

# IT APPLICATIONS IN PRODUCTION PLANNING AND CONTROL

## *A Survey of Medium Sized Business in German-speaking Europe*

Jakob Lewandowski, Matthias Buhl and Burkhard Kittl

*Institute for Production Engineering, Vienna University of Technology, Karlsplatz 13, 1040 Vienna, Austria*

**Keywords:** Enterprise Resource Planning (ERP), IT survey, Manufacturing Execution System (MES), Medium-sized business, Production Planning and Control.

**Abstract:** This paper addresses the use of IT-applications for production planning and control of medium-sized businesses in German-speaking Europe. The article summarises challenges today and expectations for the future. In particular, the kind of IT systems in use, experiences and satisfaction with IT support were key questions of the study. Basis of the research was a telephone survey with 150 IT managers of representative medium-sized enterprises in production, trade and service sectors.

## 1 INTRODUCTION

Production and therewith combined planning and controlling of resources are the core of every company in the manufacturing industry. Although most of the factories enforce development and adaptation of the technological processes, the capabilities of IT applications for organizing and handling the production process are still underestimated. Many troubles are arising out of linguistic barriers between suppliers/consultants and users. There is no obligatory nomenclature and the latest endeavours for standardisation are rarely used or even known by many users. This fact leads to misconceived coherences and in the worst case to prejudices regarding the qualities of IT systems.

Moreover, medium-sized enterprises don't have sufficient IT resources compared to bigger companies. For this segment the cost-benefit ratio of automating workflows in the production planning and control level often is not in evidence. Furthermore the mid-sized business is confronted with an unclear diversity of software applications for the production area.

The topic of IT applications in production planning and control has kept many developers and scientists busy for decades but it is more than ever relevant, because there is still no satisfying solution for bridging the divide between the shop floor and management. Even the great efforts of leading

business-software companies in the last years have only brought minor improvement. Getting a better insight into the use of and the opinions about IT solutions in the industry was the impulse to start a survey to collect useful information for further research projects.

## 2 APPROACH

The study consists of face-to-face and telephone interviews.

The subject of production planning and control is quite complex, so intensive preparation for the face-to-face interviews was indispensable. Almost half of the project time was spend on literature studies as well as developing and evaluating the questionnaire.

In the qualitative face-to-face interviews with twenty-two representative enterprises, the authors wanted to explore how comfortable the interview partners feel concerning terms and definitions in this topic. In order to get a proper data base additional telephone interviews with 150 IT managers were carried out. The point of interest was defined as systems in "Business Planning and Logistics" (layer 4) and the "Manufacturing Operations and Control" (layer 3) according to the ANSI/ISA-95 standard (Instrument Society of America, 2000).

## 2.1 Objectives

The basic objectives of the survey carried out in German-speaking regions were:

- Finding out the problems enterprises have in the area of production planning and control.
- Identifying and locating the use of IT solutions.
- Pin-pointing the prejudices and expectations concerning IT systems
- Assessing the experiences and best practices with enterprise resource planning (ERP) and manufacturing execution systems (MES).

## 2.2 Target Group

While the European German-speaking market is dominated by small to medium sized enterprises, the businesses size chosen for the survey ranged from 50 to 500 employees. The majority of the companies belonged to the continuous or discrete producing industry, but the trade and service sector was allowed also.

## 2.3 Survey Model

As a basis for the survey a theoretical framework was used. It combined the tasks and functions of the “Aachener model for production and control” (Schuh, 2006) with the structure of the ANSI-ISA95 standard (Instrument Society of America, 2000). In addition, a cross-check with further American and European literature like MESA (MESA, 1997) or the VDI-report (VDI, 2006) combined the particular advantages of each model. The functional hierarchy of the ANSI/ISA-95 standard is exposed in Figure 1.

The survey model consisted of three main parts. The first one gave a hierarchical structured overview of the functions in the production and control of the manufacturing industry. In the second part the functions of order processing were drawn in a task related flow-chart. The third part is a checklist referencing functions and processes for the face-to-face interviews in order to allow free conversation and obtain structured and comparable information at the same time.

