

Strategic Application Portfolio in SMEs*

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ABSTRACT

This paper discusses the state of a small and medium enterprise's (SME) information needs in terms of its strategic application portfolio. Specifically, it examines the strategic information requirements of a manufacturing SME with the aim of understanding the application strategy needed to formulate the firm's IT adoption so that lessons could be learnt from such technology innovation. A case study approach was chosen in which information requirements of the firm were investigated. Analysis was done to examine the evidence of potential applications strategic to the firm's business mission, goals and functional requirements. Major deliverables include an enterprise-wide data model representing a high-level overview of the firm's information requirements, a business area classification, and portfolios of applications categorized according to strategic, operational, potential and support using the classical McFarlan and McKenney Strategic Importance Matrix.

ABSTRAK

Kertas ini membincangkan keadaan keperluan maklumat syarikat kecil dan sederhana dengan melihat portfolio aplikasi strategik sebuah syarikat pembuatan IKS untuk memahami strategi aplikasi yang diperlukan untuk perolehan IT syarikat. Pendekatan kajian kes digunakan di mana keperluan maklumat syarikat dikaji dan analisa dilakukan terhadap keperluan tersebut untuk memperolehi aplikasi-aplikasi yang berpotensi yang dapat menyokong misi syarikat, matlamat dan keperluan-keperluan fungsi syarikat. Antara hasil kajian termasuk sebuah model data yang mewakili pandangan keseluruhan keperluan maklumat syarikat, klasifikasi bidang bisnes, dan portfolio aplikasi mengikut kategori strategik, operasi, potensi dan sokongan berasaskan matriks klasikal McFarlan dan McKenney Strategic Importance Matrix.

INTRODUCTION

Information strategy has been one of the major issues of concern in the information systems (IS) literature occupying the top three positions in studies conducted by Brancheau et al. (1996) and Palvia et al. (1996) involving large firms. In the SMEs, information strategy is equally important where a study by Pollard and Hayne (1998) found

that it is the most critical IS issue. This is not surprising as firms, whether large or small, need information to formulate business strategies, to make decisions and to remain competitive. However, Hale and Cragg (1996) suggested that very few studies were done on strategic information needs of small firms where more focus was given to studies such as IS Satisfaction, Usage and Success of IT adoption. With few studies focusing

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on information strategy in the SMEs, little is known regarding the state of the SMEs' information needs which could be developed to form strategic applications aligned to the firm's business strategy.

SMEs should also have the capability to process their own data and use information effectively to be able to compete and become successful. This is especially true in today's fast changing environment, which would require equally fast access to information to cope with the rapid change. Information is used on a daily basis to perform such functions as planning, controlling, organizing and decision-making. Thus information is a critical resource for the SMEs, and in today's era of digitalization and globalization, firms have never before experienced intense competitions that cross regional and international boundaries. Recent findings have shown that SMEs are now going international with the help of current technology, especially the Internet, to enable e-commerce (Westhead et al., 2002). Those who are complacent and lack innovation will fall behind, widening the gap in the digital divide, and may one day become irrelevant and cease to exist.

Clearly, a study on strategic information needs that leads to a suite of application portfolio in SMEs is required in order to further understand the SMEs' use of their IS and the extent to which their IT adoptions are aligned to their business strategies. Through such a study, firms would be able to identify and plan for their application portfolios and determine the right IT infrastructure for their firms.

This paper aims to present research findings on the state of an SME's information needs in terms of its strategic application portfolio. It is hoped that with such findings, strategic information needs of SMEs can be better understood, and be used to form guidelines to support SME's IT adoption.

METHODS

The research was conducted by adopting the case study approach. IS has been recognized as multi-disciplinary (Brancheau and Brown, 1993) and the multi-faceted nature of IS research has made case study an appropriate research strategy (Cavaye,

