Factors Influencing the Stage of MRP Implementation: An Empirical Study

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Abstract

This study aims at exploring the critical factors influencing the stage of implementation of materials requirements planning (MRP) in the Egyptian Industrial Sector. While the literature shows almost general agreement on the implementation process of MRP, few empirical studies exist to explore the critical factors affecting the level of MRP implementation. This study differs from previous investigations of the stage of MRP implementation in two main ways: in dealing with MRP implementation stage in a developing nation i.e. Egypt (the previous studies were undertaken in developed countries), and in having a wider coverage of critical factors affecting the level of MRP implementation. Questionnaire has been designed to collect data from production managers and materials managers in Egyptian manufacturing companies. The major findings of this research indicate that the organizational willingness to change is positively associated with the stage of MRP implementation achieved. The study also has found out that there is no relationship between vendor support and a more advanced stage of MRP implementation. There is also a significant relationship between the level of bill-of-materials (BOM) and the need and opportunity of the implementation of advanced stage of MRP. Valuable implications can be drawn for practitioners to carry out relevant changes as a consequence of the successful implementation of advanced level of MRP.

Key words: MRP, Manufacturing Methods, Implementation Level, Marketing Strategy, Egypt.

Introduction

Egypt like most Less Developed Countries (LDCs) strives to diagnose and find solutions for the rigorous problems, at both national and operational levels, that hinder the growth and development of its industrial sector. At national level, the Egyptian manufacturing firms just like their peers, whether in developed or less developed countries, face the pressure of time-based competition, the spread of information and communication technologies within organizations (Caridi & Cigolini, 2002), the speed of delivery required by customers (Browne *et al*., 1996), and the increase of product diversity (Slack, et al.,1998), while at operational level, they are suffering from high scrap, loosing market share, high levels of inventory, and poor quality in products and labor (Salaheldin & Francis, 1998).

Studies have shown that successful implementation of advanced level[2] of MRP[3] can help manufacturers to alleviate many of the obstructions mentioned above (Porter et al., 1996, Braglia & Petroni, 1999, Kumar & Meade, 2002, and Petroni, 2002). In response, many manufacturing companies, in both developed or less developed countries such as Egypt, have devoted a notice-

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[2] The term "level or stage" is used to rate the MRP system with A through D classification scheme suggested by Wight (1977). Whereas Class D indicates that MRP company have not achieved even the lower advanced stage of MRP implementation, they had only passed the adoption stage, while Class A indicates that MRP company has achieved the higher advanced stage of MRP implementation.

[3] The term "MRP" is used in this study to include all versions of MRP systems (i.e. Material Requirements Planning (MRP I), Closed-loop MRP, and Manufacturing Resource Planning (MRP II)) because the only concern here is with its effectiveness as in Schroeder et al. (1981); Duchessi et al. (1988); Sum and Yang (1993); Sum et al. (1995); Braglia and Petroni (1999); Petroni and Rizzi (2001).

able amount of recourses to implement different levels of MRP systems, so as to dampen the uncertainty coming from market-related variance.

However, a review of relevant literature indicates that there has been very little research conducted, and little attention paid to the critical factors that affect the successful implementation of advanced level of MRP such as top management support, organizational arrangements, the previous experience with automated information systems and vendors support (Salaheldin & Francis, 1998, Petroni, 2002, and Caridi & Cigolini, 2002). Furthermore, it was found that few studies on factors influencing the level of MRP implementation are empirical based (Cooper & Zmud, 1989 and Burns et al., 1991). In view of that, the current research aims to fill empirically the gaps mentioned above and broadening the scope of local research and directing greater attention from the practitioners towards the issues under investigation.

Background

Research has shown that successful implementation of MRP can bring significant benefits to manufacturers, namely: improving product quality, reducing lead times, reducing overtime, scrap reduction, reducing safety stock, improving productivity, increasing throughput, better cost estimation, minimizing work-in-process (WIP), and better production scheduling (Salaheldin & Francis, 1998; Koh et al., 2000; and Petroni, 2002). For that reason, most manufacturing companies, in recent years, have implemented, are implementing or are considering the implementation of the highest advanced stage of MRP systems (Caridi & Cigolini, 2002).

Anderson et al. (1982) indicated that the user class (D, C, B & A) is used to determine the stage of development of MRP system within manufacturing companies. Furthermore, Cooper & Zmud (1989) concluded that the user class can be used to indicate the extent of MRP infusion within manufacturing companies. Companies with Class D MRP have not attained even low- advanced stage of implementation, they have passed only the adoption stage and are in process of the adaptation stage to join Class C users. Companies with Class C have achieved the lowest advanced stage of MRP implementation; companies with Class B indicate that they have received the moderate advanced level of MRP implementation, while companies with Class A refer that they have achieved the highest advanced level of MRP implementation.