## 3 RESULTS

The analysis of the collected data occurred on the basis of several key questions. First of all, what kind IT systems do medium-sized enterprises use at the

moment? Furthermore how satisfied are the companies with their applications? Positive and negative experiences and expectations essentially depend on the idea the enterprises have of concepts like enterprise resource planning or manufacturing execution systems. For this reason it was important to find out how conclusive these concepts are for companies. Another critical issue was to ascertain the challenges entrepreneurs are facing in the production area. Above all, how far should processes be automated respectively is it really desirable to have every process supported by an IT system in order to stay on a competitive basis?

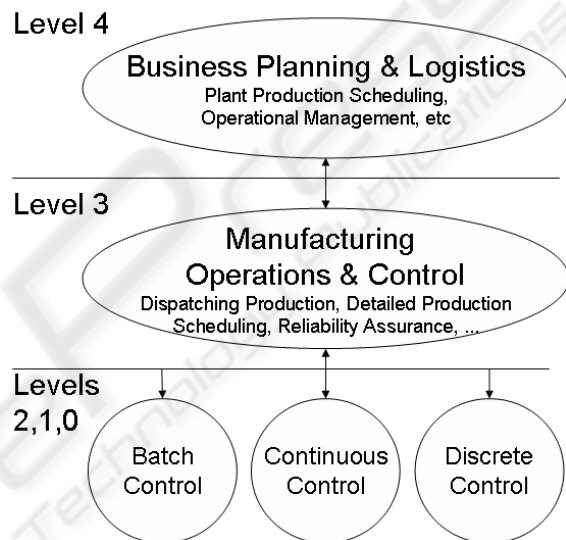


Figure 1: Functional hierarchy (Instrument Society of America, 2000).

### 3.1 Business Planning and Logistics

The first part of the results is primarily addressing Layer 4 of the ANSI/ISA-95 standard (“Business Planning and Logistics”). This is usually the domain of enterprise resource planning systems. To get a general idea of what kind of applications are in use, Table 1 reveals the size of enterprises as well as the type of ERP-system. The categories are standard software offered by global vendors, as well as standard software sold by regional vendors and individual software. The most remarkable point is that more than 50% of companies still have individual ERP-software in use, either as a stand-alone system or as an additional solution.

Concerning the age of the IT systems an important finding was that more than 20% of the analysed ERP-systems were older than 10 years. Due to this fact and the fact that the average age of the ERP-systems in use is approximately eight years

