

Challenges to sustainable Manufacturing Resource Planning implementation in SMEs: An exploratory study

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Abstract For manufacturing SMEs, Manufacturing Resource Planning (MRP II) systems can offer a multitude of benefits, but equally the potential exists to negatively affect the firms. Research that has explicitly focused on the motivations individual firms have for implementation and the challenges that may be encountered is limited. This study provides a review of some commercially available MRP II systems suitable for manufacturing SME's, and a consideration of the implications of cloud-based and locally-hosted implementations. Through a series of director-level interviews this exploratory study of five Welsh manufacturing SMEs sought to understand their perceptions of MRP II, with a particular focus on the expected challenges for implementation and opportunities for improvements.

It is found that there is much demand for SMEs to implement MRP II, from which competitive advantage is expected. Furthermore, it is highlighted that managerial knowledge of MRP II systems is low, and there is an identified requirement for private and public sector training. In terms of implementation, an important gap in managerial knowledge of Business Process Reengineering is identified, hindering manufacturing SME managers in the design of processes that are amendable to application within the constraints of MRP II systems.

Keywords: MRP, MRP II, ERP, Business Processes, Sustainable Manufacturing

1. Introduction

In a drive for long term sustainability, SMEs are increasingly considering the implementation of Manufacturing Resourcing Planning (MRP II) systems, with both internal and external pressures motivating the change [1]. Supply chain

requirements (from entities both up- and down-stream), corporate requirements for increased productivity and profitability, and increased targeting of SMEs by system vendors all contribute to this increased motivation. Together with Enterprise Resource Planning (ERP), there has been a great deal of acceptance in larger enterprises, with focus now being placed on smaller and medium sized enterprises and how best to implement it [2]. Despite the acknowledged ability of MRP II to address the challenges associated with the fragmented nature of the existing inventory and production management [3], and the suitability for Business Process Re-engineering in rollout [4], issues still which arise during and after implementation. These issues contribute towards the debate within the academic and industrial communities concerning the suitability of MRP II for SMEs. This may be further exacerbated by a lack of understanding by SMEs of the capabilities of MRP II, and of the challenges which arise in rollout.

This paper specifically focuses upon SMEs based in Wales and their motivations and experiences of implementing ERP/MRP II. Whilst there is much research exploring the concept of MRP II in SME's, there is comparatively little empirical research exploring the expectations of firms from MRP II, and consideration of the enablers and inhibitors for these businesses. Two research questions are tackled:

1. What are the motivations for the implementation of MRP II/ERP in SME's?
2. What are the challenges (perceived or realized) arising from the implementation of MRP II/ERP in SME's?

2. Research Method

In this exploratory study an inductive approach is taken, which motivates the use of research instruments capable of achieving principally qualitative data. Qualitative research is particularly appropriate where the researcher aims to understand the meaning that research participants give to events and situations, and to appreciate the context in which these are made [5]. Five semi-structured interviews (table 1) were conducted with managerial respondents in several sectors of Welsh manufacturing industry. This approach allows the respondent to talk about the topic within their own frame of reference, using ideas and concepts with which they are familiar [6]. Compared to survey methods, interviews are identified as achieving higher levels of participation from managerial respondents, since they allow the respondent to understand how their information will be used (addressing trust issues), and also negates the effort associated with writing (for example in the response to a survey) [7]. A coding schema for the interviews was developed, and the results used as a principal contributor to the research objectives of this paper.

Table 1: Summary of interviews conducted

Company	Industry Sector	Respondent(s)	Size
A	Life Science	R&D Manager	Medium (≥ 250 employees)
B	Life Science	Production Manager	Medium (≥ 250 employees)
G	Electronics	Technical Manager	Small (≥ 50 employees)
D	Engineering	Operations Director	Small (≥ 50 employees)
E	Engineering	Change Manager	Small (≥ 50 employees)

3. Development of MRP, MRP II and ERP

The term 'MRP' refers to Material Requirements Planning, and is concerned with the coordination of the entire manufacturing production. Each subsystem of MRP is unified, forming as one single subsystem which feeds into procurement, inventory, production, sales, finance and engineering technology [8]. Initially developed in the 1960's [9], MRP was commonly adopted by manufacturers for inventory order planning. Whilst MRP systems manage planning and control of production, MRP II further combines operations, finance and production management subsystem in order to form the manufacturing resource planning [10, 11].