But the literature review reveals that few efforts have been made to investigate the level of MRP implementation and correlate factors with the stage of MRP implementation. Cooper & Zmud (1989) had conducted a survey concerning MRP infusion on 62 manufacturing companies in the US (only 39 of them had implemented MRP systems). They had concluded that there is a strong relationship between the marketing strategy, manufacturing method, production complexity, inventory item dependence and the stage of MRP implementation. Burns *et al*. (1991) had conducted a survey on 502 manufacturing companies in the US (only 238 of them had implemented MRP systems). They reported that there are associations among the environmental & organisational factors and the benefits obtained from MRP implementation weighted by the respondent's expectations and the stage of MRP implementation.

Moreover, Sum & Yang (1993, 1995) and Braglia & Petroni (1999) indicated that there is a positive relationship between the company size & age and the stage of MRP implementation. Duchessi *et al*. (1988) reported in their study that there is a relationship between the organizational climate such as management style (participative or authoritarian) and the stage of new technology implementation such as MRP by manufacturing companies. Research by Petroni (2002) has investigated the critical factors affecting MRP implementation in Italian small & medium sized firms. Furthermore, they have concluded that there is a strong relationship between the stage of MRP implementation and management support. Likewise, Petroni & Rizzi (2002) and Caridi & Cigolini (2002) indicated that the organizational climate is considered to be driving force toward the implementation of the highest level of MRP. Works by Duchessi *et al.* (1988, 1989); Turnipseed et al. (1992)., and Petroni (2002) have identified several human aspects such as user education and training that may affect the stage of MRP implementation in manufacturing firms.

As a result, the problem dealt with this research concerns the level of MRP implementation in manufacturing firms in the Egyptian industrial sector.

Statement of the Problem

The literature review reveals that there are two main gaps that need to be empirically investigated. These are as follows:

(1) No previous empirical study has tried to investigate the critical factors influencing the stage of MRP in the Arab world countries such as Egypt, and (2) No previous study has tried to investigate statistically the relationship between vendors support & marketing strategy and the stage of MRP implementation.

Importance and Objectives

To date, there exists no detailed research that provides MRP users with guidance that identifies the critical determinant variables affecting the stage of MRP implementation within manufacturing companies. Exploration of the issues proposed here should contribute significantly to a better understanding the crucial factors that play an important role in manufacturing firms motivational processes in implementing advanced level of MRP system. In addition, the current study is the fourth in a series planned to investigate the implementation of innovative manufacturing tools and philosophies in the Egyptian industrial sector[1]. Moreover, this study derives its importance from its objectives:

1. To discern the level of MRP implementation based on the viewpoint of the Egyptian manufacturing firms.

2. To explore the critical factors affecting the stage of MRP implementation in the Egyptian manufacturing companies.

Research Questions

To fulfill the objectives of this investigation answers to two central questions were sought. These questions are:

1. What are the levels of MRP implementation in the Egyptian manufacturing firms?
2. What are the most critical factors affecting the stage of MRP implementation in the Egyptian manufacturing firms?

Study Methodology

Construction of the Questionnaire

The mail survey ***Questionnaire*** was constructed based on four successful studies previously conducted in related fields of study i.e. Laforge & Sturr (1986), Cooper & Zmud (1989), Burns et al. (1991), and Braglia & Petroni (1999). The modifications made to these studies were determined by the researcher's own knowledge on conditions of the Egyptian industrial sector situation and the theoretical issues discussed previously and by undertaking a pilot study.

Validity of the Questionnaire

Having established an approximate schedule of questions relevant to the issues under investigation in the current study i.e. the critical factors influencing the level of MRP implementation in the Egyptian manufacturing companies. It was decided to conduct a pilot study in order to obtain more complete information for the hypotheses and make the preliminary version of the questionnaire valid. Therefore, a round table meeting was organized with eight production & mate-

[1] The first is: A Study on MRP Practices in Egyptian Manufacturing Companies, International Journal of Operations/Production Management, Vol 18.No 5,6. pp:588:611. (1998).
The second is: TQM Strategy Implementation in Egypt: A Field - Force Analysis, The TQM Magazine, Vol 15 .No 4. (2003).
The third is: JIT Implementation in Egyptian Manufacturing Firms: Some Empirical Evidence, International Journal of Operations/Production Management (forthcoming).

rials managers directly responsible for MRP implementation within their manufacturing firms (as in Petroni & Rizzi, 2001).

The managers were asked to identify, based on their experience, those questions which they felt were irrelevant and to determine if they could disclose all of the information asked for in the questionnaire. After the comments and suggestions of the panel were reviewed, the survey instrument was slightly modified. The questionnaire was again pretested by a small convenience sample of firms. Questionnaires were provided in Arabic language where Arabic is the main language. The Arabic version was translated from English and then back-translated to ensure equivalency.