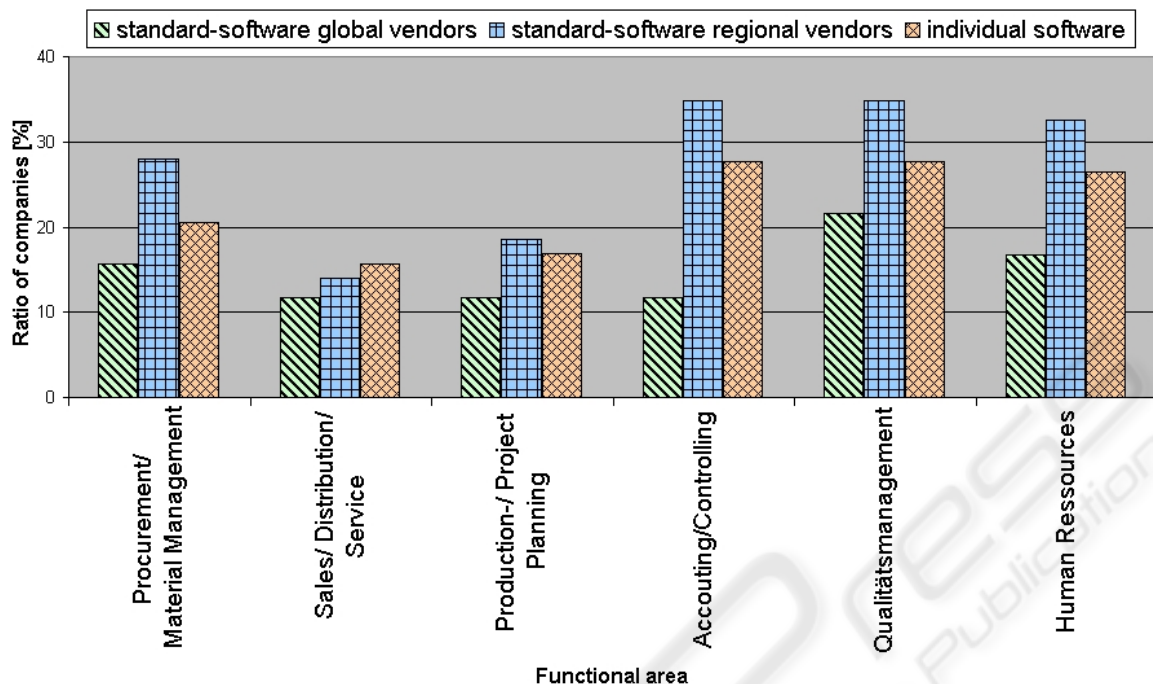


Figure 2: Companies where business processes run parallel to ERP-System (n=150, telephonic interviews).

the issue of individual software becomes more coherent.

Table 1: ERP-systems in use (n=150, telephone interviews).

	Employees			
	<100	101-250	251-500	Total
Standard software global vendors				
In use	60,5%	61,8%	87,5%	68,0%
Rollout	2,6%	2,9%	0,0%	2,0%
Planned	1,4%	0,0%	0,0%	0,7%
Nonexistent	35,5%	35,3%	12,5%	29,3%
Standard software regional vendors				
In use	30,3%	35,3%	20,0%	28,6%
Nonexistent	69,7%	64,7%	80,0%	71,3%
Individual software				
In use	63,2%	52,9%	42,5%	55,3%
Rollout	5,3	5,9%	0,0%	4,0%
Nonexistent	31,5	41,2%	57,5%	40,7%

A moderate enhancement was determined relating to the rollout time of ERP-systems. Compared with studies in the last decade, the time period decreased. Concerning the fields of application like material management or production planning, there was no significant difference between standard and individual software. Material management, procurement, sales as well as controlling and accounting were implemented by most of the

companies. Rare domains were production planning and quality management. The reason for this is the diversity of the manufacturing processes, even within an industry sector.

A conspicuous connection was detected between the type of ERP-system and the management of business processes. There were considerably less IT supported business processes running parallel to the ERP-system in companies using software by global vendors. It seems obvious that ERP-systems of leading vendors are employed more efficiently.

Table 2 contains a summary of the criterions leading to the decision for a certain ERP-system. The gist is that companies belonging to a concern or group usually have no bearing on decisions because most of these are predetermined. The second and third most relevant motives were flexibility and sectoral advantages. The fact that both consultancy and license fees are rated below three percent indicates that these costs are ranked as a non-determining factor regarding the total cost of ownership.

The information relating to how comfortable the medium-sized enterprises are with their IT systems can be regarded as inconspicuous, but even so significant. The data content of Table 3 gives an overview of the three groups of ERP-systems.

There was no difference in the degree of functional coverage as well as satisfaction between

companies with standard or individual software in use. The user driven margin that individual systems naturally should have is not recognizable.

Table 2: Criteria for selecting an ERP-System (n=150, telephone interviews).

	Employees			
	<100	101-250	251-500	Total
Concern-directive	23,7%	32,4%	37,5%	29,3%
No alternatives to specific ERP	6,6%	0,0%	7,5%	5,3%
Unknown reasons	4,0%	5,98%	2,5%	4,0%
Consultancy fees	2,6%	0,0%	2,5%	2,0%
Size of vendor	0,00%	5,9%	12,5%	4,7%
Global application of the specific ERP	10,5%	5,9%	7,5%	8,7%
System security	5,3%	5,9%	17,5%	8,7%
Vendor support	1,3%	2,9%	0,00%	1,3%
License fees	2,6%	0,0%	2,5%	2,0%
Sectoral advantage	19,7%	32,3%	12,5%	20,7%
Flexibility	13,1%	8,8%	20,0%	14,0%
N/a	18,4%	11,8%	0,0%	12,0%

Changing attitudes to IT support and the adaptation of business processes were detected. In the medium-sized businesses more than 27% of the companies using software by global vendors are outsourcing their IT support. Worthy of mention is that the smaller the amount of employees of a company is the more likely IT support is outsourced. Asked for satisfaction with external IT support in general the average evaluation number was 1,82 (1=excellent, 5=insufficient).

