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OPERATIONAL PERFORMANCE MEASURES USED AND CON- TEMPORARY MANAGEMENT PRACTICES DEPLOYED IN MAN- UFACTURING FIRMS: THE CASE OF KINGDOM OF SAUDI ARABIA

Key Words

***Non-Financial
Performance Measures;
Management
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Manufacturing
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Floor; Competition.***

Abstract

This paper aims at providing an empirical framework for exploring a proposed relationship between non-financial performance measures on the shop-floor (SFNFPMs) and a range of technological, managerial, organisational and environmental factors in Saudi manufacturing firms. The paper explains, briefly, the tentative framework of the proposed relationship between the use of SFNFPMs and the levels of deployment/importance of four contingent variables: innovative managerial practices (IMPs), advanced manufacturing technologies (AMTs), contemporary management accounting techniques, and aspects of competition. It then sheds light on levels of importance of the SFNFPMs of five evaluation categories (product quality, customer satisfaction, on-time delivery, employee morale, and efficiency and utilisation) and levels of application/deployment of the incorporated contingent variables in Saudi manufacturing firms. It also provides salient comparisons on levels of application of the incorporated variables between Saudi firms and UK firms. The paper presents summary statistics of research responses from interviewing managers of 144 Saudi manufacturing firms (belonging to various industry sectors) in mid 2005. It concludes that measures of 'on-time delivery' and 'efficiency and utilisation', amongst the five evaluation categories incorporated, are considered as highly important. Moreover, levels of importance of these two categories seem to be positively and significantly correlated with the levels of application of IMPs and AMTs and the levels of importance of aspects of competition as perceived by managers in the surveyed firms.

Introduction and Objectives

In order to be successful in today's world wide competitive environment, companies must be capable of manufacturing products of high quality at low cost and providing a first-class customer service (Kaplan, 1983 and Drury, 1990). Many companies have responded to these competitive demands by implementing Advanced Manufacturing Technologies (AMTs), Innovative Managerial Practices (IMPs), and emphasising quality, delivery, innovation and flexibility to meet customer needs in their corporate objectives (Banker *et al.*, 1993).

The adoption of these practices and technologies and the redesign of work processes have altered the stakes of corporate well being over the past two decades. These new manufacturing methods rely on increased worker involvement in the control of all phases of manufacturing and in identification of opportunities for process innovations and manufacturing performance improvement (Kaplan, 1983 and Banker *et al.*, 1993). One approach to addressing these changes is to revise the information captured by performance measurement (Clark, 1989; Mather, 1989; Dixon *et al.*, 1990; Kaplan & Norton, 1992; and Lau and Sholihin, 2005).

It is argued that interest in performance measurement is growing massively (Neely and Adams, 2000 and Ittner *et al.*, 2003). Many parties, e.g. business managers, politicians, and ministers, do seek new ways to assess performance of the organisations for which they are accountable (Neely and Adams, 2000). CIMA (1993) and Bhimani (1993) argue that the issue of appropriate performance measures is highly significant because it can affect commercial success. Also, because many manufacturers look for appropriate information about their internal processes to establish ways of cost cutting, enhancing performance, and, generally, building a better product in a shrinking market (Bhimani, 1993, and CIMA, 1993).

The development of key performance measures may require companies to go outside the company (Otley, 1997 and Ittner *et al.*, 2003). It has been suggested (CIMA, 1993; Bhimani, 1993; Bromwich and Bhimani, 1994 and Otley, 1997) that elements such as the nature of competition and the extent of AMTs/IMPs and structural innovations such as team-based work groups are important in understanding the type of performance measures best suited to the development of AMTs/IMPs within organizations. Various studies have em-

phased the use and performance consequences of non-financial measures in organisations adopting AMTs/IMPs (e.g. Ittner *et al.*, 2003). Virtually all of these studies have found positive associations between the emphasis placed on IMPs/AMTs and the provision of non-financial measures such as defect rates, on-time delivery, and machine utilisation (Daniel and Reitsperger, 1991; Banker *et al.*, 1993; Abernethy and Lillis, 1995; Perera *et al.*, 1997; and Ittner *et al.*, 2003). Positive associations have also been found between IMPs/AMTs and the use of non-financial measures in reward systems (Ittner and Larcker, 1995).

It has been claimed that performance measurement systems in use in manufacturing enterprises have remained static in spite of significant transformations witnessed in management accounting approaches and production processes (Kaplan and Norton, 1992; Bhimani, 1993; Bromwich and Bhimani, 1994 and Otley, 1997). Commentators on manufacturing performance have strongly advocated the use of non-financial measures in managing production activities (Kaplan and Norton, 1992; Bromwich and Bhimani, 1994; Otley, 1997; Jazayeri and Hopper, 1999; Neely and Adams, 2000; and Arena *et al.*, 2004).

It is advocated that more research is needed on how the design of man-

agement accounting systems interacts with manufacturing techniques to affect performance (Ittner and Larcker, 1995 and Ittner *et al.*, 2003). Commentators recommend that the nature of manufacturing performance measures appropriate for different elements of AMTs/IMPs be a useful area for further research (Kaplan, 1988; Ittner and Larcker, 1995, Chenhall and Langfield-Smith, 1998a, b and c; and Ittner *et al.*, 2003).

It can be concluded that there are different contingent managerial, technological, organisational and environmental factors that influence manufacturers' performance measurement. This study extends Abdel-Maksoud's (2004) and Abdel-Maksoud *et al.*'s (2002 and 2005) work on shop-floor non-financial performance measures in UK manufacturing firms. The study aims at examining the use of SFNFPMs in relation to levels of deployment/application of various contingent variables in Saudi manufacturing firms.

This paper has two main objectives:

First, to highlight the extent of the use of shop-floor non-financial performance measures and levels of application of IMPs, AMTs, contemporary management accounting practices, and the level of importance of aspects of competition in Saudi manufacturing firms.

Second, to examine whether the use and importance of shop-floor non-financial performance measures (SFNFPMs) of the five evaluation categories is associated with the contingent variables incorporated.

There are 19 subsidiary SFNFPMs and 29 subsidiary internal and external contingent factors in this study. The 19 SFNFPMs are as follows (See Abdel-Maksoud, 2004 and Abdel-Maksoud *et al.*, 2005):

Shop-floor non-financial performance measures (SFNFPMs) of product quality

- 1 - Scrap (% of total production).
- 2 - Defects (% of total production).
- 3 - Reworks (% of total production).
- 4 - Batches (% adjusted).

SFNFPMs of customer satisfaction

- 5 - Number of complaints received from customers.
- 6 - Number of returns.
- 7 - Number of warranty claims.

SFNFPMs of on-time delivery

- 8 - Percentage of on-time delivery to customers.
- 9 - Percentage of on-time production.
- 10-Percentage of schedule adherence.
- 11-Manufacturing cycle efficiency (MCE).