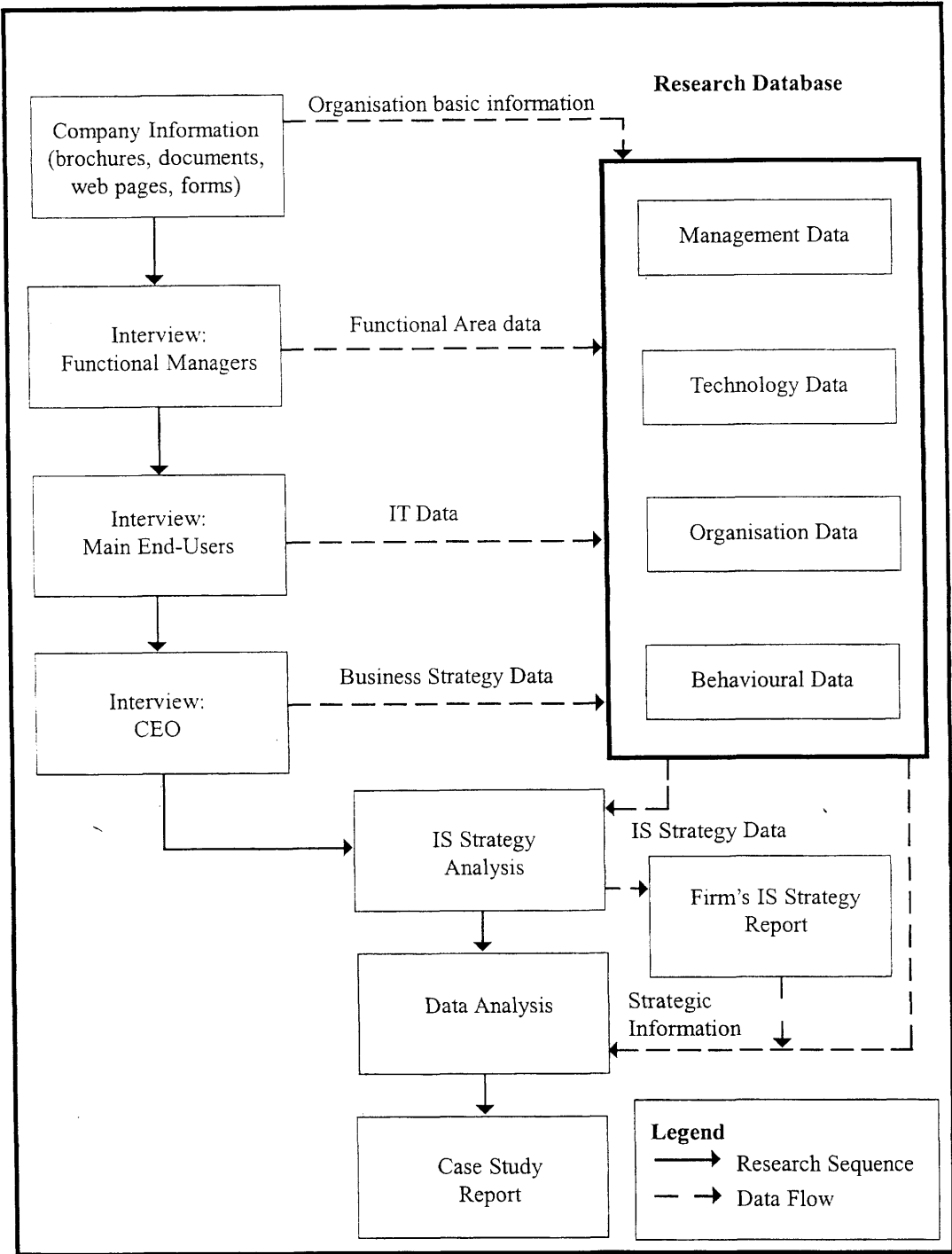
1996; Remenyi and Williams, 1996). Furthermore, studying contemporary events in their natural settings is more appropriate in a qualitative research method where case study research has emerged as a suitable candidate (Yin, 1994; Mason, 1996). Since IS is multi-faceted, therefore it is appropriate to employ the case study approach as a research strategy for this study. Moreover, according to Claver et al. (2000), case study is one of the most frequently-used method in IS research.

The overall method for conducting the case study is presented in Figure 1. A small manufacturing firm in the West Midlands, UK was chosen as the unit for analysis. According to Yin (1994), a single case study is allowed when the investigation involved a pre-defined phenomenon with the aim of achieving an in-depth understanding of its context. In this study, information strategy was thoroughly examined within the context of a SME's IT adoption.

In the UK, a firm is classified according to the number of employees. A small-medium firm is one that employs less than 500 people (DTI, 1995), whereas in the case of Malaysia, a small-medium scale industry (SMI) is defined as a company with an annual sales turnover of not exceeding RM 25 million and full-time employment of not more than 150 employees (Abdul Aziz Latif et al., 2000).