The way medium-sized enterprises saw expectations and requirements in the near future often depended on the management. In general, companies agreed to the statement: "The more business' processes are automated the bigger the benefit for the company". Furthermore, companies are poised to align business processes to save costs for customizing the IT system. These two findings were emanating from the telephone interviews as well as from the face-to-face-interviews. The

awareness of corporate responsibility for a successful IT implementation is obvious, the capability and benefits of ERP-systems are established. Basically there was a high degree of trust in ERP-systems.

Table 3: Functional coverage of and satisfaction with ERP-systems (n=150, telephone interviews).

	Standard software / global vendors	Standard software / sectoral vendors	Individual software
<b>Degree of functional coverage</b>			
Procurement / Material Management	91,3%	90,9%	91,0%
Sales/ Distribution/ Service	91,3%	90,4%	88,5%
Production-/ Project planning	90,3%	92,0%	92,0%
Controlling	93,5%	90,9%	91,8%
Quality Management	91,6%	91,6%	87,0%
Human Resources	92,7%	85,1%	90,4%
<b>Satisfaction (1=very satisfying, 5=unsatisfied)</b>			
Procurement / Material Management	1,8	1,5	1,8
Sales/ Distribution/ Service	1,8	1,6	1,9
Production-/ Project planning	1,7	1,8	1,9
Controlling	1,7	1,7	1,7
Quality Management	1,8	1,7	1,9
Human Resources	1,8	1,7	1,8

This confidence was reflected in the fact that calculating the return on investment very often is no issue to companies. They attach great importance to the factors, which are impossible to measure (e.g. transparency, communication, etc).

The expectations in the ERP-system itself rise after an adaptation phase, so long-term support is very important for the companies as well as the vendors. In most cases the area of material management indicates improvement very quickly. Users are noticing the limits of the ERP-systems in the area of manufacturing. Reported reasons are the

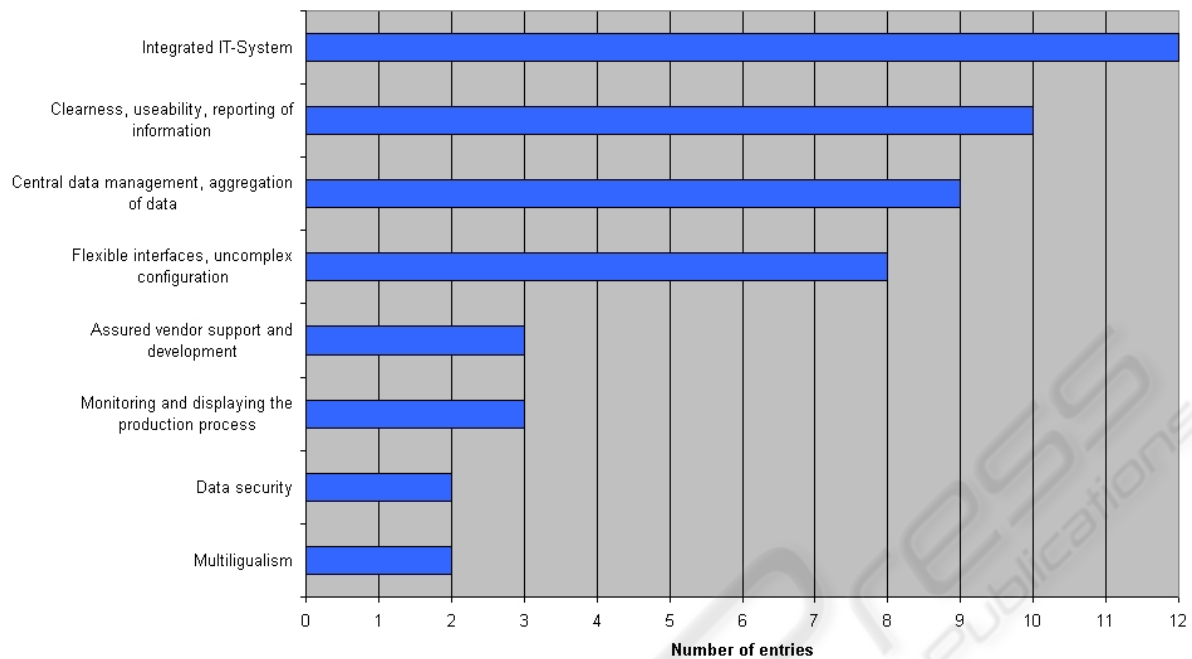


Figure 3: Requirements for IT software in the production area (n=22, face-to-face interviews).