SFNFPMs of employee morale

- 12-Staff turnover.
- 13-Absenteeism.
- 14-Lateness.
- 15-Employee attitude survey.

SFNFPMs of efficiency and utilisation

- 16-Efficiency (e.g. standard hours produced / hours worked)
- 17-Activity (e.g. standard hours produced / budgeted standard hours)
- 18-Capacity utilisation (e.g. actual hours worked / budgeted hours)
- 19-Proportion of overtime worked (e.g. overtime hours / total hours)

The 29 internal and external contingent factors are (See Abdel-Maksoud, 2004 and Abdel-Maksoud *et al.*, 2005):

1. Level of application of six IMPs; these are: JIT, TQM, TPM, MRP I/II, ERP, and OPT.
2. Level of application of eight AMTs: FMS, CAD, CAM, CIM, CNC, CAE, AS/RS, and AGVS.
3. Level of deployment of nine contemporary management accounting practices: benchmarking of performance, ABC, ABB, ABM, EVA, BSC, throughput accounting, strategic management accounting, and customer profitability analysis.
4. Managers' perceptions of the levels of importance of six aspects of competition: quality, innovation, customer service, price, delivery, and flexibility.

The paper comprises six sections. Literature on performance measurement at shop-floor level and specific various contingent variables is briefly reviewed in the next section. Section 3 presents the methodology adopted in data collection. Section 4 provides some descriptive statistics derived from the raw data and some commentary on them (first objective). Section 5 reports results of analysing associations between the use and level of importance attached to SFNFPMs of the five categories and the levels/extent of deployment of the four contingent factors specified in the study (second objective). Summary and conclusions are presented in Section 6.

Literature Review

Shop-floor performance measurement and technological, managerial, organisational and environmental factors⁽¹⁾

Leading manufacturers in Europe, Japan, and USA have been reported as focusing on certain broad categories of performance measures; these are on-time delivery, product quality, customer satisfaction, employee morale, and efficiency and utilisation (CIMA, 1993, 1996; Otley, 1997; Ittner and Larcker, 1998; Abdel-Maksoud, 2004; and Abdel-Maksoud

et al., 2005). The first five categories formed the framework which guided this research, and as AMTs/IMPs depend crucially on shop-floor workers, this provided the focus of the research. In addition, given the importance of non-financial performance measures in an AMT/IMP environment, the focus of this paper is confined only to the non-financial performance measures in each of the five evaluation categories.

Furthermore, evidence permeates the literature of the possible effect of different internal (technological, managerial, and organisational) and external (environmental) factors and the emphasis placed on the use of performance measures. However, emphasis is placed on performance measures at organisational, divisional, or managerial level and the literature lacks research evidence at shop-floor level.

Following commentators (e.g. Khandwalla, 1972; Banker *et al.*, 1993; CIMA, 1993; Otley, 1997; Chenhall, 1997; Jazayeri and Hopper, 1999; Abdel-Maksoud, 2004; and Abdel-Maksoud *et al.*, 2005) who suggest that variables such as: the extent of deployment of innovative managerial practices (IMPs) and advanced manufacturing technologies (AMTs), organisational structure, and environmental factors be important in understanding perfor-

(1) It is noteworthy to indicate that, for brevity, only a brief literature review is presented in this paper. For more details, the reader is advised to refer to one of Abdel-Maksoud's leading work in this particular area (e.g. Abdel-Maksoud, 2004 and Abdel-Maksoud *et al.*, 2005)

mance measurement systems, this research has adopted a contingency framework. A brief explanation of this framework is presented below.

Contingency Theory

In early 2000, a large-scale survey of 2,242 UK manufacturing firms⁽²⁾ belonging to 21 different industries on the use of shop-floor non-financial performance measures was carried out (See, Abdel-Maksoud, 2004 and Abdel-Maksoud *et al.*, 2005). Abdel-Maksoud's study has adopted a contingency framework following many other commentators (See, for instance, CIMA, 1993; Otley, 1997; and Jazayeri and Hopper, 1999) where the levels/extent of application of various technological, managerial, organisational and environmental contingent variables were examined in relation to the levels of importance of SFNFPMs in use in UK manufacturing firms. This study has adopted Abdel-Maksoud's (2004) and Abdel-Maksoud *et al.*'s (2005) contingency framework.

Abdel-Maksoud *et al.* (2005:262-263) argue:

'Our methodological approach is based on contingency theory, the theoretical perspective that emphasises how contingent factors such as technology and environment affect the design and functioning of organisations. Its central premise is that no universally appropriate organisational structure applies equally to all organisations in all circumstances.

Instead, each structure is, or should be, a response to a set of contingencies. The variables most commonly identified in the contingency theory literature are size, environmental uncertainty, production technology, corporate strategy and market environment (Otley, 1999). A company's management accounting system is a significant element of its organisational structure and the features of an appropriate accounting system will depend upon the specific circumstances that the company faces (Otley, 1980). Accordingly, numerous researchers (See, Gordon and Narayanan, 1984; Chenhall 1997; Chenhall and Lang field-Smith, 1998b, and Anderson and Lanen, 1999) have attempted to identify important contingencies and assess their impact on the design of management accounting systems'.

They (p. 263) continue:

'As explained by Hartmann (2000), we adopt the contingency framework as a pragmatic device to explore this specialist field with a view to theoretical development. Also, this study differs from the formal contingency approach in that some of our 'contingent variables', such as management accounting practices or innovative managerial practices, would normally be outcomes rather than inputs'.

In this study, the internal factors incorporate IMPs and AMTs as managerial and technological factors respectively, and contemporary management

(2) Where 313 usable responses were received, in 2001, comprising 14.3% response rate.

accounting practices as organisational factors. The competitive environment a company operates in is considered as an external factor. A brief account of the above factors is presented below.

IMPs and AMTs

Various studies (e.g. Banker *et al.*, 1993; Drury *et al.*'s, 1993, CIMA, 1993 and Ittner *et al.*, 2003) have emphasised the use and performance consequences of non-financial measures in organisations adopting IMPs/AMTs. Nearly all of these studies show positive association between the emphasis placed on IMPs/AMTs and the provision of non-financial performance measures (Banker *et al.*, 1993; CIMA, 1993; Abernethy & Lillis, 1995; Perera *et al.*, 1997; and Ittner *et al.*, 2003). Despite evidence permeating the literature of the effect of IMPs/AMTs on performance measures in general, the effect of these IMPs/AMTs on the use of performance measures at shop-floor has not been examined in depth until early 2000 (in Abdel-Maksoud *et al.*, 2005).

Contemporary Management Accounting Practices

It is argued that management accounting is well placed to provide information to develop performance measures and that many accounting techniques have been prompted to enhance the way in which performance measures assist in the management of change (Nanni *et al.*, 1992; Shields and Young, 1992; Chenhall

and Langfield-Smith, 1998a and b; Abdel-Maksoud, 2004; and Abdel-Maksoud *et al.*, 2005 and 2006). These techniques incorporate the design of the balanced scorecard and performance measurement hierarchies (Kaplan and Norton, 1992; Nanni *et al.*, 1992; and Chenhall & Langfield-Smith, 1998a and b). Following this view, this study investigates whether the deployment of contemporary management accounting techniques is associated with the existence and importance of SFNFPMs.

