A "DEA" Based Taxonomy to Map Successful SMEs

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Abstract

The study investigates the dimensions and characteristics that effect SMEs performance. SME's productivity can be measured using the ratio of its outputs and inputs. The study utilizes the Data Envelopment Analysis (DEA) methodology to derive a novel taxonomy for mapping successful SMEs. The paper presents the results of business performance measurements of 248 SMEs.The taxonomy reveals that owners of efficient SME's concentrated on cost reduction activities. Efficient SMEs owners did not invest in marketing activities. We found that the least efficient SMEs invested in advertising and marketing activities more than the others.

Keywords: Data Envelopment Analysis, SME, Performance Measures, Efficiency Frontier

Introduction

Micro, small and medium-sized enterprises (SMEs) are the engine of economies in developed and developing countries.Following Katz et al. (2000) they are the major type of organizations and their performance is critical for the economic and social development of each country. For researchers SMEs are attractive, since they "live and die quickly" (Katz, et al., 2000; Abouzeedan and Busler, 2004). The role of small and medium size businesses in providing productive employment and earning opportunities has emerged as an important concern among researchers and policy makers because SME's are considered an effective way of fostering economic and societal development. They establish the vanguard of the modern enterprise sector and present the most prominent force of modernization and growth in developing economies.

Thus, for example in the 25 countries of the enlarged European Union about 23 million SMEs provide around 75 million jobs and they represent 99 percent of all enterprises (European Commission, 2005). Following the new SME definition of the European Commission enterprises are categorized in terms of headcount, turnover or balance sheet total, with medium-sized enterprises having less than 250 employees, a turnover of 50 million Euro or less or a balance sheet total of 43 million Euro or less; small enterprises having less than 50 employees, a turnover of 10 million Euro or less or a balance sheet total of 10 million Euro or less; and micro enterprises having less than 10 employees with a turnover of 2 million Euro or less or a balance sheet total of 2 million Euro or less (European Commission, 2005). In Europe about two-third of employment in the private economy is located in SMEs with their contribution to employment growth (84 percent) being higher than could be expected from their share in total employment (67 percent) (Zoetermeer, 2009). Especially for policy makers the question of efficiency of SME's is of critical importance, because inefficient SME's are unlikely to compete and survive.

In the Israeli context SMEs are defined as having up to 50 employees, with a turnover up to 5 Million Dollar and being at least 90 percent of private ownership (Israel Small and Medium Enterprise Authority, 2005). In 2003, 98.6 percent of all businesses in Israel were of small or medium size, their number was about 414,000 and they employed about 1.1 million people (Friedman, 2005). The survival rate of SME's in Israel after 5 years of operation was only 30 percent, while the survival rate for all enterprises, not considering their size was 47 percent (BDicoface, 2006).The literature is unclear as to the question of how efficient SMEs are relative to larger firms (Little, Mazumdar and Page, 1987; Cortes, Berry and Ishaq, 1987; Liedholm and Mead, 1987), but a number of factors such as lack of capital, lack of access to information sources, low levels of skills, weak management, and limited technological capabilities are identified as causes for inefficiency (Geeta Barta and Hong Tan, 2003).

In the light of the above, the purpose of our study is to endorse a taxonomy that will enable the mapping of successful SMEs. This paper introduces the usage of a well proven quantitative methodology, the Data Envelopment Analysis (DEA) in order to endorse the taxonomy. Using the DEA methodology enables to conduct a relative comparison, on a given marking scale, of various SMEs under a predefined set of performance characteristics.

SME Performance Measurement

Performance measurements support the managerial activities of every organization including SMEs. Understanding how SMEs achieve high performance has significant implications for SME owners/managers, SME employees and the economies in which the SME operates (Wolff and Pett, 2006). Hudson-Smith et al. (2001) highlighted the various aspects of the business to be covered. It includes: the financial results, the operating performance (through the dimensions of time, quality and flexibility), the way the company is perceived externally (through its customers) and the cultural aspects of the working environment (through the human resource dimension).In addition, given the resource and time constraints imposed on SMEs, performance measures should be clearly defined, have an explicit purpose, be relevant and easy to maintain and be simple to understand and use. Hudson-Smith et al. (201) conducted a survey to build the picture of the use of performance measures within SMEs. Results show that none of the companies had measures covering all the various managerial aspects. The only common area was that all of the companies had a plethora of financial measures. None of the companies attempted to measure flexibility and few of them had human resources measures covering only staff turnover. Measures were usually developed in an ad hoc fashion and difficulties were identified when staff was asked to start collecting data for which they could see no use.