inflexible structure of the ERP-systems, the unsatisfying reporting capabilities and unsolved problems with machine and control interfaces. In the face-to-face interviews it was found out that IT trainings often are not mandatory in order to reduce costs during the implementing phase. At least some of the companies came to the conclusion that these retrenchments have negative effects on the system operation.

Finally the most important, because most often mentioned demands on IT software from the survey are summarised in Figure . The first four positions in the bar chart are demands for one integrated system, simple usability, central data management and flexible interfaces. Additional needs were assured vendor support, as well as monitoring and displaying the production process.

In many companies management demands more key performance indicators, this naturally militates in favour of integrated IT system. As a closing insight, companies know that there is still potential within the ERP-sector, thus it is not remarkable that the IT budgets stay equal or will increase within the next 5 years.

### 3.2 Manufacturing Operations and Control

Compared to the layer of business planning and logistics, the IT systems used for the shop floor show a lower level of integration respectively are not existent. Whereas almost each business (97%) uses ERP-software and the majority even works with an integrated standard software tool (more than 80%), the situation of MES-software presents itself absolutely different.

The number of enterprises, which have a totally integrated IT System is limited to approximately 10%. Most of the questioned companies apply IT systems just for certain activities in their shop floor. They use a combination of standard software tools like quality- or scheduling-software (approx. 40%), individually developed software (30%) and MS Office products (30%). About 20% of the enterprises run the production area even without any IT system.

Remarkable is the fact that IT systems in use are quite old. More than half of the companies quote to work with software which is older than ten years. Moreover there has not been any rollout of an IT system at the questioned companies in layer 3 since 2005, and the satisfaction with the existing IT applications is quite positive (with an average of 1,4 using 1 as very satisfying and 5 as unsatisfying). The companies polled in the face-to-face interviews

didn't think it's necessary to exchange their current IT systems in the shop floor. Some of them had already started IT projects in the shop floor, which were cancelled later due to the confusing situation of available IT solutions and vendors on the market or not evident cost-benefit ratio.

A few enterprises try to fill the gap between the layer of business planning and logistics and the manufacturing operations and control by extending their existing ERP-system. But the majority thinks that the ERP-system is not flexible enough to cope with their requirements in the shop floor, which are:

- Clustering and analysing existent data.
- Decentralising know-how
- The need for traceability.
- The reduction of partial solutions and interfaces.
- Increased transparency.

The general requirements for IT software in the production area are shown in Figure . The main points deal with system integration and data management.

A lot of enterprises were not sure about the cost-benefit of an integrated MES solution, because there are only a few running reference systems. This could be the reason, why the integration of standard MES software is a low priority subject in many companies.

The possibility of expanding the ERP-software was more often considered by companies which are not so familiar with MES yet. Furthermore the number of employees is an indicator whether an enterprise is thinking about this alternative. The smaller a business is, the more it tries to avoid a second integrated system next to ERP. Usually the manpower of mid-sized businesses for implementation and service of a second IT system is insufficient. On the other hand there were a significant number of companies, who didn't believe that an extension of an integrated ERP system into the shop floor is possible. They pointed out that an ERP system is not able to cope with the requirements of the shop floor. In particular flexibility and planning intervals were mentioned.

Gathering and clustering data from the shop floor is a main topic in almost every enterprise. Most of the data is transferred in the direction from layer three to four. The opposite direction regarding order data is often realized by manual instructions or documents. Only few companies, who have already dealt intensely with the subject of MES, demand a bidirectional information flow.

Although most of the enterprises don't have an IT system for detailed scheduling, it is seen as a critical business process for the ability to respond to the market.

Another topic in the shop floor was traceability. Many companies are confronted with this subject due to legal obligations or product claims. In many cases the functionalities of ERP-solutions in this regard are not satisfying and systems without IT support are in use.