Competitive environment

The dynamics of the markets in which a company operates are recognised as an important factor influencing the use of performance measures (CIMA, 1993; Bhimani, 1993; Bromwich and Bhimani, 1994; Otley, 1999; Drury *et al.*, 1993; Abdel-Maksoud, 2004; and Abdel-Maksoud *et al.*, 2005). It is argued that different types of competition (price, marketing or product competition) affect the use of accounting controls in manufacturing firms (Otley, 1980).

The greater emphasis placed on non-financial measures in firms facing competitive pressure is consistent with research showing positive associations between perceived environmental uncertainty and the demand for broad-based information systems incorporating non-financial indicators (e.g. Chen-

hall & Morries, 1986; Abdel-Maksoud, 2004; and Abdel-Maksoud *et al.*, 2005). As the shop-floor is the core of this study, emphasis is placed on possible association between competitive environment and SFNFPMs.

Research Method and Data Collection

The research study was funded by Institute of Research and Consultation, King Abdulaziz University, KSA. The research sample frame was confined to 2,991 KSA Ministry of Economy and Planning Statistical Yearbook 2005 listed manufacturing firms. Firms incorporated are located in three regions: Makkah, Riyadh and the Eastern Region. It is noteworthy that manufacturing firms located in these three regions comprise 85% of the total number of firms in the kingdom and the total investments in these firms is about 78% of total investments in the industry sector in the kingdom.

A random sample of 300 firms (10%, approximately, of the sample frame) belonging to seven different industry sectors in the three specific regions was selected. These belong to manufacturing of chemicals, petroleum, coal, rubber and plastic products; manufacturing of fabricated metal products; manufacturing of basic metal and non-metallic mineral products; manufacturing of food products; manufacturing of wood and wood products; publishing and repro-

duction of record media; and manufacturing of wearing apparel, tanning and dressing of leather.

A postal survey was initially used to collect data from the surveyed firms. However, the response rate was quite disappointing. Subsequently, the researchers had to collect data using a different method.

Structured interviews with managers of the surveyed firms (using structured questionnaire forms) were, consequently, carried out by trained research assistants with managers of 144 manufacturing firms in the three industrial areas (composing a 48% final response rate) in June-July 2005.

The current study deploys the same questions that were used by Abdel-Maksoud (2004) and Abdel-Maksoud *et al.* (2005) in variables measurement. Questions were translated into Arabic, then they were reviewed and tested by many academics and practitioners in the field to ensure clarity and consistency with the English version. The questionnaire form was then tested through the pre-testing stage which included many academics and managers in manufacturing firms in KSA. Subsequent to the piloting stage, some amendments were incorporated; for instance, in questions related to contemporary management accounting practices and IMPs/AMTs, respondents were asked to indicate, in addition to ranking the extent of deployment/level of application (as in the original English version), whether the practices/technologies were unknown to them.

Table 1
Distribution of Respondents According to Industry Sector they Belong to

Industry sector	Firms responding		% of firms in KSA (Population)
	No.	%	
1. Mfg of chemicals, petroleum, coal, rubber and plastic products	43	29.9%	21.5%
2. Mfg of fabricated metal products	37	25.7	28.3
3. Mfg of basic metal and non-metallic mineral products	24	16.7	17.4
4. Mfg of food products	20	13.8	16.1
5. Mfg of wood and wood products	10	6.9	5.2
6. Publishing and reproduction of record media	5	3.5	6.4
7. Mfg of wearing apparel, tanning and dressing of leather	5	3.5	5.1
Total	144	100%	100%

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The final questionnaire form consisted of two parts: the first part relates to the use and importance of shop floor non-financial performance measures (SFNFPMs) and the second contained questions on the level/extent of application of the contingent variables. Explanations and definitions of the incorporated techniques and practices were explained to respondents during interviews, in addition providing them in the final questionnaire form. A questionnaire form showing measurement of the variables incorporated in this paper is presented in the Appendix.

The distribution of respondents by industry sector to which they belong is presented in Table 1.

In support of the validity of the survey, it is worth mentioning that questions incorporated in the questionnaire form, for the assessment of

the validity of measurement of these questions, were constructed based on the literature. Also, different in-depth interviews and questionnaire pre-testing stages were applied in the development of the research questionnaire form. The reliability of measurement and objectivity of respondents' judgment were also examined (See Appendix). Results show an acceptable level of reliability and a high degree of objectivity of judgment among respondents. The next section presents details on variable measurements and descriptive statistics.

Descriptive Analysis of Responses

Virtually half of the respondents (52.8%) represent manufacturing firms employing between 150 and 2000 employees while 47.2% employ less than 150 employees.

The main conclusions of the analysis of the responses are presented in this

section. It is noteworthy to indicate that in presenting the results below, every effort was made to compare, where possible, the existing results with results of other studies in KSA.

Importance of SFNFPMs

Respondents were asked to indicate whether 19 shop-floor non-fin-

cial performance measures were applied in their companies and the importance attributed to each. Importance was signified on a seven point Likert scale from 1 (no importance) to 7 (critical importance) (Abdel-Maksoud 2004 and Abdel-Maksoud *et al.*, 2005) and the 19 measures are shown in Table 2.

Table 2
Distribution of Respondents by Evaluation of Level of Importance of Shop-Floor Non-Financial Performance Measures

Shop-floor non-financial performance measures of:	Mean importance for firms using the measure	% of firms using this measure
Product quality		
Scrap (% of total production)	2.95	100
Defects (% of total production)	2.71	99.3
Rework (% of total production)	2.60	93.8
Batches (% adjusted)	2.50	92.4
Customer satisfaction		
Number of complaints from customers	2.69	98.6
Number of customer returns	2.81	99.3
Number of warranty claims	2.94	88.9
On-time delivery		
% of on-time delivery to customers	5.55	96.5
% of on-time production	5.51	98.6
Manufacturing cycle efficiency	5.01	99.3
% of schedule adherence	5.03	99.3
Efficiency and utilisation		
Efficiency	4.02	99.3
Activity	4.64	99.3
Capacity utilisation	4.31	98.6
Proportion of overtime worked	4.36	99.3
Employee morale		
Employee lateness	4.43	99.3
Staff turnover	2.85	98.6
Employee attitude surveys	2.88	95.1
Absenteeism	2.89	98.6

N = 144.

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Table 2 shows that all surveyed Saudi firms do have SFNFPMs of the five evaluation categories in use. However, it can be concluded that there is a great tendency towards considering all measures of on-time delivery as being more important (mean > 5 in the four 'on-time delivery' measures) than other measures incorporated. Managers in the surveyed firms also consider all measures of 'efficiency and utilisation' as being of average importance (mean > 4).