The primary data gathering technique used was semi-structured interviews whilst other sources of evidence used included company documents and observations. An established IS development methodology known as *Information Engineering* was used where the enterprise data in the form of strategic business and functional area requirements were identified in the process of understanding the firm and its business. To ensure accuracy and completeness of information, all interviews were recorded and transcribed and copies returned to interviewees for review. Through the series of interviews and observations the enterprise data was synthesized according to several categories as shown in Figure 1 to form the research database. A total of 15 interviews were carried out each lasting between 1 to 3 hours for a duration of 3 months. A further 3 months were spent on data transcription, and another 2 months on analysis and preparation of the firm's IS strategy report. In total the case study took 8 months to complete.

Figure 1
Case Study Method



ANALYSIS

Company Profile

The firm is a small manufacturing company established 13 years ago and is located in a suburban area in the West Midlands, UK. Its primary business is in the design, manufacture and supply of products and components for the heat transfer industry. This includes heat exchangers, coolers, condensers and tubes with sales coming from diverse markets such as power generation, petro-chemical, marine and other industrial firms, both domestic and international. Annual profits have been good with sales ranging from £4 to £6 million. It has set a 30% annual growth target for expansion. A summary of the firm's basic characteristics is presented in Table 1.

The firm is registered as a Private Limited company and was originally a family-based business. This is quite typical of most small firms in the region as discovered by Dahalin and Golder (1998) in their earlier study. This is also true in Malaysia where SMEs have a long tradition of family run business (Hodge, 2001). The firm employed 45 full-time staff, 20 in the site office and the remaining 25 in the shop floor within the same location. It has 6 management staff headed by a managing director and supported by 5 departmental managers. The MD is also the owner of the company. The departments include the Sales and Marketing department, the Works department, the Contracts department, the Quality Assurance department, and the Development department. Appendix 1 shows the organization structure of the firm.

Some of the data presented in Table 1 provide support for previous studies on IT adoption in small firms, whilst other evidence may suggest the contrary. The capability of SMEs to develop their own applications confirms earlier studies (Raymond, 1985; Lees, 1987). The lack of IT support is typical of many SMEs (Doukidis et al., 1996; Raymond, 1990). A strong CEO support implies an increase in IT adoption (Thong et al. 1996). This is supported by the pattern of evidence on the number of PCs and the number of users as well as the number of systems and IT products used by the firm.

Contrasting results can also be seen based on the data presented. There is no evidence to suggest that the firm is experiencing difficulty in developing applications due to having users with low level of computer literacy as suggested by Montazemi (1988). However, difficulties have been experienced in other areas such as time constraint and limited IT human resources. Though the firm had experienced design problems in its application development, it has never suggested the lack of technical knowledge as the problem to application development. The fact that the firm has a high-level of computer literacy may suggest the growing trend not only in IT adoption but also end-user development in the SMEs.

The presence of a Champion as one of the organizational factors has been observed and identified in many IS implementation studies. A strong Champion has been identified as a critical factor for the success of technology assimilation (Lai, 1997). Evidence of a strong IT Champion as shown in Table 1 above suggests that IT Champion may also contribute to the increase in IT adoption.

Firm's Strategic Plan

Part of the effort to acquire an IS strategy is to examine the company's strategic business plan. The *information engineering methodology* calls for the alignment of IS strategy with the firm's business strategy so that any IS implementation will support the business in terms of its mission, goals and business functions (Martin, 1986). Hence the firm's strategic plan is a prerequisite for its IS strategy formulation, and the success of the research study depends on whether such a plan exists. In the absence of a documented plan as in the case of the firm investigated, an alternative is to seek senior and top management's views of the current state of the business as well as their opinions regarding the future direction of the business. This was done by conducting semi-structured interviews to identify the firm's mission, business functions, organizational units and their functional areas, strategic goals and objectives, and critical success factors and problems. The following analyzes the firm's business strategy based on interviews with top and senior management of the firm.