Respondents were asked to gauge the extent to which they agreed with any of the several statements regarding the critical factors affecting the stage of MRP implementation. Specifically, the instrument was closely tied up with the purpose of research, to address the research hypotheses and to provide data for testing. The items were written to operationalize the six main factors influencing the stage of MRP implementation i.e. (1) management support, (2) manufacturing methods & marketing strategy, (3) organizational climate, (4) vendor support, (5) the previous experience with automated information systems, and (6) company size & age.

Sample

The mail survey was sent to approximately 200 ex-public (holding) manufacturing firms in Egypt. Firms of the sample were randomly selected from a list of all manufacturers in the Egyptian ex-public industrial sector[1]. The target respondent in each company was the production manager or materials manager. Care was taken to include all MRP and non-MRP firms in the sample. Usable responses of 92 obtained resulted in a response rate of 46% (Table 1). This rate was found to be similar to the previous studies reported in the literature (Cooper & Zmud, 1989, and Burns *et al.,* 1991). The final usable sample was broken into manufacturing firms that have implemented MRP systems (51) and manufacturing firms that are considering MRP implementation (41).

Table 1

Survey Responses Rate

Mailing list	200
Total responses	95
Unusable responses	3*
Final usable responses	92
Response rate as percentage of mailing list	46%

*Three questionnaires are unusable because they are with a high proportion of missing values.

Hypotheses

In pursuit of the aim of this paper, our methodological approach is based on testing hypotheses, taken from the literature sources and which are presented so that reflect the hypothesized relationships.

Hypothesis -1- supposes that "the more the management support is, the more advanced the stage of MRP implementation" appears to be.

Hypothesis -2- suggests that "a more advanced level of MRP implementation is likely to occur with continuous (assembly, repetitive) manufacturing methods opposed to intermittent (job shop) methods, make to order strategy opposed to make to stock strategy".

Hypothesis -3- supposes that "there is a relationship between the organisational climate such as management style (participative or authoritative), communications (top-down or bottom-up) and the stage of MRP implementation".

[1] Firms were identified from two sources: the General Organization for Industrialization (GOFI) of Egypt and the Egyptian Industrial Chambers.

Hypothesis -4- suggests that "the more the vendor support is, the more advanced the stage of MRP implementation" is.

Hypothesis -5- supposes that "the more the experience with the automated information systems is, the more advanced the stage of MRP implementation"is.

Hypothesis - 6 - suggested that "larger and older Egyptian manufacturing companies would have a highest advanced stage of MRP implementation".

Data Analysis Methods

Once the data had been gathered and categorized, three statistical techniques were used to test the suggested relationships between the stage of MRP implementation and its determinants:

The Contingency Coefficient is employed to measure the strength of the association between the independent nominal variables and the dependent nominal variables. It's calculated from the **Chi-square** statistic by using the following equation:

Equation 1. The Coefficient of Contingency

$$C = \sqrt{\frac{X^2}{X^2 + N}}, \tag{1}$$

where $\mathbf{X^2}$ is the Chi-square test. **N** is the sample size.

- The Mantel-Haenszel **Chi-square** technique is used to evaluate the null hypothesis of independence between two variables when one of both is ordinal and the other is nominal. This test is based on the Person correlation, ***r*** commonly used. It has the following formula:

Equation 2. The Mantel- Haenszel Test for Linear Association

$$M^2 = (n-1)r^2, \tag{2}$$

where *n* is the sample size, *r* is the strength of correlation between the two variables based on Person correlation.

- The Logistic Regression Model (Logit) is used to measure the relationship between two dichotomous variables. The logistic model has the form:

Equation 3. Logistic Regression Model (Curve Estimation)

$$Y = 1/(1/u + b0 * b1 ** X), \tag{3}$$

where ***X*** is the specified independent variable affecting the stage of MRP implementation; ***Y*** is MRP implementation stage; ***u*** is the population mean; ***b*** is the regression coefficient or amount that ***Y*** varies, on the average, with change of one unit of ***X***.

Data Analysis

Industry and MRP Users Classification

Table 2 shows how the MRP users in the Egyptian industrial sector classified themselves using the Class A-B-C-D system.

Table 2 indicates that 49.0% of MRP companies claimed to be Class C users which means that they use MRP system as an order launching system to managing inventory, but do not include the use of feedback for the readjustment of orders in response to actual performance, while 43.2% of MRP companies reporting MRP usage identify themselves as a Class B users, namely, they use MRP system as a Closed-loop MRP system for production operations control, for vendor follow-up system, and for detailed capacity requirements planning (Davis et al., 2003). To a large extent, these findings are similar to the findings of Kumar & Meade (2002) study, especially for using MRP as a valid tool for production planning and control.