Table 2 shows that all other SFNFPMs, apart from 'employee lateness', are not considered to be important by all interviewed managers.

The above results are interesting. The weight of importance managers put on measures of 'on-time delivery' could be interpreted to mean that managers focus on timeliness as one way to keep their customers satisfied. However, given the lack of interest in measures of 'product quality' and 'customer satisfaction' (means < 3), such an interpretation becomes equivocal. It could be that managers tend to focus on timeliness measures in order to avoid any possible fines attributed to delay in delivery.

One would have expected that, in such a giant oil producer country's culture, managers in manufacturing firms

would be less keen on fully utilising their resources. However, the importance managers attach to all measures of 'efficiency and utilisation' is surprising and it does ring a bell. Results suggest that managers in Saudi firms are aware of the effect of their utilisation of resources on their competitiveness in the Saudi market. This could be attributed to the fact that the Saudi market is the largest, and the oldest, market in the Gulf area. It could also be attributed to the persistent post-Second Gulf War rising oil prices which force all firms to become keener on fully utilising their resources.

The lack of interest in 'employee morale' measures by managers in the surveyed firms is, also, interpretable. It is the high cheap labour supply that makes managers consider their labour force as replaceable.

Level of Application of AMTs and IMPs

Respondents were asked to rank the levels of application of eight AMTs⁽³⁾ on a 7 point-scale, [1 (not at all), 4 (moderately), and 7 (extensively)]. Precise definitions of the incorporated technologies were explained to respondents (See, partial questionnaire form in the Appendix). Table 3 shows the distribution of respondents by their evaluation.

(3) The levels of application of these techniques were examined similarly in previous studies (See, Drury et al., 1993; Dean and Snell, 1996; Abdel-Maksoud, 2004; and Abdel-Maksoud et al., 2005). The same comment applies to the IMPs.

Table 3
Distribution of Respondents by Evaluation of their
Level of Application of AMTs

AMTs	Mean	% firms applying this practice
Computer aided design (CAD)	2.79	68.7
Computer aided manufacturing (CAM)	2.90	72.9
Computer numerical control (CNC)	2.65	67.4
Computer integrated manufacturing (CIM)	2.58	65.3
Computer aided engineering (CAE)	3.20	75.0
Flexible manufacturing systems (FMS)	3.39	80.5
Automated storage and retrieval system (AS/RS)	<u>4.50</u>	91.0
Automated guided vehicles systems (AGVS)	4.41	91.0

(1 = Not at all, 4 = moderately, and 7 = extensively)

N = 144

Table 3 shows that AS/RS and AGVS are widely applied in Saudi manufacturing firms. One can conclude that the levels of application of the other AMTs are low (mean < 4).

The above results are confusing. Saudi firms seem to focus entirely on inventory/product handling techniques. But such techniques should be supportive in nature; in other words, they have a complementary role with-

in the production process (handling and storing).

Respondents were, also, asked to rank the level of application of six IMPs on a 7 point-scale, [1 (not at all), 4 (moderately), and 7 (extensively)]. Again, precise definitions of the incorporated practices were explained to respondents (See, partial questionnaire form in the Appendix). Table 4 shows the distribution of respondents by their evaluation.

Table 4
Distribution of Respondents by their Evaluation of Application of IMPs

IMPs	Mean	% firms applying this practice
MRPI/ II	3.92	97.2
Enterprise requirement planning (ERP)	3.98	97.9
Total quality management (TQM)	<u>5.23</u>	99.3
Total preventive maintenance (TPM)	3.49	86.8
Just-in-time production (JIT)	<u>5.70</u>	100
Optimised production technology (OPT)	3.80	80.5

(1 = Not at all, 4 = moderately, and 7 = extensively)

N = 144

Table 4 shows that respondents give higher levels of application to JIT and TQM (i.e. means are 5.7 and 5.23 respectively on a 1 to 7 scale) than the other IMPs.

Responses can be compared to findings of previous research in UK firms during the last decade and earlier this decade. For example, the present survey results reveal that 100% of responding companies apply JIT to varying degrees. The reported rates of implementation of JIT in UK firms have fluctuated, in the last decade, varying from 23.6% (Murphy and Braund, 1990) to 28% in 1993 (Drury *et al.*, 1993). Findings of surveying 313 UK manufacturing firms earlier in 2000 (See, Abdel-Maksoud *et al.*, 2005) show an 81% JIT application rate.

Similar disparate implementation rates of TQM, MRP, FMS, CAD, CAM, CIM, and CNC in UK firms were reported. For instance, Davis and Sweeting (1991a and b) report 69% and 77% implementation rates of TQM and MRPI/ II respectively (Davis and Sweeting, 1991a and b). Murphy and Braund (1990) report 51.7% implementation rate of FMS, (Drury and Tayles, 2000) report 48%, Davis and Sweeting (1991a and b) report 23%, and Abdel-Maksoud *et al.* (2005) report 46.6%. Application rates of 69.2% and 80.8% for CAD were reported in Murphy and Braund

(1990) and Abdel-Maksoud *et al.* (2005) respectively. Murphy and Braund (1990), also, report application rates for CAM and CIM as 80.6% and 54.75% respectively. Davis and Sweeting (1991a and b) report a 43.0% application rate of CIM. (Drury and Tayles, 2000) report that 64% of their survey respondents used CNC to some extent.

A comparison between implementation rates of different IMPs/AMTs reported in the present survey and other surveys of UK firms in 1990s and early 2000 is summarised in Table 5.

In such comparison, the figures used in the present survey represent the cumulative percentage of respondents who apply the specified IMPs and AMTs to any extent (points 2-7 on the scale). The same concept was used in reporting such application rates in Abdel-Maksoud *et al.* (2005). This is consistent throughout Table 5. It was not fully clear, in the other studies reported (i.e. Drury *et al.*; Davis and Sweeting; and Murphy and Braund) what basis was used to report the proportion of application.

It is noteworthy that discrepancies between application rates of IMPs/AMTs, reported in Table 5, in UK firms and Saudi firms, could be ascribed to the passage of time and the increased adoption of these practices and technologies by Saudi manufacturers in their endeavour to modernise.