The growth of SMEs can be measured in various ways (Robson and Bennett, 2000). It can be measured in terms of increase in SME employment, growth of sales or turnover growth (Bartlett, 1994). This is the measure of the firm's total level of activity. A further measure is profitability since this focuses on the earnings of the firm owners (Kelleberg and Leicht, 1991). Various measures of profitability can be used: absolute profitability, profitability per employee, profitability as a percentage of turnover, or percentage change in profitability. Voulgaris et al. (2000), presented a case study addressing the evaluation of SMEs performance on the basis of financial ratio analysis, for a sample of Greek SMEs. The evaluation framework is based on a multiple criteria decision aid (MCDA) method, namely the UTADIS method (Jacquet-Lagreze, 1995; Doumpos and Zopunidis, 1998). It aggregates all financial ratios into a single evaluation index that represents the performance of the SMEs.

Chu (2009), empirically examined the influence of founding-family ownership on SME performance, by raising a research question: is founding-family ownership detrimental or beneficial to the performance of small family firms? The study used both the accounting and stock market indexes to measure firm performance, average annual rate of profit after tax and the ratio of the firm's market value to the replacement cost of its assets. Results did not show any significant performance differences between family and nonfamily firms, but contributes positively to both the accounting and the stock market indexes of performance.

Ahmad and Qiu (2009) studied operations effectiveness of SMEs by employing the integration of the Analytical Hierarchy Process and Data Envelopment Analysis. The study assessed the SMEs' current resources and operations and providing them knowledge about their own weaknesses and strengths with respect to their competitors. In general it appears that all the companies that were identified as the most efficient seem to be operating efficiently in the Human Resources, Operations Management, Market Management and Quality Management areas. The success of any SME depends on its ability to assure a good quality level and on the will of its management to do what is needed to at least meet customer expectations. Under such conditions, standardization of good quality practices, management flexibility and continuous improvement philosophy become essential. The problem is that the SME lack the resources and the time to make the required cultural changes needed to gain the productivity and efficiency levels required to achieve a world-class manufacturer status.

Kearney and Abdul-Nour (2004) developed a step by step management approach to help SMEs to reach better quality level in term of quality management, quality assurance, quality control and continuous improvement process, despite their area of operation and level of expertise in quality matter. They suggest that one way to acquire expertise is to exchange knowledge and know-how in networking environment involving large organizations and other SMEs. It is well documented that SMEs exhibit different characteristics from larger organizations (Hudson-Smith and Smith, 2007). SMEs are most closely aligned with the adhocracy model, as they are considered to have flat structures with few management layers, be flexible and adaptable to changing market needs and have a high potential for innovation.

The ability to operate effectively within a culture of adhocracy may be restricted by the fact that SMEs are also seen as suffering from "resource poverty", both in terms of human resources and financial stability and security. Appiah-Adu and Singh (1998) investigated the relationship between customer orientation and performance measurements in SMEs. Their research findings supported the hypothesis: "A firm's level of customer orientation is positive related to its performance measured by new product success, sales growth and ROI. Birely and Westhead (1990) suggested a multidimensional approach to the understanding of the development of the small firm by providing empirical evidence as to the kaleidoscope of factors which describe firms of different sizes. The factors used were: Age and ownership, Management, Production, Positioning-industry and location and Product/Market profile. The results suggest that firms do change, but not necessarily in any prescribed sequence. For example: it was found that the more that ownership and management is divorced from the original owners, the higher the profitability. High levels of performance facilitate firm growth that, in turn, can yield employment gains and contribute to the general economic health of a nation.