Table 2

Industry and MRP Users Classification

Industry	Number of Companies	% of Total	Reorder Point	MRP Classification D	C	B	A
Textiles	19	20.7	11	1	5	2	0
Mining and petroleum industries	6	6.5	3	0	2	1	0
Drink and tobacco	3	3.3	3	0	0	0	0
Engineering & electronic	29	31.9	4	1	11	13	0
Garments	0	0.0	0	0	0	0	0
Chemicals	20	21.9	9	1	7	3	0
Leather	0	0.0	0	0	0	0	0
Wood	0	0.0	0	0	0	0	0
Food industries	10	10.9	6	1	0	3	0
Paper	3	3.3	3	0	0	0	0
Printing	0	0.0	0	0	0	0	0
Plastics	2	2.1	2	0	0	0	0
Total	92	100.0	41	4	25	22	0
	Percent of Total	100.0	44.6	4.3	27.2	23.9	0.0
	Percent Considering only MRP			7.8	49.0	43.2	0.0

Furthermore, it indicates that no MRP companies in Egypt claimed to be Class A users. This result can be interpreted in the light of the fact that a manufacturing company needs the longer experience with MRP implementation in order to be Class A user, while the Egyptian users are still relativel beginners. In this occasion Voss (1986) said that manufacturing companies need ten years to learn how to implement MRP systems.

In addition, Table 2 indicates that the engineering & electronic industries have achieved the highest level of MRP implementation among the Egyptian industries. 11 out of 25 MRP companies with Class C and 13 out of 22 MRP companies with Class B are engineering & electronic companies. The previous result is consistent with Cooper & Zmud (1989) study, concerning MRP infusion within the US companies. The study found that 12 out of 37 MRP users with Classes C & B are electronic companies. The foregoing analysis provides a strong evidence that MRP systems is more developed in the engineering & electronics industries than in the other industries.

For comparative purposes, our findings are displayed alongside the findings of Cooper & Zmud study and Laforge & Sturr study, as illustrated in Table 3 below.

Table 3

MRP Classification Percentages of the Sample Firms

User class	Current Study		Cooper & Zmud Study		Laforge & Sturr Study	
	N	%	N	%	N	%
Class A	0	0.0	1	2.4	25	25.0
Class B	22	43.8	12	28.5	31	31.0
Class C	25	47.9	24	57.0	41	41.0
Class D	4	8.3	5	12.0	3	3.0
Total	51	100.0	42	100.0	100	100.0

Table 3 indicates that a majority of MRP companies classified themselves as either Class B or Class C MRP users in the three studies. 91.7% out of the MRP companies in the current study, classi-

fied their system as either Class B or C. By comparison, 85.5% of the Cooper & Zmud sample claimed to be Class B or Class C MRP users, in contrast, 72.0% of MRP companies of the Laforge & Sturr sample reported themselves to be Class B or Class C MRP users. This result clarifies that MRP companies in Egypt and in the US are to some extent similar in relation to the stage of MRP implementation.

MRP Implementation Stage and Management Support

It was suggested that there is a relationship between the organisational support (measured by the organisational willingness to change and lack of top management support) & the formal arrangements (measured by the responsibility of MRP project manager and organisational arrangements) and the stage of MRP implementation within the Egyptian manufacturing companies. Table 4 presents the Mantel- Haenszel between MRP project manager responsibility and the stage of MRP implementation.

Table 4

The Association Between MRP Project Manager Responsibility and the Level of MRP Implementation Achieved

Factors	M^2	*P-value*	Sig L
MRP project manager responsibility	.40	.52	N.S.

N.S.: Not Significant

In contrast to our hypothesis the above analysis indicates that there is no statistically significant association between having someone with responsibility for managing MRP project and the stage of MRP implementation within the Egyptian manufacturing companies (*P = .52*). This result indicates that full-time project manager is not considered as a critical success factor in implementing MRP system in Egyptian manufacturing companies as it was demonstrated by Duchessi at al. (1988). Therefore, we can not reject the null hypothesis concerning the relation under investigation.

Table 5

Contingency Coefficient Between Organisational Arrangements and the Stage of MRP Implementation Achieved

Organisational Arrangements	Contingency Coefficient	Sig L
A steering committee was formed	.06	N.S.
A steering committee met at least once a month	.10	N.S.
The project team generally met weekly	.34	*

N.S.: Not Significant
* Significant at .10 Level

From Table 5 we notice that only 1 out of 3 popular organisational arrangements followed by MRP companies for achieving the successful implementation is associated with the stage of MRP implementation in the Egyptian manufacturing companies, namely, the contingency coefficient between organisational arrangements and the MRP implementation stage reveals that there is a strong relationship between the project team met weekly and the stage of MRP implementation (.34). An evaluation of Table 6 indicates that manufacturing companies which have achieved less advanced stage of MRP implementation (MRP users with class C) need the organisational procedures related to meeting the MRP project team weekly more than those that had achieved more advanced stage of MRP implementation (MRP users with class B).

The likely interpretation for this result is at follows: MRP users with class C are still relatively baggy with MRP implementation as compared to MRP users with Class B, so they need to meet for an approximate time to enhance the project management and to foster user involvement.