Table 5
Comparison between Reported Application Rates of Salient IMPs/AMTs
in Surveys of UK Firms and Present Survey

AMTs/IMPs	Application rates reported in current survey (in %) (2005)	Application rates reported by UK surveys (in %)			
		Abdel-Maksoud et al. (2005)	Drury <i>et al.</i> (1993)*	Davis & Sweet- ing (1991a, 1991b)*	Murphy & Braund (1990)*
JIT	100%	81%	28.0%	48.0%	23.6%
TQM	99.3	87	-	69.0	-
MRPI/II	97.2	84	-	77.0 (MRPII)	-
ERP	97.9	54	-	-	-
TPM	86.8	81	-	-	-
OPT	80.5	37	-	-	-
FMS	80.5	46.6	48.0	23.0	51.7
CAD	68.7	80.8	-	-	69.2
CAM	72.9	56.5	-	-	80.6
CIM	65.3	48.2	-	43.0	54.75
CNC	67.4	51.8	64.0	-	-
CAE	75	44.7	-	-	-
AS/RS	91	31.3	-	-	-
AGVS	91	15	-	-	-

* Adopted from Abdel-Maksoud (2004)

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Application of Contemporary Management Accounting Practices

Respondents were asked to indicate whether nine contemporary management accounting practices were (1) not applied, (2) partially applied or (3) systematically applied in their organisations. It is noteworthy to emphasise that the extent of some of these practices was examined similarly in previous studies (*See*, Murphy and Braund, 1990; Drury *et al.*, 1993; Dean and Snell, 1996; Otley, 1999; Abdel-Maksoud, 2004; and Abdel-Maksoud *et al.*, 2005).

Table 6 shows that all respondents tend to systematically (mean > 2) apply all management accounting practices incorporated in this study. 95% and 94% of responding firms partially/systematically apply 'strategic management accounting' and 'benchmarking of performance' respectively. In general, over 90% of the respondents do deploy, partially/systematically, ABC, ABB, BSC, and throughput accounting.

Such deployment rates far exceed deployment rates that are reported in other survey results in many countries.

Table 6
Distribution of Responses Concerning Contemporary
Management Accounting Practices

Management accounting practices	Mean (on the 1-3 scale)	Unknown	Percentage of respondents		
			1	2	3
Benchmarking of performance	2.62	1.4	3.4	29.9	65.3
Activity-based costing (ABC)	2.54	4.2	4.1	36.1	55.6
Activity-based management (ABM)	2.49	4.2	6.2	36.8	52.8
Activity-based budgeting (ABB)	2.42	0.7	4.9	47.2	47.2
Economic value added	2.32	1.4	15.3	36.8	46.5
Balanced scorecard	2.34	0.7	9.0	47.9	42.4
Strategic management accounting	2.46	0	4.2	45.8	50.0
Throughput accounting	2.46	2.1	4.8	43.1	50.0
Customer profitability analysis	2.39	6.3	13.8	29.2	50.7

N = 144

(1 = not applied; 2 = partially applied; 3 = systematically applied)

Results of previous surveys of UK firms in the early 1990s report a 10.0% average ABC adoption rate⁽⁴⁾ (Drury *et al.*, 1993). However, adoption rates of ABC increased in the mid 1990s to 20% (Innes and Mitchell, 1995). In addition, Innes *et al.* (2000) report 17.5% application rate of ABC and 20.3% of respondents who did not adopt ABC were considering implementing it.

Different adoption rates of ABC were found in the 1990s in Europe and North America. In Europe, an adoption rate of 10% was found in Ireland (Clarke, 1992) and 19.5% in Belgium (Bruggeman *et al.*, 1996). Bruggeman *et al.* (1996) found that 49.5% of their

survey respondents were planning to apply ABC.

In USA, Green and Amenkhieman (1992) claim that 45% of their surveyed firms used ABC to some extent, Shim and Sudit (1995) indicate that 27% of their respondents had adopted ABC and 38% intended to do so, and Hrisak (1996) found that 53% of survey respondents were using ABC. In Canada, an adoption rate of 14% was reported (Armitage and Nicholson, 1993).

As regards activity-based management (ABM) and activity-based budgeting (ABB), Bruggeman *et al.* (1996) report a 13.8% adoption rate, in Belgium, of ABM with 28.4% intending to adopt it, and 13.9% adoption rate of ABB with 58.6% planned adoption.

(4) However, Davis and Sweeting (1991a and b) report a 32% implementation rate of ABC in UK firms. Also, Cobb *et al.* (1992) and Drury *et al.* (1993) indicate that 33% and 37% of their surveyed firms were considering the adoption of ABC respectively.

Table 7
Different Deployment Rates of Salient Contemporary Management Accounting Practices in Saudi and UK Manufacturing Firms

Management accounting practices**	Present survey of 144 Saudi firms		Abdel-Maksoud et al.'s survey of 313 UK firms (Abdel-Maksoud et al., 2005)	
	% of respondents*	Mean	% of respondents*	Mean
Customer profitability analysis	79.9%	2.39	63.6%	1.85
Benchmarking of performance	95.2	2.62	71.9	1.84
Economic value added	83.3	2.32	38.1	1.52
Strategic management accounting	95.8	2.46	61.1	1.78
Balanced scorecard	90.3	2.34	41.2	1.56
Throughput accounting	92.1	2.46	43.5	1.6

* Cumulative percentage of firms applying the practice partially/systematically.

** In Abdel-Maksoud (2004) and Abdel-Maksoud *et al.* (2005) ABC, ABM, and ABB were combined under one heading 'activity-based techniques' (ABT); thus they were excluded from this comparison.

Findings reported from previous studies, also, reveal different implementation rates of 'strategic management accounting' that ranged from 17.9% to 44% in the mid 1990s (Murphy and Braund, 1990; Davis and Sweeting, 1991a and b; and Drury *et al.*, 1993). A 40% implementation rate of 'throughput accounting' was also reported (Davis and Sweeting, 1991a and b). In Denmark, Israelsen *et al.* (1996) state that benchmarking is applied by 25.0% of the surveyed firms.

A UK study by Innes and Mitchell (1995) reports that 50% of respondents use 'customer profitability analysis' and a further 12% planned to do so in future. Also, another survey of 187 UK firms by Drury and Tayles (2000) indicates that 74% of respon-

dents, which complies with the rate reported in this study, analyse profits either by customers or customer categories. Furthermore, a 39% deployment rate of Balanced Scorecard in UK FTSE 100 registered firms was reported (Tonge *et al.*, 2000). Also, Gosselin (2004) study on Canadian firms concludes that BSC was not used to a large extent.

A thorough comparison between deployment rates reported in the present survey and those reported by Abdel-Maksoud *et al.*'s (2005) survey is presented in Table 7.

Table 7 shows that the deployment rates of contemporary management accounting practices in Saudi firms far exceed those in UK firms. With

similar findings on the deployment rates of AMTs/IMPs in the two countries, one might be inclined to think that Saudi firms are more advanced, management practices-wise, compared to their UK counterparts. However, the reader is reminded that such discrepancies could be attributed to the passage of time and the increased adoption of these practices and technologies in Saudi firms in their pursuit to catch up with the global competition train.

Levels of Importance of Aspects of Competition

Respondents were asked to indicate the importance of six aspects of competition on a 7-point Likert scale (See Gordon and Narayanan, 1984; Abdel-Maksoud, 2004 and Abdel-Maksoud *et al.*, 2005).

Table 8 shows that Saudi manufacturing firms take all aspects of competition *very* seriously (mean > 6). Virtually all the respondents regard all the competitive dimensions as very important.