Kurbel [12] notes that many current ERP systems originate from earlier incarnations as MRP II systems, which combined with the diverse range of business requirements each implementing company imposes on suppliers, has led to the development of a large number of commercially available ERP systems. However, despite the prevalence of a range of systems, the \$24.5B worldwide ERP market is dominated by five principal suppliers [13]: SAP (www.sap.com) 25%, Oracle (www.oracle.com), 13%, Sage (www.sage.com), 6%, Info (www.infor.com) 6%, and Microsoft (www.microsoft.com) 5%.

The focus of much literature on ERP (rather than MRP II solutions) is understandable given the increased overall capabilities of ERP systems, and their suitability for both manufacturing and non-manufacturing applications. However, for many SME manufacturers ERP solutions provide unnecessary functionality which incurs cost in purchase, configuration, and ongoing support. In addition to this some ERP systems, in particular open source ones, are targeted towards non-manufacturing businesses [14] Whilst it is a fallacy to assume that all SMEs are unable to finance sophisticated computer systems, cost is often a critical factor in considering system choice. Perhaps equally important is the recognition that SMEs often do not have in-house capabilities for selection, installation, and configuration of MRP II Systems. In Table 2 a literature synthesis highlights some of the principal advantages and disadvantages for choosing a cloud based implementation over a locally hosted solution, and Table 3 provides an overview of some of the principal MRP II systems suitable for manufacturing SMEs, ordered in terms of increasing sophistication.

Table 2: Perceived advantages and disadvantages of cloud-based MRP II/ERP
 (Adapted from [15-17])

	Perceived Advantages	Perceived Disadvantages
Financial	Reduced initial capital expenditure	Ongoing subscription costs may cost more in long-term
	Predictable subscription fees	
	Lessened overall costs	
Performance	Improved productivity	Service Level Agreement issues
	Improved customer service	Performance risks
	Vendor managed upgrades without service interruption	Challenging to audit
	Improved accessibility	
	Faster deployment	
Security	Improved disaster recovery	Access control
	Eliminates backup requirements	Data security
		System management made more difficult
		Susceptible to network attack
Strategic	Scalable system	Risk of service loss through failure of vendor
	Allows SME to focus on core competence	Compliance risks
	Integration with other cloud services	Loss of control
Technical	Elimination of internal IT requirement	Reliance on fast reliable internet connection
	Elimination of internal development team requirement	Heightened risk of server stress and network congestion
	Access to latest technology	
	Availability of support	
	Improved system availability	

Table 3: Summary of costs and features of some systems suitable for SMEs

Metric	Exact JobBOSS	Opentaps (Configurable)	123insight	Lakeview ERP	Eci M1	Winman ERP	SAGE 200 Manufacturing
Software Cost (based on 10 users)	£18,750	Depends on configuration Likely £10K	£5.6K £894 monthly fee	£18K	£20K (including installation)	22K	£44K
Maintenance Costs	£3750	Negotiable fees	Covered by monthly fee	£4K	£2351	£4K	£6K p/a
Standard Modules/Features	Fixed core modules based around job-shop requirements	Configurable as required	One core module covering main manufacturing features. Optional CRM package	Nominal Ledger Accounts Payable Stock Control Purchase Order Processing Sales Order Processing Sales Invoicing Credit Control Bill of Materials Batch & Serial Number Tracking	Accounts CRM Quotations/Orders Scheduler Resource Inventory Shipping Quality Payroll	Not modular except customer/supplier portals and eCommerce	Manufacturing Financials Business Intelligence Workspaces CRM Commercials
Allocation of cost centre's	Basic	Yes configurable	Yes	Yes	Yes	Yes	Yes
Batch number and serials module	Yes	Yes configurable	Yes	Yes	Yes	Yes	Yes
BOMS	BOMs as standard in core system	Yes configurable	Yes	BoM's as standard in core system	Yes	99 levels	BoM's as standard in core system BOM Versioning
Foreign currency transactions	US Dollars GBP & Euros	Yes configurable	Yes	All currencies supported	Yes	All currencies supported	All currencies supported
Local/Hosted Deployment	Local	Normally Hosted	Local	Both	Both	Local	Both
System requirements	SQL Server	SQL Server	SQL Server	SQL Server	SQL Server	SQL Server	SQL Server

4. Results

The interview respondents were from the Life Science, Electronics and Engineering manufacturing sectors (Table 4) and consisted of 2 medium sized (up to 250 employees) and 3 small sized (up to 50 employees) manufacturing companies. Four of the five companies interviewed had experience of implementing and/or using MRP II/ERP systems, whilst company E was planning to introduce a system. None of the SMEs were using an advanced system such as SAP (Table 4). Companies A and B were using commercially available systems (CAS) whilst the remaining 3 SMEs had "Other" systems. For example, E was using a combination of Sage 50 and Microsoft Excel for inventory control and production planning. This is in agreement with the work of Buonanno, Faverio [18] who found that the rate of MRP II/ERP system adoption amongst micro and small enterprises was low. The adoption of MRP II/ERP systems by the two medium sized firms surveyed supports the view of Howard and Hine [19] that as manufacturing SMEs grow in size their need to plan and co-ordinate their operational activities increases.