Table 1
Summary of the Firm's Basic Characteristics

Characteristics	
<p>I. Basic Profile</p> <ul style="list-style-type: none"> Ownership Industry Age Size (staff) Sales (£ million) Profitability Location 	<ul style="list-style-type: none"> Private Limited Manufacturing 10 years 45 £6.0 £500,000 Sub-urban
<p>II. IT Adoption</p> <ul style="list-style-type: none"> Years using IT No. of PCs No. of Users IT Support No. of systems/IT products No. of applications CEO Support IT Champion 	<ul style="list-style-type: none"> 3 18 18 Nil 10 13 Strong Strong
<p>III. End-User Development (EUD)</p> <ul style="list-style-type: none"> End-User Typology Applications developed by end-users Source of end-user support Experience in EUD 	<ul style="list-style-type: none"> 1 – End-User Developer 3 – Command-Level end-user 12 Self-supported 4 years

Though no formal mission statement has been identified, the firm's mission can best be described based on the perspective of the top management as follows:

We are committed to our people and we strive for product excellence to be the number one in our area and to be recognized internationally

To support the above mission, a number of strategic goals have been identified.

| Diversify into hi-tech markets while sustain-

ing the traditional marine business.

| Introduce modern, state-of-the-art technology company-wide.

| Increase production capability.

| Improve product quality through better skills and machinery.

| Enhance R&D by investing £150,000 a year.

| Become an Original Equipment Manufacturer (OEM) for world-wide distribution.

| Sell products internationally at very competitive prices.

| Increase sales turnover by £2 million a year

| Maintain growth rate at 30% per annum.

The firm's business can be categorized into 3 main functions. These are the Sales and Marketing function, the Production function, and the Research and Development function. Each of these main functions can be sub-divided or decomposed into several sub-functions. Each sub-function in turn can further be decomposed into sufficient levels of detail to determine distinct business processes and activities. In this study, however, for the purpose of obtaining a high-level overview of the enterprise, decomposition stopped at the sub-function level or when the lowest-level function was reached. A summary and breakdown of each of the main function is described in Appendix 2.

Next, for each of the main business function above, critical success factors (CSF) were identified. CSF can be defined as those few key areas where things must go right for the business to flourish. These could be critical processes or business activities, or critical information that are required where failure in these areas could be disastrous to the business. The purpose of the CSF is to analyze the potential information needs of the respective business functions and to determine whether these needs are supported by the business goals and consistent with the functional objectives. Table 2 summarizes the CSF of the 3 main business functions identified in this study.

Table 2
Critical Success Factors

Business Function	Critical Success Factors
1. Sales & Marketing	<ul style="list-style-type: none"> Timeliness – sales to production to dispatch Access to customer's information Availability of parts to produce components/products for sales New, current, potential and outstanding orders Status of jobs-in-progress at a particular instance Kept informed about competitors Status of stock at any one time'
2. Production	<ul style="list-style-type: none"> Current and accurate information about incoming contracts Materials received at acceptable quality standards Employees sufficiently skilled, and trained and with the right attitude towards tasks Maintain quality of machines, procedures and tasks Information on major orders coming in Reduce/eliminate complaints and rejects
3. Research & Development	<ul style="list-style-type: none"> Skilled employees doing development tasks Clear policy and procedure on development Better machinery to improve quality and productivity

Based on the analysis of each functional area requirements, its CSFs and problems, information needs of the firm can then be identified. First-cut broad data subjects representing the highest-level overview of the firm's information needs have been identified in this study. This is repre-

ented in the form of a data subject decomposition diagram as shown in Figure 2.