Testing for Associations

The second objective of this paper was to examine possible associations between the existence and levels of importance of shop-floor non-financial performance measures in the five evaluation categories (on-time delivery, quality, customer satisfaction, efficiency and utilisation, and employee morale) and the specified four independent contingent factors. In doing so, a non-parametric statistical test is applied. Data was primarily ordinal, thus Kendall's tau statistic test was applied (Cramer and Bryman, 2001 and De Vau, 1996).

Table 8
Distribution of responses to question about importance of competition on various characteristics

Dimensions of competition	% of respondents giving some degree of importance (4-7 on the scale)	Mean
Quality (N = 143)	98.6	6.51
Price	99.3	6.38
Customer service	100	6.53
Delivery	99.3	6.45
Flexibility	100	6.38
Innovation	98.6	6.10

(1 = no importance, 4 = moderate importance, and 7 = critical importance)

N = 144

Two hypotheses are postulated in applying Kendall's tau statistic test: the first is the null hypothesis (H_0) that the levels of deployment of the contingent variables are not associated with the use and importance of the SFNFPMs in the population and the second is the alternative hypothesis (H_1) that they are associated. It is worth mentioning that the null hypothesis H_0 (there is no correlation between the variables) will be rejected in favour of the alternative hypothesis H_1 (there is a correlation between the variables) when, and only when, the probability associated with the occurrence under H_0 of any value (α) is equal to or less than (0.05) (Seigel, 1956).

There are five sets of hypotheses in this study, these are as follows:

- H_1 0: There is no association between $X_1 - X_4$ (composite) and the existence and importance of product quality (composite)⁽⁵⁾ (Y_1) measures in manufacturing firms⁽⁶⁾.
- H_1 ⁽⁷⁾: There is an association between $X_1 - X_4$ (composite) and the existence and importance of pro-

duct quality (composite) (Y_1) measures.

- H_2 : There is no association between $X_1 - X_4$ (composite) and the existence and importance of customer satisfaction (composite) (Y_2) measures.
- H_3 : There is no association between $X_1 - X_4$ (composite) and the existence and importance of on-time delivery (composite) (Y_3) measures.
- H_4 : There is no association between $X_1 - X_4$ (composite) and the existence and importance of employee morale (composite) (Y_4) measures.
- H_5 : There is no association between $X_1 - X_4$ (composite) and the existence and importance of measuring the efficiency and utilisation (composite) (Y_5) measures.

Where:

- X_1 : The level of application of IMPs composite (adding up the scores given by respondents in their evaluation⁽⁸⁾ of the level of application of JIT, TQM, etc.).
- X_2 : The level of application of AMTs (composite).

(5) The composite measure is the arithmetical composite that is ascertained by adding up the scores given by respondents in their evaluation of the importance of SFNFPMs (e.g. scrap, defects, rework, and batches (% adjusted) in SFNFPMs composite of product quality, ect.).

(6) in manufacturing firms" applies hereafter but is omitted for brevity.

(7) From hereafter the alternative hypothesis will be assumed and not stated.

(8) The same logic is followed in interpreting 'composite' from hereafter.

Table 9
Kendall's tau C correlations between Independent Variables and Use and Importance of SFNFPMs of Five Evaluation Categories

X 1 - X4 (Composite)	Y ₁ PQ	Y ₂ CS	Y ₃ OTD	Y ₄ EM	Y ₅ EU
X ₁ : Level of application of IMPs (JIT, TQM, etc.)	.103	.019	.242**	.049	.296**
X ₂ : Level of application of AMTs (FMS, CAD, CAM, etc.)	.054	.042	.248**	-.029	.176**
X ₃ : Level of deployment of contemporary management accounting practices (benchmarking, ABC, ABB, etc.)	.037	0.70	-.008	.000	.109
X ₅ : Level of importance of aspects of competition (quality, price, etc.)	-.037	.043	.133*	.023	-.106

** Significant at 99% level of significance ($\alpha = .01$, 2-tailed).

* Significant at 95% level of significance ($\alpha = .05$, 2-tailed).

- X₃: The level of deployment of contemporary management accounting practices (composite).
- X₄: The level of importance of aspects of competition (composite).

The significant correlations between the four contingent variables and the existence and importance of composite SFNFPMs are shown with asterisks in Table 9. For brevity, the acceptance or rejection of the null hypotheses will depend on the reported correlations in Table 9. A discussion of the reported associations is shown hereafter.

One would have expected to see many significant correlations between the use and importance of SFNFPMs and the level of deployment/applica-

tion of the specified independent variables. However, Table 9 shows that the use and importance of SFNFPMs of the two prominent evaluation categories in Saudi manufacturing firms (on-time delivery and efficiency and utilisation⁽⁹⁾) are the only categories that seem to be highly positively and significantly correlated with the variables included in the study.

Brief comments on the above reported correlations are presented below.

Levels of Application of IMPs/AMTs and Use and Importance of SFNFPMs

It was expected to see many positive significant associations between the levels of application of IMPs/AMTs and the use and importance

(9) Means > 5 and 4 respectively.

of SFNFPMs of the five evaluation categories. For instance, CIMA's (1993) study on UK manufacturers shows that, to a large extent, the manufacturing process would play a large part in determining the adopted performance measures. CIMA argues that a company adopting just-in-time production system is likely to deploy novel measures to police delivery performance. Also, the adoption of a TQM philosophy is matched with an enhanced level of quality tracking (CIMA, 1993). Such a view is augmented by many studies which found positive associations between the emphasis placed on IMPs/AMTs and the provision of non-financial measures (Daniel and Reitsperger, 1991; Banker *et al.*, 1993; Abernethy and Lillis, 1995; Chenhall, 1997; Perera *et al.*, 1997; Drury *et al.*, 1993; and Abdel-Maksoud *et al.*, 2005).

The positive, significant correlations between the levels of application of IMPs and AMTs and the use and importance of SFNFPMs of 'on-time delivery' and 'efficiency and utilisation' do make sense and are evident. AMTs may be deployed in pursuit of production capacity utilisation (Mackey and Thomas, 1991). IMPs incorporate the efficient use of a company's resources. It could, also, be that the application of IMPs depends crucially on the involvement of shop-floor staff, thus managers may be

interested in measures of 'efficiency and utilisation' at operational level.

One might be driven, by these few significant correlations, to conclude that companies that apply IMPs/AMTs show interest in monitoring measures of efficiency and utilisation and timelines as to ensure a successful application of these techniques. This is consistent with other studies which found positive associations between the emphasis placed on AMTs and the provision of non-financial measures such as on-time delivery and machine utilisation (Banker *et al.*, 1993; Chenhall, 1997; Perera *et al.*, 1997; Drury and Tayles, 2000; and Abdel-Maksoud *et al.*, 2005).