If this preliminary study is representative of the wider situation with Welsh SMEs, it implies that the majority may not have adopted bespoke commercially available MRP II/ERP systems but are using "other" systems; these have been described by previous authors as "legacy" systems [e.g. 20]

Table 4: Company size, system and pre-implementation expertise level

Company	Sector	Size	Type of System	Pre-implementation Level of expertise in MRP II/ERP
A	Life Science	Medium	CAS	Novice
B	Life Science	Medium	CAS	Novice
C	Electronics	Small	Other	Intermediate
D	Engineering	Small	Other	Intermediate
E	Engineering	Small	Other	Novice

Barriers to SMEs implementing MRP II/ERP systems

The barriers to SMES implementing MRP II/ERP systems have been discussed in the literature [e.g. 21] and include: cost of implementation [22] the need for business process reengineering (BPRE) [9, 23] length and complexity of implementation [24] and employees adjusting to working in new systems [25]. However, the respondents all felt that MRP II/ERP systems were needed by SMEs despite the pitfalls. One new feature of this study was that data regarding the pre-implementation level of knowledge regarding MRP II/ERP systems amongst the respondents was collected. All the respondents graded their pre-implementation knowledge as novice or intermediate. Respondent A commented that there was a lack of concise literature about MRP II/ERP systems aimed at managers of SMEs.

If the results of this preliminary investigation are representative of Welsh SMEs, there appears to be a demand for greater knowledge of MRP II/ERP systems so that managers have improved levels of understanding prior to procuring and implementing them. This could be achieved in a number of ways including workshops and /or focus groups. If local and national governments want to encourage an increase in sustainable MRP II/ERP adoption amongst SMEs they could consider funding and/or supporting such activities.

SMEs Expectations of MRP II/ERP systems

The results of the preliminary study revealed that all five companies expected to gain advantages from implementing a system (Table 5) but the types of predicted advantages varied between respondents. All 5 respondents expected systems to deliver enhanced control of inventory and 4 respondents improved levels of production planning. This appears to be a realistic expectation as Adam and O'Doherty [24] state that optimization of inventory control and order acquisition and processing is a key benefit of ERP. Three of the five respondents expected the systems to deliver integration of activities across different areas of the business (e.g. Purchasing, Production and Customer Service) and this is in agreement with Esteves [20]. Only 2 respondents expected the system to deliver future growth of the business, which is an interesting result as the use of MRP II/ERP has been shown to deliver improvements in areas such as productivity and inventory control which are all factors in business growth [26]. Respondent E was the only one to expect a reduction in human errors as an advantage and respondent A felt that systems were sometimes seen as a panacea for solving all the challenges experienced by SMEs. This indicates that some expectations SMEs have of the benefits of MRP II/ERP may be unrealistic. In a study of Italian SMEs [21] found that the most frequently observed benefits of MRP II/ERP adoption were internal procedure simplification, enhanced information retrieval, improved performance management and some production efficiency increases.

Table 5: Respondents Pre-implementation expectations of advantages of ERP systems

Advantage	A	B	C	D	E
Increased Productivity				✓	✓
Future Growth		✓			✓
Reduce Human errors					✓
Integration	✓	✓			✓
Inventory Control	✓	✓	✓	✓	✓
Production Planning	✓	✓	✓	✓	
Solution to all problems	✓				

Implementation Challenges for SMEs

The interviewees' responses on anticipated challenges associated with MRP II/ERP implementation are collated in Table 6. Four companies gave changing working practices as a challenge as well as adjusting to working in "real time". This is because it is documented that MRP II/ERP implementation usually requires business process re-engineering (BPPE) [9, 23] and this can be challenging both operationally and culturally to the organization [27]. One advantage of ERP systems that is very popular with senior managers is the availability of up to date information and reports. However, ERP systems can only deliver this if all the employees are trained and empowered to carry out transactions as soon as tasks are completed resulting in data of high quality. Several of the respondents said they would welcome training or workshops on BPPE and felt that this could assist them in implementing and maintaining MRP II/ERP systems.

