product and system link product, while after the business merger, the MES data architecture employed PPN and the factory category (FC) for product differentiation, as shown in Fig. 3-2.

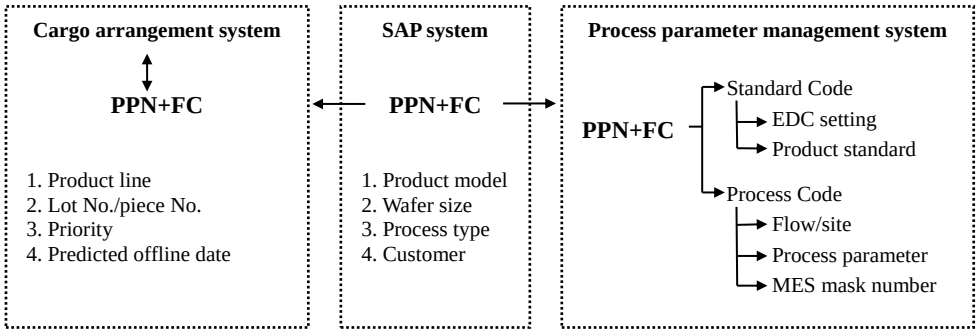

Figure 3-2: The Metadata Architecture after MES Integration

4. Case Analysis

When conducting the system integration, the case company encountered many problems in the system, human resource, and procedural levels. We expected to find the key factors in MES integration from the data collected in each interview.

4.1 System Factors

During the system integration, this case study showed that there were some functions that the company could not integrate as expected and thereby required IT professionals to use plug-in codes to aid the integration. Due to project schedule problems, some project functions did not cause production problems. They were arranged to be developed or corrected only after the system integration was complete. Now, the main objective of the project management was to promote the system integration, as indicated by the following comment recorded in an interview with interviewee B:

"*The two factories had very different data coding rules. Data fusion and data integration encountered many difficulties. Challenges existed in the method of interpersonal communication. The second largest problem was that the data format was not consistent; therefore, many data could not be directly placed to the (database), which required manual entry and was very time-consuming. With respect to the production operation, given the discrepancy across the different operation system; the acquired employees needed re-training.*"

"*When conducting the system integration, the company did not consider purchasing a new system; which was likely depending on whether the cost of a brand-new system purchase would be higher than the cost of repairing the current system. Moreover, if the data would be placed into the brand new system, all employees of the two factories would need to be re-trained. At last, there was a scheduling problem. If a brand-new system was used, the project deadline would be postponed.*"

The original MES primarily provided the product part number (PPN), and the merged company also employed this method before the merger. After the merger, the product was labeled with the PPN + factory category (FC) as its only number. Moreover, the merged company did not have the same product coding rules as the acquiring company. Which led to difficulty in inputting data to the system, and batch data entry was not possible. Therefore required manual input, which most of the users considered very tedious.

Due to various cost problems, the merging company did not consider using a brand-new system. The problems included are the cost of training the employees, purchasing the brand-new system, and assessing the provider of the new system. All these costs would be greater than the labor cost just to modify the existing system.

4.2 Human Resource Factors

If a supervisor did not have an effective communication channel, or the management method was inappropriate then supervisor would not be able to obtain clear orders from the higher management levels. Also, collect important information or listen to and respond to employees' advice which would result in discrepancies in the perceptions between the management levels and the actual executors. And these discrepancies, once formed, would greatly hamper the project implementation. The supervisors in our case company followed up with each department on whether the required projects had already been completed within the deadline.

Cooperation and support from employees is a factor affecting work efficiency. Project implementation is advanced when employees are dedicated to the work, get well along with one another, and have a high work efficiency. In our case company, the employees were highly cooperative. When implementing a project, support from senior managers is very important. If senior managers do not show enough support or give advice, it would not be properly implemented or resolved in many

cases, and consequently, only superficial problems would be resolved and not achieving a thorough improvement. In general, the degree of support from senior managers is positively proportional to the coordination capability of all departments; a higher degree of senior management support is associated with a higher degree of department coordination. Senior managers can enhance inter-department communication. In our case company, most of the senior managers showed a high degree of support and cooperation.

If a company has a new policy to implement and employees have a high degree of agreement with the policy, the employees will have a high degree of support and cooperation and thereby give a high degree of compliance. Which would enable smooth implementation and improve work efficiency. However, these are the prerequisites that the employees should accept from the company policy. In our case, the employees of the acquired company were not certain about the details of the policies and therefore concerned. But these negative emotions were dissipated through consultation with the supervisors and the company's announcement that not all of the employees would be laid off.

4.3 Workflow Factors

There were different viewpoints among the interviewees about their difficulty with the workflow. When a system is under integration, many tasks should be completed within a limited time frame. Each employee could be in a different stage in the workflow and from their perspective, experience a high level of difficulty. With respect to this issue, three interviewees considered that these items would not have been so difficult if more time and resources could be allocated. While two other interviewees held opposite opinions, thinking that different departments should be mobilized to collect operation information from different parts and then brainstorm to determine the most appropriate practices suitable for the current situation. And all these processes should be reviewed for improvement.