Table 6

Contingency Coefficient Between the Project Team Met on a Weekly Basis and the Stage of MRP Implementation Achieved

The project team met weekly	MRP Implementation Stage D	C	B	Row Total	Row Percent
Yes	4 100.0	13 59.1	8 36.4	25	55.1
No	0 0.0	9 40.9	14 63.6	23	47.9
Column Total	4	22	22	48	
Column Percent	8.3	45.8	45.8		100.0
Contingency Coefficient (.34) *P- value* = .04**					

* Key: (D) No MRP advanced stage of MRP implementation
(C) Lowest advanced stage of MRP implementation
(B) Highest advanced stage of MRP implementation
** Significant at .05 Level

Based on the previous result we partly reject the null hypothesis, because it found only relationship between the project team met on a weekly basis and the stage of MRP implementation within the Egyptian manufacturing companies. This result is consistent with Burns *et al.* (1991) study, which concluded that there is a strong relationship between the project team met on a weekly basis and the stage of MRP implementation.

The Mantel-Haenszel test indicates a significant relationship between the lack of top management support and the stage of MRP implementation in Egyptian manufacturing companies (*P = .03*). An examination of Table 7 shows that MRP users either with Class C or Class B have considered the lack of top management support as a big obstacle caused severe problems in implementing MRP systems.

Table 7

Cross-tabulation of the Lack of Top Management Support by the Stage of MRP Implementation Achieved

Lack of top management support	MRP Implementation Stage D	C	B	Row Total	Row Percent
No causes problems	0 0.0	0 0.0	0 0.0	0	0.0
2	0 0.0	0 0.0	0 0.0	0	0.0
3	0 0.0	2 8.3	0 0.0	2	4.0
4	0 0.0	4 16.6	4 18.2	8	16.0
Caused severe problems	4 100.0	18 75.0	18 81.8	40	80.0
Column Total	4	24	22	50	
Column Percent	8.0	48.0	44.0		100.0
*P = .03**					

* Significant at .05 Level

This result indicates that MRP users in Egypt feel that the management commitment represent a great factor affecting the implementation of more advanced stage of MRP system. So, we expect that MRP users will tend to support any actions taken by the top management. In other words, the result reveals that MRP users are willing to co-operate with top management for achieving the advanced stage of MRP implementation. This result is consistent with Petroni (2002) study, which indicated that there is a strong relationship between the inclination of top management to spend time with people and the stage of MRP implementation. Table 8 shows a large contingency coefficient (.42) between the organisational willingness to change and the stage of MRP implementation achieved.

Table 8

Contingency Coefficient Between the Organisational Willingness to Change and the Stage of MRP Implementation Achieved

Organisational Willingness	MRP Implementation Stage* D	C	B	Row Total	Row Percent
Oppose change	0 0.0	0.0 0.0	0.0 0.0	0	0.0
Resist change	0 0.0	5 20.0	0 0.0	5	9.8
Suggest change	0 0.0	8 32.0	7 31.8	15	29.4
Actively seeks change	4 100.0	12 48.0	15 68.1	31	60.8
Column Total	4	25	22	51	
Column Percent	7.8	49.0	43.2		100.0
Contingency Coefficient (.42) *P- value* = .08**					

* Key: (D) No MRP advanced stage of MRP implementation
(C) Lowest advanced stage of MRP implementation
(B) Highest advanced stage of MRP implementation
** Significant at .05 Level

An important inference from the previous result is that the organisational willingness to change is positively associated with the stage of MRP implementation achieved. This result supports Burns *et al.* (1991) study, and Petroni (2002) study, with respect to the relationship between the organisational willingness to change and the implementation of more advanced stage of MRP. This suggests that the more willing an organization is to change, the more successful the implementation of more advanced stage of MRP is.

All in all, we conclude that our hypothesis relating to the association between management support and the stage of MRP implementation within the Egyptian manufacturing companies is partly verified**.**

MRP Implementation Stage and Manufacturing Methods and Marketing Strategy

It was suggested that "a more advanced MRP implementation is likely to occur with continuous (assembly, repetitive) manufacturing methods opposed to intermittent (job shop) methods, make to order strategy opposed to make to stock strategy, high number of parts per product opposed to low number (as a measure for production complexity), and high level of bill of materials opposed to low level (as a measure of inventory item dependence) in the Egyptian manufacturing companies". The logistic Regression Model was employed to test this hypothesis (as in Cooper & Zmud, 1989).

The results of Table 9 reveal that there is only a statistically significant association between the bill-of materials levels and the stage of MRP implementation namely, hypothesis (H_{24}) is supported at level ($p = .05$). This result can be interpreted in the light of our findings which indicate that 24 out of MRP users their levels of bill-of-materials had over 7 levels (Salaheldin and

Francis, 1998). Consequently, the degree of interdependence among the items will increase because the lot-sizing decisions made for higher level items will affect more levels and items, in turn the need for more advanced stage of MRP implementation appear to increase.