It is surprising, though, that the application of IMPs/AMTs seems to have no correlation with the use of SFNFPMs of 'product quality', 'customer satisfaction', and 'employee morale'. This is confusing as implementing IMPs/AMTs can lead to less scrap and rework (Barnett, 1992). Accordingly, organisations which apply IMPs/AMTs might be expected to be keen on measuring product quality to ensure that such benefits are achieved. One might conclude that technology is introduced into 'islands of excellence' (Murphy and Braund, 1990). In addition, many companies are driven by profit and with IMPs/AMTs in application, profits come

from customer satisfaction. Hence many commentators (See, Goodman *et al.*, 1998) advocate that non-financial measures will lead to improved financial performance.

On the other hand, the lack of significant correlations between levels of application of AMTs and the level of importance of 'employee morale' measures could be attributed to the unmanned nature of AMTs where computerised machines take over workforce (Mackey and Thomas, 1991).

Contemporary Management Accounting Practices and Use and Importance of SFNFPMs

It is striking that the level of deployment of contemporary management accounting practices is not related, any how, with the use and importance of SFNFPMs of the five evaluation categories. Significant correlations were expected to be found between variables in this group and the existence and importance of SFNFPMs of the five evaluation categories.

For instance, the application of 'balanced scorecard' was expected to be correlated with 'employee morale' measures (learning and growth perspective) and 'product quality' (internal business perspective) measures (See, for instance, Kaplan and Norton, 2001). In addition, throughput accounting embraces managing bot-

tlenecks and theory of constraints, hence companies will be keen to monitor efficiency, delivery timeliness and workforce. Furthermore, benchmarking of performance requires an adaptation to competitive environment and that will require upgrading workforce skills, efficient use of resources and delivery timeliness.

It could be that managers apply management accounting practices in their companies as they hear about them or as evidence of adopting contemporary management accounting practices, but they do lack an understanding of the overall requirements of their application. Hence, one is driven to conclude that Saudi manufacturing firms need a better understanding of the requirements of the deployment of such techniques. This conclusion is consistent with results reported from the Computer Aided Manufacturing International (CAM-I) (1988) survey (See, Murphy and Braund, 1990) of 263 CIMA members working in a broad cross-section of industry in UK, in support for the view that companies introduce technology into 'islands of excellence' rather than comprehensively (Murphy and Braud, 1990).

Aspects of Competition and Use and Importance of SFNFPMs

It is argued that the dynamics of the markets in which a company oper-

ates are recognised as important factors that influence the use and importance of performance measures (e.g. Otley, 1999; Hoque *et al.*, 2001; and Abdel-Maksoud *et al.*, 2005). Evidence permeates the literature on the associations between competitive environment and the use of non-financial performance measures. For instance, Hoque *et al.* (2001) in surveying 71 New Zealand manufacturers report a significant positive relationship between the intensity of the market competition and the use of non-financial performance measures.

It is interesting, though disappointing that only one significant correlation is reported, to find a positive, significant association between managers' perception of the level of importance of aspects of competition in Saudi market and the importance and use of SFNFPMs of 'on-time delivery'. It could be that such measures enhance competitiveness by clearly monitoring a firm's competencies.

Summary and conclusions

Two main questions were raised on the use and importance of SFNFPMs in Saudi manufacturing firms. First, what is the extent of the use and importance of 19 subsidiary SFNFPMs of five evaluation categories (product quality, customer satisfaction, on-time delivery, employee morale, and efficiency and utilisation) and four specific contingent

internal and external variables? These contingent variables relate to the level of application of IMPs, the level of application of AMTs and of contemporary management accounting practices, and the competitive environment. Second, are there significant correlations between the use and level of importance of SFNFPMs and levels of the deployment of the specified contingent variables?

Interviews were carried out with managers of 144 Saudi manufacturing firms belonging to various industry sectors. Analysis of the responses showed acceptable level of reliability and objectivity of judgement among respondents.

The main conclusions of the analysis of the responses are:

- The majority of responding Saudi manufacturing firms tend to consider measures of 'on-time delivery' and 'efficiency and utilisation', amongst the five evaluation categories incorporated, as highly important.
- Responses show that, amongst the AMTs and IMPs, 'automated guided vehicle systems', 'automated storage and retrieval system', 'just in time' and 'total quality management' have the highest level of application in Saudi firms.
- Respondents tend to deploy all contemporary management accounting practices incorporated in this study

systematically. They consider all the six aspects of competition incorporated in this study to be very important.

- The use and importance of SFNFPMs of the two prominent evaluation categories in Saudi manufacturing firms (on-time delivery and efficiency and utilisation) are highly positively and significantly correlated with the levels of deployment of variables included in the study. The use and importance of SFNFPMs of the other three evaluation categories (i.e. product quality, customer satisfaction, and employee morale) are not significantly correlated with the level/extent of deployment of any of the contingent factors incorporated.
- The level of deployment of contemporary management accounting practices in Saudi manufacturing firms, though ranking high, does not seem to be significantly correlated with the use and importance of SFNFPMs. One is inclined to conclude that managers in Saudi firms might need a better understanding of the synergetic interrelationships between the deployment of management accounting practices and the use of performance measurement systems.
- Many discrepancies were found when findings in this study were

compared to those reported in other countries. Such discrepancies could be attributed to the following factors: country-specific contextual factors, passage of time, and the extent of country development.

Last, this study derives its importance from the fact that it is considered the first study on Saudi manufacturing firms, to the best of the authors' knowledge, that tackles such a theme. Findings and conclusions reported in this study contribute to enriching Saudi literature on performance measurement. They could be used as a schema for a better understanding of the use of non-financial performance measures and levels of deployments of various factors affecting such use in Saudi manufacturing firms. This, in turn, is expected to enhance Saudi manufacturers' performance.

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Appendix I
Questions about variables included in this paper
(listed in the questionnaire form used in data collection)

Part A:

- 1) How important is each of the following shop floor non-financial performance measures in helping your company to compete effectively? (Please circle the appropriate number on the seven-point scale below). **Please note that if you do not use a measure NM (Not Measured) should be circled.**