Given the resource constraints of small firms and their susceptibility to distress, hardship and outright failure, a better understanding of the contributing factors for higher performance is desirable (Lee and Marvel, 2009). They investigated the relationships between R&D investment (the ratio of total R&D expenditures compared to total sales) and home region orientation (the magnitude of sales occurring within Asia and not the European Union or North America) on international performance of international Korean SMEs. Results show that the presence of R&D investment alone is not enough. Instead, SMEs must execute a clear strategy in order to reap performance advantages. The relationship between R&D performances is not a linear, straight-forward, relationship as much research has assumed. Boards of directors are regarded as one of the major elements in the governance framework, influencing firm outcomes. Well functioning boards of directors in SMEs private firms, as good governance practices seem to result in the creation of firm value, improved company structure and firm continuity (Heuvel et al., 2006). Cooke and Wills (1999) explored the extent to which social capital is advantageous to SME growth. Social capital is a communal property involving civic engagement, associational membership, high trust, reliability and reciprocity in social networks. In the study were involved SMEs from Denmark, Ireland and Wales. Results showed that a good portion of respondent firms ascribed performance gains to extra-program effects as related to business performance (Turnover, employment, market share, productivity exports, and profit) and business growth. Business associations are collective bodies that are intermediary between individual business action and state action. As such they are one of a number of organizations that may influence the development of individual business and the wider competition of the nation.

Bennett (1998) studied the role of business associations in influencing the competitiveness of their members or the sector from which they are drawn. The association contributes to competitiveness by provision of collective services, such as industry standards, codes of conduct and branding of quality. The study detailed the services provided by various professional and commercial associations: member conferences, government lobbying, information on the government, European Union lobbying, business directory, newsletters, technical journals, fact sheets, management courses, employee training, technical advice to members, and benchmarking. Covin (1991) describes a study of the business strategies and performance levels of firms with entrepreneurial and conservative strategic postures. Firms with conservative strategic postures are risk-averse, non-innovative and reactive. Firms with entrepreneurial strategic postures are risk-taking, innovative and proactive. Results show that entrepreneurial firms are, on average, larger and younger than the conservative firms. The entrepreneurial firms outperform the conservative firms on the key dimension of organizational effectiveness- firm growth rate. The financial performance score for the entrepreneurial firms is also significantly higher than that of the conservative firms.

To summarize the issue of SMEs performance measurements it can be said that: a. SMEs are mainly using financial performance measurements; b. SMEs are lacking the human resources needed to establish and maintain performance measurements infrastructure and c. SMEs usually do not have the culture of regular and consistent data collection, analyzing and decision making procedures.

Methods, Materials and Tools

A sample of 248 businesses and their owners were investigated in 2006 in Israel. Using a combination of snowball and convenient sample, data were collected by use of a comprehensive questionnaire. We started out with a convenient sample, asking students from the Ruppin Academic Center (located in the center of Israel), from Haifa University (located in the North of Israel) and from Ben Gurion University (located in the South of Israel) to administer the questionnaire to family members. We proceeded with the snowball method, whereby students' family members suggested names of friends and acquaintances, who were subsequently surveyed.

For data collection was performed as follows: a. students received a training session on the arts of administering questionnaires; b. the questionnaire was administered to the business owners by students; c. Although the questionnaire was anonymous the students had to provide a list of names and telephone numbers of business owners approached by them; d. A quality control process was conducted. SMEs under investigation were randomly (about 20%) approached by the authors to verify that data collection was conducted properly. The students met with business owners in person and were present while the latter provided the data.

The questionnaire included background data on the SMEs owners and their businesses. They were told that they participate in a survey which is an integral part of an academic seminar. Students did not report on problems while gathering the data. About 20% of the approached business owners did not agree to participate in the study.The population of the study includes 248 business owners. The average age of the business owners is 38.7 (Std. D. 11.3). 72 percent have spouses with an average of 1.6 children. Table 1 presents the distribution of businesses' types in the sample.