Table 9

Logistic Regression for MRP Implementation Stage

Function = Logistic Model:	51 cases Marginal	3 iterations Full	Diff		
-2 Log (Likelihood)	58.129	45.333	12.796	*df* = 4	sig = .0123
Full model estimates [a]		Coeff	Std Err	Ratio	1 Tailed Sig
Constant		-.9447	.5734	-1.647	
H_{21}		-.4561	.4408	-1.034	0.30
H_{22}		-.8683	.5649	-1.537	0.12
H_{23}		.5693	.4268	1.333	0.18
H_{24}		.9340	.4528	2.063	0.03

[a] $H_{21,}$ Manufacturing method was coded 0 for continuous and 1 for intermittent.
$H_{22,}$ Marketing strategy was coded 0 for make to stock and 1 for make to order.
$H_{23,}$ Production complexity is measured by the average number of parts per product.
$H_{24,}$ Inventory item dependence is measured by the average number of bill of material levels.
* Significant at .05 Level
N.S.: Not Significant

The major contribution of this result is that as bill-of-materials becomes high, the need and opportunity of the implementation of advanced stage of MRP appears to increase.

MRP Implementation Stage and Organisational Climate

It was suggested that "there is a relationship between the organisational climate such as: management style (participative or authoritative), communications (top-down or bottom-up), and the stage of MRP implementation in the Egyptian manufacturing companies". This hypothesis was tested by M^2, as illuminated in Table 10.

Table 10

Organisational Climate Factors Associated with the Stage of MRP implementation

Organisational climate factors	M^2	*P-value*	Sig L
Management style (participative Vs authoritative)	.63	.43	N.S.
Strategy formation (formal Vs informal)	.57	.45	N.S.
Degree of centralization (centralized Vs decentralized)	2.9	.08	*
Organisational hierarchy {high (many levels) Vs flat (few levels)}	2.7	.09	*
Communications (top down Vs bottom up)	.01	.90	N.S.
Degree of innovation (pioneering Vs traditional)	.28	.60	N.S.

N.S.: Not Significant
* Significant at .10 Level

There exists only statistically significant relationship between the degree of centralization & the organizational hierarchy achieved and the stage of MRP implementation at ($P = .10$), so we partly can verify Hypothesis 3. This result does not support the findings of the Petroni & Rizzi (2001) study, which concluded that as the openness shown by different organizational members towards the new technology such as MRP and its application increases, the inclination toward the implementation of advanced level of MRP appears to increase.

MRP Implementation Stage and Vendor Support

It was supposed that "the more the vendor support is, the more advanced the stage of MRP implementation in the Egyptian manufacturing companies" is. This hypothesis was tested by conducting M^2 test (Table 11).

Table 11

Vendor Support Associated With the Stage of MRP implementation

Factor	M^2	*P-value*	Sig L
Vendor support	.32	.57	N.S.

N.S.: Not Significant

The above result does not support the initial hypothesis.This result may stem back into the fact that MRP users in the course of time had good experience with MRP system. Consequently, their interdependence on vendor support was less. In contrast, Braglia & Petroni (1999) reported in their study on MRP practices in Italy that most large companies experiences indicated that the support available to them from vendors was essential for the implementation of advanced level of MRP systems. Moreover, Petroni (2002) found in his study on the critical factors affecting the stage of MRP implementation in Italy that training provided by the vendor of MRP system is a prerequisite for the effectiveness of the implementation of advanced level of MRP.

MRP Implementation Stage and the Previous Experience

It was supposed that "the more the experience with automated information systems is, the more advanced the stage of MRP implementation in the Egyptian manufacturing companies appears to be". This hypothesis was tested by the Mantel-Haenszel techniques, as illustrated in Table 12.

Table 12

Cross-tabulation of the Previous Experience of MRP Users by the Stage of MRP Implementation Achieved

The previous experience	MRP Implementation Stage			Row Total	Row Percent
	D	C	B		
Somewhat	0 0.0	12 48.0	2 9.5	14	28.0
Moderate	3 75.0	10 40.0	11 52.4	24	48.0
High	1 25.0	3 12.0	8 38.1	12	24.0
Column Total	4	25	21	50	
Column Percent	8.0	50.0	42.0		100.0
$M^2 = 5.17$ $P = .02$*					

* Significant at .05 Level

This indicates that there is a significant relationship between the previous experience of MRP users with automated information systems and the stage of MRP implementation. Consequently, we reject the null hypothesis and conclude that as the MRP users become more experienced with the automated information systems, the opportunity of the implementation of advanced stage of MRP system appears to increase. This result supports the literature review concerning the need to have an effective information system and high level of knowledge and experience with automated information systems prior to the implementation of the highest advanced level of MRP system (Petroni & Rizzi, 2001 and Lee, 2003).

MRP Implementation Stage and Size & Age of Company

It was suggested that "larger and older Egyptian manufacturing companies would have a greater advanced stage of MRP implementation". Table 13 depicts the results of testing the relationship between the company size (measured by gross sales) and company age and the stage of MRP implementation by using the Mantel-Haenszel test (M^2) technique.