	Not Mea- sured	1 No importance	2	3	4 Moderate importance	5	6	7 Critical importance
<u>Shop-Floor Performance Measures of Product Quality:</u>								
Scrap - percentage of total production	NM	1	2	3	4	5	6	7
Defects - percentage of total production	NM	1	2	3	4	5	6	7
Rework - percentage of total production	NM	1	2	3	4	5	6	7
Batches - percentage adjusted	NM	1	2	3	4	5	6	7
<u>Shop-Floor Performance Measures of Customer Satisfaction:</u>								
Number of complaints from customers	NM	1	2	3	4	5	6	7
Number of returns	NM	1	2	3	4	5	6	7
Number of warranty claims	NM	1	2	3	4	5	6	7
<u>Shop-Floor Performance Measures of On-Time Delivery:</u>								
Percentage of on-time delivery to customers	NM	1	2	3	4	5	6	7
Percentage of on-time production (to finished goods store)	NM	1	2	3	4	5	6	7
Percentage of schedule adherence (in individual shop floor processes)	NM	1	2	3	4	5	6	7
Manufacturing cycle efficiency [Processing time / (processing time + inspection time + wait time + move time)]	NM	1	2	3	4	5	6	7
<u>Shop-Floor Performance Measures of Employee Morale:</u>								
Staff turnover	NM	1	2	3	4	5	6	7
Absenteeism	NM	1	2	3	4	5	6	7
Lateness	NM	1	2	3	4	5	6	7
Employee attitude survey	NM	1	2	3	4	5	6	7
<u>Shop-Floor Performance Measures of Efficiency and Utilisation:</u>								
Efficiency (e.g. standard hours produced/ hours worked)	NM	1	2	3	4	5	6	7
Activity (e.g. standard hours produced/budgeted standard hours)	NM	1	2	3	4	5	6	7
Capacity utilisation (e.g. actual hours worked/budgeted hours)	NM	1	2	3	4	5	6	7
Proportion of overtime worked (e.g. overtime hours/total hours)	NM	1	2	3	4	5	6	7

Part B:

(In the following questions, please circle the appropriate number)

The following question concerns the application of management accounting practices in your business

2) Please indicate the degree to which the following management accounting practices are applied in your business?

	Unknown	Level of application		
		1 Not applied	2 Partially applied	3 Systematically applied
Benchmarking of performance	10	1	2	3
Activity-Based Costing (ABC)	10	1	2	3
Activity-based Management (ABM)	10	1	2	3
Activity -Based Budgeting (ABB)	10	1	2	3
Balanced Scorecard [Translates company strategies into a coherent and comprehensive set of performance measures for top management. It emphasises four perspectives - financial, customer, innovation and learning, and internal business processes].	10	1	2	3
Economic Value Added (EVA) [Financial performance measures focusing on the delivery of shareholder value. Defined as accounting profit less a charge for capital employed]	10	1	2	3
Throughput Accounting [Defined as sales less materials (and bought-in services) routinely reported. Throughput per bottleneck minute might be calculated as a decision making aid].	10	1	2	3
Strategic Management Accounting [Reporting information relating to a firm's market and competitors]	10	1	2	3
Customer Profitability Analysis [Identifies customers who place numerous small orders (with fixed cost for each order) and/or purchase non-standard production items]	10	1	2	3

The following question (3) concerns the monitoring of your competitive environment.

3) Please indicate the importance of the following aspects of competition:

	1 (No Importance) --4 (Moderate Importance)--7 (Critical Importance)						
Quality	1	2	3	4	5	6	7
Innovation	1	2	3	4	5	6	7
Customer service	1	2	3	4	5	6	7
Price	1	2	3	4	5	6	7
Delivery	1	2	3	4	5	6	7
Flexibility	1	2	3	4	5	6	7

The following question (4) concerns the application of technologies and managerial practices within your business.

- 4) To what extent is each of the following technologies and managerial practices used in your company? (You may wish to consult the production/ logistics manager).

	Un-known	Extent of Application						
		(1) Not at all	-----	(4) Moderately	-----	(7) Extensively		
Just-In-Time (JIT)	10	1	2	3	4	5	6	7
Total Quality Management (TQM)	10	1	2	3	4	5	6	7
Total Preventive Maintenance (TPM)	10	1	2	3	4	5	6	7
Materials Requirements/Resource Planning MRPI/II	10	1	2	3	4	5	6	7
Enterprise Requirement Planning (ERP)	10	1	2	3	4	5	6	7
Optimised Production Technology (OPT)	10	1	2	3	4	5	6	7
Flexible Manufacturing Systems (FMS)	10	1	2	3	4	5	6	7
Computer Aided Design (CAD)	10	1	2	3	4	5	6	7
Computer Aided Manufacturing (CAM)	10	1	2	3	4	5	6	7
Computer Integrated Manufacturing (CIM) -	10	1	2	3	4	5	6	7
Computer Numerical Control (CNC)	10	1	2	3	4	5	6	7
Computer Aided Engineering (CAE)	10	1	2	3	4	5	6	7
Automated Storage and Retrieval System (AS/RS)	10	1	2	3	4	5	6	7
Automated Guided Vehicles Systems (AGVS)-	10	1	2	3	4	5	6	7

* Definitions of these technologies / practices were given at the end of the questionnaire list.

Appendix II

Testing for the reliability of measurements and objectivity of respondents' judgment

In our efforts to augment the meaningfulness of the results of this study, two statistical tests were carried out on responses to ensure both the reliability of measurement and the objectivity of respondents' judgement.

In assessing the reliability of the measurement of questions related to the variables incorporated, Cronbach's alpha correlation coefficient was calculated using SPSS 13. The results show an acceptable level of reliability of measurement (Alpha correlation coefficients were 0.759 for SFNFPMs and 0.897, 0.777, 0.514, and 0.742 for AMTs, IMPs, contemporary management accounting practices, and aspects of competition respectively.

Moreover, the objectivity/subjectivity of judgement of respondents was evaluated⁽¹⁰⁾. The results reveal communalities ranging from 0.795 to 0.987. See Table A.

Table A
Distribution of communalities of respondents

Communality range	No. of respondents	% of respondents
.795 -.800	2	1.40
.801 -.900	10	6.95
.901 -.987	132	91.65
Total	144	100

The high values of the communalities presented in Table A indicate a high degree of objectivity among respondents. We, therefore, conclude that there is a high degree of objectivity among the respondents in this study. This should augment the final results reported.

(10) The total variance in any O's set of judgements is composed of three sources: common-factor, specific, and error variance (Guilford, 1954). Guilford (1954) argues that "the proportion of any O's variance that is objective in any set of judgements depends upon the extent to which his judgements are determined by common-factors. His/her proportion of common-factor variance is known as his/her communality" (p 254).

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الملخص

مقاييس الأداء التشغيلية و الممارسات الإدارية الحديثة المطبقة بالمؤسسات الصناعية بالمملكة العربية السعودية

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تهدف هذه الدراسة، في ضوء إطار عملي، إلى دراسة العلاقة بين استخدامات مقاييس الأداء التشغيلية اللامالية، ودرجة تطبيق عدد من العوامل التكنولوجية والإدارية والتنظيمية، ودرجة التنافسية بالمؤسسات الصناعية بالمملكة العربية السعودية. و تعرض الدراسة النتائج الإحصائية للبيانات الناتجة عن إجراء مقابلات مع مديري ١٤٤ مؤسسة صناعية، تنتمي لقطاعات صناعية متعددة، في منتصف ٢٠٠٥. وقد خلصت الدراسة إلى ارتباط استخدام عدد من مقاييس الأداء التشغيلية اللامالية بتطبيق الأساليب التكنولوجية والإدارية، ودرجة التنافسية بالمؤسسات الصناعية بالمملكة.

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