Table 6: Anticipated Challenges for SMEs implementing MRP II/ERP systems

Challenge	A	B	C	D	E
Resources required	✓	✓			✓
Changing working practices	✓	✓		✓	✓
Extra investment required	✓	✓			
Greater risk	✓				
Increased training and development of workforce			✓	✓	✓
Challenge of working in real time	✓	✓		✓	✓

Three of the respondents saw finding extra human resources as a challenge for MRP II/ERP implementation. Adopting MRP II/ERP often requires the organization to form a cross-functional team, who has to spend a considerable amount of their time working on the project. This means they either have a greatly increased workload during the implementation or other employees have to temporarily take on their roles. The majority of SMEs have a lack of human resources and so this can be a significant challenge for them to address [28, 29]. All 3 of the respondents from the small SMEs thought that the need for increased training and development (T&D) of employees would also be a challenge. This could be for a number of reasons including: difficulties with finding time for T&D in general, availability of finance [30]organizational culture barriers to T&D (Lange, *et.al.*,2000), or access to T&D [31]. This area could be further investigated in a wider study of Welsh SMEs. Respondent A was the only one to mention "Increased Risk" as an implementation challenge. There are several case studies where organizations have experienced difficulties or even company failures following MRP II/ERP adoptions [27, 32] and it is prudent for SMEs planning implementations to be aware of these.

The results of this study highlights the question that if SMEs are aware of the predicted challenges of implementing MRP II/ERP systems, can they use a

combination of planning, training and risk analysis to effect more efficient adoptions of such technologies?

This was partially answered by examining the responses to asking the companies what were the most important issues for SMEs to consider before implementing a system.

Pre-implementation Issues

The interviewees' responses to important issues for SMEs to consider prior to implementing an MRP II/ERP system are shown in Table 7.

Table 7: Important issues for SMES to consider pre-implementation

Issue	A	B	C	D	E
Contingency Planning			✓		
Operations Management training	✓				✓
Business Process Engineering training	✓			✓	✓
Dedicated Superuser to run the system	✓	✓	✓		✓
Awareness of total costs				✓	
Recognition for employees taking on additional responsibilities	✓				
Changes in roles and responsibilities	✓				
Ability to update the system in "real time"	✓	✓		✓	✓
Training in the system			✓	✓	

Four of the five companies thought that a dedicated "Superuser" to run the system and provide assistance to other users would assist in a successful implementation. Super users (one or more individuals trained to an expert level) have been shown to play a critical role in larger companies during their implementation and deployment of new ERP systems ([33]. Clearly the SMEs would need access to appropriate training for the superuser(s) in order to benefit from this improvement. Currently, there does not appear to be government funding for SMEs to train ERP superusers and so this could be an opportunity for improvement. Respondents A, B, D & E all felt that employees' ability to keep the information in the system updated in "real time" was also of crucial importance. This also appears to be a T&D issue, where individual workers need to be confident and empowered to enter data into the system as they complete tasks. Several of the respondents acknowledged that if this doesn't happen the company can't take fully leverage the advantages of the system. Three of the companies thought that training in BPPE would be of assistance and two of those thought that training in Operations Management would also have a positive effect. Overall, all of the issues collected in this section could be covered under the umbrella of planning, risk analysis and T&D and indicates that this could assist SMEs to fully harvest the benefits of

successful, sustainable ERP implementations. This is in agreement with the work of Besson [34] who discussed whether the failure of some ERP implementation projects was due to a lack of planning by managers.

One solution to a number of these issues would be to form a focus group of SMEs which could identify best practice for manufacturing companies implementing systems and ideally construct a procurement and implementation road map to follow.

5. Conclusions

This exploratory study of 5 Welsh SMEs indicated that despite the well documented barriers, there is demand for companies to implement and maintain MRP II/ERP systems and they expect to gain competitive advantages from doing so.

The results show that whilst the 2 medium sized manufacturing companies had adopted bespoke commercially available systems, the 3 small firms were using legacy systems. One new finding of the study was that respondents' level of knowledge of ERP systems prior to implementation was only novice or intermediate and they would welcome workshops or focus groups to increase this. Access to government funding to train superusers would be an opportunity to assist SMEs in raising their level of expertise of procuring and implementing ERP systems. The SMEs also felt that companies planning to implement systems could benefit from training in BPPE. Formation of a focus group of SMEs could assist in constructing a roadmap for MRP II/ERP for other companies to follow.

Governments could assist SMEs in procuring, adopting and maintaining sustainable MRP II/ERP systems by providing funding and support for training superusers and forming focus groups. This was an exploratory study of 5 Welsh SMEs and a wider study is planned to gather additional data to see if these results are representative of Welsh manufacturing firms.

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