Table 13

Company Size and Age Associated With the Stage of MRP implementation

Company size and age factors	M^2	*P-value*	Sig L
Size measured by gross sales	.26	.58	N.S.
Size measured by number of employees	1.09	.29	N.S.
Age	.002	.97	N.S.

N.S.: Not Significant

In contrast to our hypothesis Table 13 indicates that none of the suggested relationships were statistically supported. Although the previous studies such as: Anderson et al. (1982), Duchessi et al. (1988), and Sum & Yang (1993, 1995) reported that there is a relationship between company size and age and the stage of MRP implementation, the current study shows that these factors are not associated with the stage of MRP implementation in the Egyptian manufacturing companies. This result can be interpreted in the light of the fact that there are other factors, so-called external ones i.e. increased competition, changes in strategy and market decline, that may force the manufacturing firms to acquire and implement the highest advanced level of MRP systems (Cooper & Zmud, 1989).

Summary and Conclusions

The current study provides a strong sense of the identification of significant factors that affect the stage of MRP implementation within manufacturing companies, whereas the large number of statistically significant factors affecting the stage of MRP implementation reported by the present study at the same time most of them not included in the previous studies. Six hypotheses were tested by using Contingency Coefficient, Logistic Regression Model, Mantel- Haenszel and Cross-Tabulation. Hypothesis 5 was verified, hypotheses 1, 2 and 3 were partly verified, but hypotheses 4 and 6 were rejected. Having discussed the statistical results of the critical factors affecting the stage of MRP implementation in the Egyptian manufacturing companies, the following statements illustrate the significance of findings:

1. Our findings to some extent are parallel to those in Burns et al. (1991), in terms of the relationship between the project team met on a weekly basis and the stage of MRP implementation. In contrast, our findings are dissimilar with the findings of Cooper & Zmud (1989) study, which concluded that there exist relationships among marketing strategy, manufacturing method, production complexity, inventory item dependence and the stage of MRP implementation.
2. The present study provides a strong evidence that MRP system is more developed in the engineering & electronics industries than in the other ones.
3. The current study indicates that there is no statistically significant association between having someone with responsibility for managing MRP project and the implementation of more advanced stage of MRP within the Egyptian manufacturing companies.
4. An important inference from the study's results is that the organisational willingness to change is associated with the stage of MRP implementation achieved.
5. The finding that a more advanced stage of MRP implementation is associated with MRP users that their organizations are more centralized is likely to reflect a climate which embraces the centralization of the development and implementation effort within the organization.
6. The current study shows that there is no significant association between company size and age and the implementation of more advanced stage of MRP in the Egyptian manufacturing companies.

7. An important inference from the study's results is that there is no relationship between vendor support and the implementation of more advanced stage of MRP within the Egyptian manufacturing companies.
8. The present study provides a strong evidence that as the MRP users become more experienced with the automated information systems, the opportunity of the implementation of more advanced stage of MRP systems appears to increase.

Managerial Implications

Basing on the results of analysis, we can draw the main managerial implications:

1. A very significant implication of the current study is that the Egyptian manufacturing firms can use the implementation of the highest advanced level of MRP system as a strategic competitive weapon, if they use it as a strategic philosophy whether to face recent changes in the domestic and international environment or through ensuring that firms will always have sufficient inventory to meet production demands.
2. Another implication of this empirical study is that manufacturing firms would be advised to be aware of this conjunction of management commitment and appropriate organizational climate and the successful implementation of advanced level of MRP system.
3. Decision makers in manufacturing companies would be advised to understand that the implementation of advanced level of MRP is not equally effective in all manufacturing environments. MRP implementation is more effective for engineering & electronics industries than the other industries.
4. One of the main implications of the current study is that the successful implementation of advanced level of MRP can happen if the two way communication between top management and workers is considered as a rule rather than an exception.
5. Policy makers in the Egyptian industrial sector should pay more attention to the domestic supplying industries as a path to overcome unexpected delays as a result of purchasing the required parts and components from foreign suppliers.
6. Non-implementers of MRP systems can take advantage of the experiences of MRP implementers which provide a preview of what they can expect to challenge and the pitfalls they need to avoid when they implement MRP.
7. Policy makers in the Egyptian industrial sector should enhance the capability of manufacturing firms that are willing to implement an advanced level of MRP system through grants, incentives, and free educational programs.

Areas of further research

There are numerous research areas where the critical factors affecting the stage of MRP implementation should be expanded. First, testing the impact of uncertainties of supply unavailability and variability of queue on the implementation of advanced stage of MRP system. Second, testing the impact of degree of computerization and the integration among MRP modules & data accuracy on the stage of MRP implementation. Further research should be undertaken concerning the stage of MRP implementation in the private sector. The current study calls for undertaking case studies to present more details concerning the critical factors affecting the stage of MRP implementation in the service sector. Finally, this study provides the opportunity for other researchers to execute more research in this field and to merge with disciplines such as marketing and finance.