A lot of enterprises use specialised IT systems for particular functionalities in their production. The interfaces between these systems are a main, but unsolved problem. Attempts to solve this problem with Manufacturing Execution Systems were stopped, because the offered systems were not able to integrate the existing IT applications or programmable controllers satisfyingly.

Many enterprises were aware of the fact that the implementation of new systems has to go together with reengineering the processes.

Further chances of development were assigned to maintenance. This MES function turned out to be an exception, especially in the face-to-face interviews. More than 50% of end-users claimed that maintenance is a very important element but only a percentage under 10% declared to use a standard-software for planning and controlling the maintenance processes at all.

Compared to a study of Trovarit (Trovarit, 2004) the awareness level of MES has not changed significantly. More than half of the companies have not heard about MES yet. In particular enterprises with less than 350 employees usually don't know this term. Furthermore there is a relation between the date of rollout of the ERP system and the know-how of MES. Only companies, who had applied their ERP system more than 10 years ago, have dealt intensely with the topic, or even used an MES software.

## 4 CONCLUSIONS

In general the potential for further development in the field of production planning and -control is estimated very high. Almost each of the questioned companies quoted to struggle with one or more functions of this area. Up to the rough planning the enterprise resource planning systems got well established within the last decade. It emerged that when moving from planning to the control of the production process that the bigger part of the medium-sized enterprisers places emphasis on

individual software or “no software” solutions. Although there are many old systems in use the companies are highly satisfied and prefer solutions decoupled from the ERP-system. In particular the segments quality assurance and staff work time logging are concerned.

Based on the findings of this study, one may generally conclude that for the majority of the medium-sized companies in the production industry the term MES is largely unknown. Even if some enterprises are familiar with the definition of MES they are not able to distinguish the functional environments of a manufacturing execution system. The most criticised items headed by this group are the complexity of the MES-market, as well as the unfeasible commitments from software vendors.

Also remarkable for the authors was that no enterprise polled in the face-to-face interviews had implemented a new software-system within the last three years. The statement of uncertainty relating to new software was considerable. Companies doubt that implementation of new MES will bring more benefits. The case that positive references are missing has to be mentioned additionally at this point.

Production enterprises, having long lasting experience with ERP-system are more willing to evaluate functions in the area of MES. Their know-how in implementing and maintaining this standard-software system is instrumental in realising new IT systems.

In general there is an unexplainable gap between the demands and the willingness to invest in the shop floor. In other words enterprises agreed to the advantages of an automated workflow but almost none of the polled companies has an automated workflow established or is willing to provide the required resources.

Users that exhaust the functional limits of ERP-system in the production area are increasingly claiming for more flexibility and more transparency, attributes very often expected from MES software. In the first instance the fixed framework and the not available real-time data are criticised, a standardised bi-directional interface between ERP and control layer does not exist. A high potential is attributed to this unsolved section.

Looking into the future there is an irrepealable tendency to integrated systems. The majority of the medium-sized businesses prefer one fully integrated IT system as personal resources are regularly undersized. This fact offers a chance for ERP-systems. There is still an enormous potential for the development of ERP-systems in particular

concerning interfaces. These systems have to provide more and better connectivity in order to allow easy integration of satellite systems. All in all, companies are quite happy with their ERP-systems. In the sector of MES the request for one fully integrated IT system is more likely to meet the idea of an integration framework. Moreover enterprises are reluctant to substitute successful partial software solutions by a totally integrated MES. Together with the problem of low IT resources the step of exchanging the whole software landscape in the shop floor seems to be too risky for medium sized companies. But the integration of capsuled MES functions into a framework with the opportunity of step by step extension is a worthwhile alternative. Another benefit of an integration framework is that MES functionalities like maintenance can easily use existing functionality of the ERP system. Information about the production process or machine parameters are usually collected by several systems in the shop floor and the ERP. The job of the integrating framework is to allocate and analyse the information in order to provide it to a planning tool.

## 5 FUTURE RESEARCH

In a test facility different MES scenarios will be simulated. In one scenario it is planned to cover the functionalities of an MES by using an off-the-shelf MES product. In another scenario we are going to use an IT framework such as xMII for the integration of dedicated software tools like scheduler, shop floor data acquisition or tool management.

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