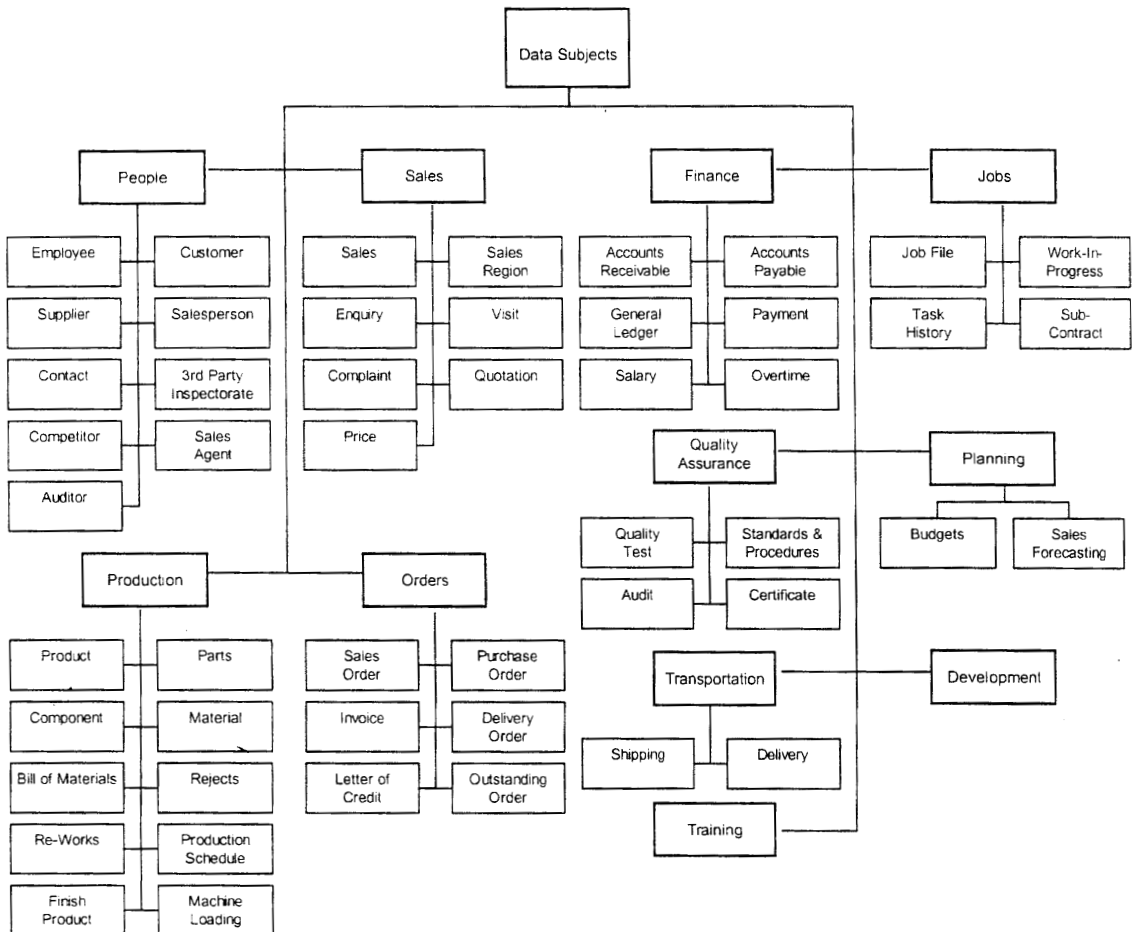
The data subjects were then expanded to form entity types and a data model representing the firm's information needs can then be created in the form of an Entity Relationship Model. This

model can later be used in the design stage as the basis for developing the firm's database.

The data subject decomposition diagram provides a complete overall description of the information needs of the firm. However, it needs to

be transformed to a logical database schema for subsequent designing. This would require the identification of the underlying attributes and identifiers that made up the entity in order to form the database structure.

Figure 2
Data Subject Decomposition



FINDINGS

Based on the analysis that has been done, a number of information systems applications have been identified that would satisfy the firm's business needs as reflected in the firm's business strategy

discussed previously. These applications were formed as a result of performing a clustering technique in the information engineering methodology, known as *Affinity Analysis*, associating the firm's business functions with its information needs (entities as described in the preceding sec-

tion). Association matrix mapping the firm's business functions with its information needs was created. This constitutes the input for the Entity Clustering Algorithm which is a major procedure within the Affinity Analysis.

The matrix defined the relationship between the 48 functions and the 59 entities found in the study. A relationship between a function and an entity exists if the function uses the entity in its execution. The algorithm computes Affinity Factors, which represent the proportion of the number of functions using a pair of entities out of the number of functions using one element of the pair. For example let $E_1, E_2, E_3, \dots, E_m$ be the entities and $F_1, F_2, F_3, \dots, F_n$ be the business functions in the M-by-N matrix. The Entity Clustering algorithm can examine every process and calculate (1) the number of processes using a given entity E_i , say; (2) the number of processes using the entity pair E_i and E_k where k is between 1 and m /inclusive and $k \neq i$. Hence, let

$$P(E_i) = \text{number of processes using entity } E_i.$$

$$P(E_i, E_k) = \text{number of processes using both entities } E_i \text{ and } E_k.$$

$$\text{The Affinity Factor } E_i \text{ to } E_k = \frac{P(E_i, E_k)}{P(E_i)}$$

If the two entities, E_i and E_k , are never used together for the same process then their affinity will be zero. On the other hand, if they are always used together then their affinity will be one. The Affinity Factor is computed for every entity in the matrix and the result is stored in an M-by-M matrix containing the 'm' number of entities.