References

1. Anderson, J., Schroeder, R., Tupy, S. and White, E. (1982), "Material Requirements Planning Systems: the State of the Art", *Production and Inventory Management*, Fourth Quarter, pp. 51-67.
2. Braglia, M. and Petroni, A. (1999), "Shortcomings and Benefits Associated with the Implementation of MRP Packages: A Survey Research", *Logistics Information Management*, Vol. 12 No. 6, pp. 428-438.

3. Browne, J., Harhen, J. and Shivnan, J. (1996), *Production Management Systems: An Integrated Perspective*, Addison-Wesley, London.
4. Burns, O. and Turnipseed, D. (1991), "Critical Success Factors in Manufacturing Resource Planning Implementation", *International Journal of Operations Management*, Vol. 11, pp. 5-19.
5. Caridi, M. and Cigolini, R. (2002), "Improving Materials Management Effectiveness: A Step Towards Agile Enterprise", *International Journal of Physical Distribution and Logistics Management*, Vol. 32 No. 7, pp. 556-576.
6. Cooper, R. and Zmud, R. (1989), "Information Technology Implementation Research: A Technological Diffusion Approach", *Management Science*, No. 36, pp. 123-139.
7. Davis, M., Aquilano, N. and Chase, R. (2003), *The Fundamentals of Operations Management*, McGraw-Hill, London.
8. Duchessi, P., Schaninger, C., Hobbs, D. and Pentak, L. (1988), "Determinations of Success in Implementing Material Requirements Planning (MRP)", *Manufacturing and Operations Management*, No.1, pp. 263-304.
9. Duchessi, P., Schaninger, C. and Hobbs, D. (1989), "Implementing a Manufacturing Planning and Control Information System", *California Management Review*, pp. 75-90.
10. Koh, S., Jones, M., Saad, S., Arunachalam, S. and Gunasekaran, A. (2000), "Measuring Uncertainties in MRP Environments", *Logistics Information Management*, Vol. 13 No. 3, pp. 177-183.
11. Kumar, S. and Meade, D. (2002), "Has MRP Run its Course?. A Review of Contemporary Developments in Planning Systems", *Industrial Management and Data Systems*, Vol. 102 No. 8, pp. 453-462.
12. Laforge, R. and Sturr, V. (1986), "MRP Practices in a Random Sample of Manufacturing Firms", *Production and Inventory Management*, Third Quarter, pp. 129-137.
13. Lee, C. (2003), "Total Manufacturing Information System: A Conceptual Model of a Strategic Tool for Competitive Advantage", *Integrated Manufacturing Systems*, Vol.14 No. 2, pp. 114-122.
14. Petroni, A. (2002), "Critical Factors of MRP Implementation in Small and Medium-Sized Firms", *International Journal of Operations and Production Management,* Vol. 22 No. 3, pp. 329-348.
15. Petroni, A. and Rizzi, A. (2001), "Antecedents of MRP Adoption in Small and Medium – Sized Firms", *Benchmarking : An Integrated Journal*, Vol. 8 No. 2, pp. 144-156.
16. Porter, J., Jarvis, P., Little, D., Laakmann, J., Hannen, C. and Schotten, M. (1996), "Production Planning and Control System Developments in Germany", *International Journal of Operations and Production Management,* Vol. 16 No. 1, pp. 27-39.
17. Salaheldin, S. and Francis, A. (1998), "A Study on MRP Practices in Egyptian Manufacturing Companies", *International Journal of Operations/Production Management*, Vol. 18 No. 5,6, pp. 588-611.
18. Schroeder, R., Anderson, J., Tupy, S. and White, E. (1981), "A Study of MRP Benefits and Costs", *Operations Management*, Vol.2, pp. 1-9.
19. Slack, N., Chambers, S., Harland, C., Harrison, A. and Johnston, R. (1998), *Operations Management,* 2nd ed. Pitman Publishing, London.
20. Sum, C. and Yang, K. (1993), "A Study of Manufacturing Resource Planning (MRP II) Practices in Singapore", Omega, *International Journal of Management Science*, No.21, pp. 187-197.
21. Sum, C. and Yang, K., Ang, J. and Quek, S. (1995), "An Analysis of Material Requirements Planning (MRP) Benefits Using Alternating Conditional Expectations (ACE)", *Operations Management*, Vol. 13, pp. 35-58.
22. Turnipseed, D., Burns, O. and Riggs, W. (1992), "An Implementation Analysis of MRP Systems: A Focus on the Human Variable", *Production and Inventory Management*, First Quarter, pp. 1-5.
23. Voss, C. (1986), "Implementing Manufacturing Technology – A Manufacturing Strategy Perspective", in Voss, C. (ED.), *Managing Advanced Manufacturing Technology*, IFS Publications, UK, pp. 95-107.