In the workflow of this case company, many interviewees considered that the employees from an acquired company should enter the acquiring company and maintain good contact with its employees; this practice would be equivalent to providing educational training earlier than planned and ensuring that the employees receive more thorough training. Educational training for employees would enhance the individual's value and responsibility, correct work attitude and ethics, strengthen professional skills, and improve the current work efficiency and production. From the company's perspective, educational training planning is developed according to the company's regulations with the purpose of improving the company's performance. One of the interviewees' replies to a question about what should be improved in the workflow integration:

"*The collaboration between the two factories could be closer. When the merger occurred, their collaboration was not as high as expected. I feel that this limitation may be further improved, and even from the very beginning of the merger, the employees (key users) from the acquired factory may be allowed to directly enter the acquiring company for more contact and study*."

5. Conclusion and Discussion

Based on case observation, subjects' interviews and analysis, we generalize the following conclusions and suggestions:

(1) Difficulty in the system integration

The extent to which a system may be integrated should be determined prior to the integration by evaluating the effect and referring to the polices. The older the system to integrate is, the more difficult the integration process becomes and the higher the integration cost is; thereby, the higher the failure possibility is. Given that system developers differ across different systems, there will be difficulty in integrating the

system which blocks inter-system communications that will not only make it difficult to combine and analyze operational information, but also increase the labor cost due to data processing.

Provided that the data integration is conducted beforehand across business units and systems, the firm prepares to expand the systems such as more deeply developing e-operations like e-commerce, customer relationship management (CRM), and supplier relationship management (SRM). The company can reduce much of the time that can be spent on discussion and avoid the difficulties or errors in data acquisition, thereby expediting the development of new system functionality for online use.

(2) Customization problems

The introduction of many customized systems affects enterprise information systems. However, given marginal profits nowadays; system customization seems to be inevitable, and each enterprise system has, more or less, customized functions. To appear "slightly different" than other companies, a company may develop a software; meaning that regular employees would know nothing about that software when the company recruits them. Since the employees do not know how to operate the software, managers should implement training; if they use a standard, universal software, then the employees would know it well before beginning to work for the acquiring company. Thereby greatly reducing employees' learning curve to operate the information system. As well as preventing information staff from spending much time on follow-up updates and corrections.

(3) Support from supervisors

Employees with a highly supportive supervisor will have a high like-mindedness to the company and thereby a high passion for the work and high work efficiency. The employees may, on a regular time basis, bring the reports and descriptions of the business merger in formal working meetings; thus allowing the supervisors to know the status and difficulties in the current stage of integration. In addition, to accurately know the resources that each project member used and the contributions that each project member made.

(4) Collaboration from employees

The study tries to classify employees into four types and provided some points to pay attention after conducting interviews as well as analyzing case data. The list is as follows:

I. Learning-and-growth type: this employee has a high degree of collaboration, but have low working capability. They are highly collaborative with their supervisors and the work processes across different departments, do not have many opinions, and are willing to coordinate various task assignments. Most of the new hires belong to this type, and are easy to lead.
II. Crisis-awareness type: this type of employee has high working capability and good job performance that depends on the situation. They perform well on tasks they prefer, yet become passive and unproductive when doing a job that they dislike. This type of high-capability yet low-collaboration employees are most challenging to supervisors; they will not only influence other colleagues' work attitudes and work performance, but also make the supervisors feel frustrated and impotent. In general, most of the employees who trouble supervisors most may fall in this type.
III. Care-and-adjustment type: this type of employee gives others the impression that they are passive, inactive, and indifferent. They work with the least dedication and passion. Their work performance is not good, and they have low collaboration with the management levels. When facing problems and difficulties, they will not report proactively. When the company prepares to lay off unsuitable employees, it will give priority to dismissing this type of employee.

IV. Motivation-and-challenge type: this type of employee works hard and responsibly, is proactive, and has strong capability and high willingness. When facing problems or difficulties, they will take the initiative to solve them. When unable to solve the problems on their own, they will take the initiative to report the problems to supervisors for support and assistance. For supervisor-assigned tasks, they will do their best to get the job done. And they can consider all kinds of issues and policies from supervisors' perspectives. However, once disappointed with the supervisors or the company, this type of employee is very likely to be poached or to quit.

The above four types of employees exist in each company. Employee collaboration and execution affects production efficiency. Companies should pay more attention to the crisis-awareness type and the motivation-and-challenge type of employees because of their high working capability; if the companies can help those employees improve their drawbacks, they may obtain additional competitiveness. In our case company, most of the key users were the motivation-and-challenge type. Moreover, this study found that key users not only needed integration capabilities, but also needed power because they needed to allocate each task after they were informed of the business merger, and later follow up on the integration. This can only be achieved smoothly with some power.

(5) Difficulty in workflow

There were many workflow issues during the merger process. Each of the work tasks needed key users or people in charge to follow up on the implementation. Except for tasks that needed more time to complete, each specification should be confirmed and unified, which was the most difficult part of the workflow in our merger case.

When solving workflow issues, if supervisors find that the employees have complaints about some problems, they should help the employees solve the problems and reduce their difficulty in using the new tools. Implementing process management requires some skills. For example, when making a big change, departments that show the best execution and collaboration will be asked to conduct a trial. On the other hand, opinions from those departments will be considered seriously to make improvements. When these departments succeed in implementation, it is easier to persuade other departments.

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