Entities with high Affinity Factors will be grouped together to form an entity cluster. This is repeated for all combinations of entities in the matrix resulting in several clusters of entities. In order to ensure consistency in the results, combinations of different threshold values were applied to examine the movement of entities among the clusters in order to identify the best patterns that fit these entities. Among the thresholds used included (1) a minimum Affinity Factor needed to create a new cluster; (2) a minimum Affinity Factor of the symmetric entity pair needed to include

an entity in an entity cluster; (3) a minimum Affinity Factor needed to add an entity to a present cluster; and (4) a minimum Affinity Factor needed to include an entity in the analysis. A value of 1 (ie. 100%) tends to create as many clusters as there are entities. If one the other hand the value of the Affinity Factor is 0, then there will be only one big cluster containing all the entities. The idea was to use combinations of different Affinity Factors among the different thresholds and let the algorithm determine the number of clusters by exhaustively examining the entities.

The analysis yields 17 clusters utilizing all 59 entities. These clusters were then examined for similarity in their characteristics to form groups representing potential business areas where applications were then identified. A miscellaneous group was formed comprising numerous and varied entity types that constantly moved between clusters when different thresholds were applied. Because of this, the miscellaneous group was not considered a potential business area but some of the entities were taken out and included in the existing clusters that mostly represent those entities.

A summary of the potential business area classification is shown in Appendix 3. Basically, 12 business areas (not including the miscellaneous group) were identified with each revealing their own distinct characteristics as a result of the cluster groupings. The business areas are Product Information, Personnel, Inventory, Customer Information, Delivery, Contract, Financial, Order Processing, Sales, Production, Quality Assurance, and New Product Development.

Each business area identified consists of entities that are closely related that would result in the formation of several applications accessing the same data sources. For each business area an application portfolio was formed to analyse the information strategy by dividing the applications into one of 4 priority areas. Using the Strategic Importance Matrix suggested by McFarlan and McKenney (1983) the areas are (1) *Strategic*; (2) *Operational*; (3) *Potential*; and (4) *Support*. Strategic applications are those that are critical to the future success of the business. Applications that are closely related to support the company's mission and business goals should belong to this category. Applications in the Operational category

are those that are critical in supporting the day-to-day business activities. Their development should be given top priority. Whereas Potential applications are those that will move to the Strategic category depending on the availability of future technology and resources. Applications that belong to the Support category are those that can facilitate and improve the management and activities of the business area. Table 3 shows the result of the application portfolio.

Al together 43 applications were identified, out of which 20 applications belonged to the Strategic and Operational categories supporting the firm's business strategy and its daily operations. Out of these, only 5 applications were being addressed and these were in various phases of development. Three applications were implemented i.e. Invoice Printing, Sales Forecasting and Pricing applications. One application, the Sales and Purchase Order Processing System, was in the design phase. The fifth application, Inventory Control and Bills of Materials, was in the analysis phase. It is interesting to observe that 65% of the applications identified as important in this study (belonging to the Strategic and Operational categories) have neither been addressed nor planned prior to the study.

Out of the 3 applications implemented, one was strategic (Sales Forecasting) and the other two (Invoice Printing and Pricing) were operational. The Sales and Purchase Order Processing System, which was strategic, was in the design phase, and the Inventory Control and Bills of Materials application belonged to the operational category. Interestingly, if not for this study majority of the applications identified as strategic and critical to the firm would not have been known and the potential for application development and acquisition would have been missed.

CONCLUSIONS

The firm's business mission and strategies highlight the importance of the people, the product and the process aspects of the business. Foremost among the people aspect is the customer, an external entity that keeps the company in business. Equally important is the internal entity, the em-

ployees, who ensure the company is operating effectively and most importantly meeting the needs of the customer. Another very important resource is information, required by the employees to make decisions, make better quality products and improve business processes in order to satisfy customer needs. This is what SME should aim to achieve and this study provides the understanding as to how firms can formulate their information strategies through the analysis of the business area and identification of the application portfolio.

To ensure the effectiveness of the firm's application requirements, the firm's strategic information has to be closely aligned to its strategic business objectives. The implementation of this information strategy has to take into account the firm's business strategy so that the priority of developing IS applications will be based on the firm's mission and objectives. That is what this study has undertaken, and the suites of application portfolios identified in this study were all related to the firm's business strategy. The firm has recognized applications in the Strategic and Operational categories as most critical and closely related to its business mission and objectives.

Employing a strategic IS approach as part of the case study method has brought numerous benefits to the study and the firm. The study was able to progress systematically based on a well established IS development methodology known as Information Engineering. Enterprise data in the form of strategic business and functional area requirements were identified in the process of understanding the firm and their businesses. The firm was able to benefit directly from this study as the approach involved building an information architecture through the information strategy study incorporating analysis of its business area. Deliverables from this could interest the management because they are concerned with how technology can be used to promote better work processes, increase efficiency and even how it can be used as a weapon against competition. The process itself invites management to think about the organizational structure, its goals, factors critical for success, critical problems, critical decisions, and their information needs.

Table 3
Application Portfolio for the Firm's Business Area

Business Area	Strategic	Operational	Potential	Support
Product Information		Product and Component Database Application		
Personnel			Human Resource Information System	Personnel Database; Staff Training; Skill Inventory
Inventory		Inventory Control; Bill of Materials	Interface Triggers to Suppliers	
Customer Information	Customer Database	Customer Enquiry		Ad-hoc queries; Appointment System
Delivery		Invoice; Delivery Order; Packing Notes	E-Document	Delivery System
Contract		Job Booking		Contract Specification Database; Sub-contract application
Order Processing		Sales Order Processing Purchase Order Processing System		Order Information System; Supplier Database application
Sales	Sales Forecasting	Pricing; Quotation Printing; Account Maintenance	Sales DSS	Complaints; Agents Database Competitors Information
Production	MRP System	Production Scheduling; Work-in-progress; Capacity Planning		Tasks Archive; Re-work and Reject Database
Quality Assurance	Quality System	Audit System		Certificate Prints
New Product Development				New Product Design Spec.; Product Maintenance Spec; New Product
Total:	6	14	4	19

*Tables created as part of other applications

This study suggests a suite of application portfolios that are strategic to a manufacturing SME and demonstrates the importance of conducting an information strategy study. It is hoped that the findings from this study can be used as guidelines to help SMEs create the right environment for IT adoption. However, this study should not be considered conclusive and more studies involving other SMEs and of different sectors of the industry should also be done. In addition, IS research in SMEs should also focus on issues related to the development of the firm's own applications since existing studies on this have been generally focused on large businesses with Information Centers and formal IT structures. With such studies deliverables from this study can be used to facilitate planning and development of the SME's IT adoption.

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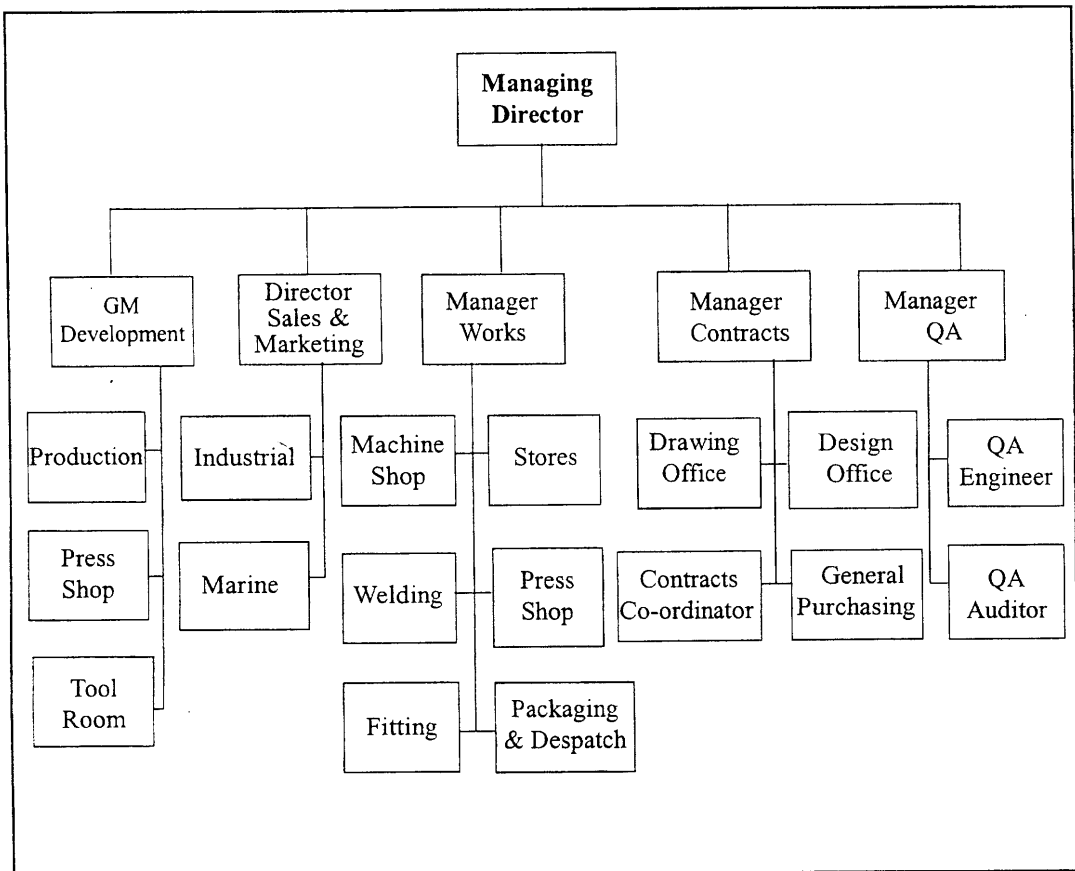
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APPENDIX 1
Organization Structure of the Firm



APPENDIX 2
Summary Business Function Decomposition

1. Sales & Marketing	
1.1 Regional Sales	
1.1.1	Marine Sales
1.1.2	Industrial Sales
1.1.3	Agents
1.2 Customer Relations	
1.2.1	Customer Enquiry
1.2.2	Customer Visits
1.2.3	Complaints
1.3 Marketing	
1.3.1	Publication
1.3.2	Sales Presentation
1.3.3	Advertisement
1.3.4	Exhibition
1.3.5	Sales Forecasting
1.3.6	Product Training
1.3.7	Market Research
1.4 Selling	
1.4.1	Order Entry
1.4.2	Maintenance
1.4.3	Repair
1.5 Contracting	
1.5.1	Purchasing
1.5.2	Designing
1.5.3	Drafting
1.5.4	Job Booking
1.5.5	Contract Review
1.5.6	Sub-Contracting
1.5.7	Inventory Control
1.5.8	Delivery
1.6 Pricing	
1.6.1	Quotation
1.6.2	Costing
1.6.3	Invoicing

2. Production	
2.1 Scheduling	
2.1.1	Resource Planning
2.1.2	Materials Allocation
2.1.3	Works Allocation
2.1.4	Machine Allocation
2.2 Machining	
2.2.1	Loading
2.2.2	Cutting
2.2.3	Bending
2.3 Welding	
2.4 Assembling	
2.5 Fitting	
2.6 Quality Auditing	
2.6.1	Testing
2.6.2	Job Specification
	Procedure
2.6.3	Procedures Manual
	Mainte.
2.6.4	Training
3. Research and Development	
3.1	Machine Development
3.2	Component Development
3.3	Planning Development
3.4	Tool Development
3.5	Design & Drawing
3.6	Pressure Fitting

APPENDIX 3
Potential Business Area Classification

Business Area	Entity Type	Cluster
1. Product Information	Product Component	1
2. Personnel	Employee Department Staff Training Skill Job	2 14
3. Inventory	Machine Tool Parts Materials Bill of Materials Machine Load	3 4
4. Customer Information	Enquiry Visit Site Customer	5
5. Delivery	Packing Notes Destination Carrier Invoice Delivery Finished Product	6
6. Contract	Job File Sub-Contract Contract	4 7
7. Financial	Receivable Payable Payment Financial Salary Overtime Budget	1 8 13 15

(continued)

Business Area	Entity Type	Cluster
8. Order Processing	Outstanding Order Sales Order Supplier Purchase Order	9 15
9. Sales	Sales Competitor Sales Training Commission Complaints Quotation Cost Price Sales Agent Sales Region	5 10 16
10. Production	Work-in-Progress Re-Work Task History Production Schedule Reject	11
11. Quality Assurance	Audit 3 rd Party Inspectorate Quality Test Quality Standards Certificate	12
12. New Product Development	Development New Products	17
13. Miscellaneous	Patent	10