Table 1: Frequencies of Types of Businesses

Type of Business	Frequency	Percent
Production	19	7.6
Retail and wholesale	70	28.2
Professional services	48	19.4
Personal services	79	31.9
Tourism	26	10.5
(Missing)	(6)	(2.4)
Total	248	100%

About one third of the businesses are located within the sphere of personal services, such as: cosmetic studios, hairdressers, and kindergartens. Nearly 20 percent professional services which demand some kind of academic education, examples are economists, financial services, lawyers. Few businesses are located within the sphere of production and tourism. Table 2 presents the distribution of size of the businesses under investigation.

Table 2: Businesses' Size Distribution

Size of businesses (no of employees)	Frequency	Percentage
0*	41	16.6
1 – 5	120	48.4
6 – 10	34	13.7
11+	37	14.9
(Missing)	(16)	(6.4)
Total	232	100%

* Owner only

Table 2 reveals that nearly two third of the businesses are small, employing less than 5 workers. Only about 16 percent employ more than 11 workers. Therefore, we are dealing primarily with micro-businesses. As to investment, 45.9 percent invested less than NIS 50,000, 46.1 percent invested between 50,000 and NIS 500,000 whereas 7.8 percent invested more than half a million NIS to set up their businesses. In sum, most of the businesses in the sample are located within the service sector; they are of small size and used relatively low capital investment.

Data Envelopment Analysis

The data envelopment analysis (DEA) is a mathematical programming approach that is commonly used to evaluate the efficiency of a number of business units. These units are a set of decision making units (DMU) within organizations such as: branches at banks, departments at hospitals, departments at factories, and faculties at universities where the presence of multiple inputs and outputs makes comparison difficult. Charnes et al., (1978) first introduced the DEA concept and many articles have since appeared that deal with various types of implementations ((e.g. Banker et al., (1984), Friedman and Sinuany-Stern, (1997), Post and Spronk, (1999), Cook and Green, (1999), Maital and Vanisky, (2001), Sarkis (1999), Thamassoulis (2001), Vitner et al. (2006)). Charnes et al. (1978) recognized the difficulty in seeking a common set of weights to determine relative efficiency. They proposed that each DMU should be allowed to adopt a set of weights, which shows it in the most favorable light in comparison with the other DMUs.

Therefore, the DEA allows efficiency to be measured without any assumptions regarding the functional form of the production function or the weights for the different inputs and outputs chosen. Actually the DEA performs a benchmark betweens the DMU. The DEA defines a best practice efficiency frontier that can be used. The efficiency of a DMU is defined as a weighted sum of its outputs divided by a weighted sum of its inputs. Charnes et al. (1978) used the following formulation: the efficiency of a decision-making unit (DMU) *j* incorporated multiple inputs and outputs denoted in equation 1; the efficiency of a DMU *j* is defined as weighted u_r sum of its *S* outputs divided by a weighted v_i sum of its *m* inputs.

(1)
$$\max \; h_0 = \frac{\sum_{r=1}^{S} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

subject to*:*

$$\frac{\sum_{r=1}^{S} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad j = 1,\ldots n,$$

$$u_r, v_i \geq 0 \qquad r = 1,\ldots,m.$$

The DEA methodology can be used to perform a benchmark of similar units within a corporation or to perform a benchmark between similar SME's organizations that has the same set of inputs and outputs.

Dimensions of Inputs and Outputs

The open-system approach to organizations defines them in terms of inputs, transformation and throughputs (Katz & Kahn, 1966), encompassing a cycle interrelating with the environment. This approach (Samuel 1996) states that organizations exist only in mutual interaction with their environments. The environment provides inputs in form of people, material, money, information etc. and the organization – the process of transformation/throughput - produces outputs in form of products and/or services for and to the environment. Taking into account particularities of SME's inputs and outputs were defined in the following way: Based upon former research we define that four dimensions of input in the context of SME's are human capital, costs, marketing and management (Davidsson and Honig, 2003; Randoy and Goel, 2003; Mcmahon, 2001). Three dimensions of output are financial results, clients (Lerner and Khavul, 2003; Watson, 2002; Kushnirovitch and Heilbrunn, 2008) and survival in terms of age of the business. (Abouzeedan and Busler, 2004).

Figure 1 depicts the research model of the here presented study. The model produces efficiency frontiers based upon inputs and outputs of the enterprises under investigation.
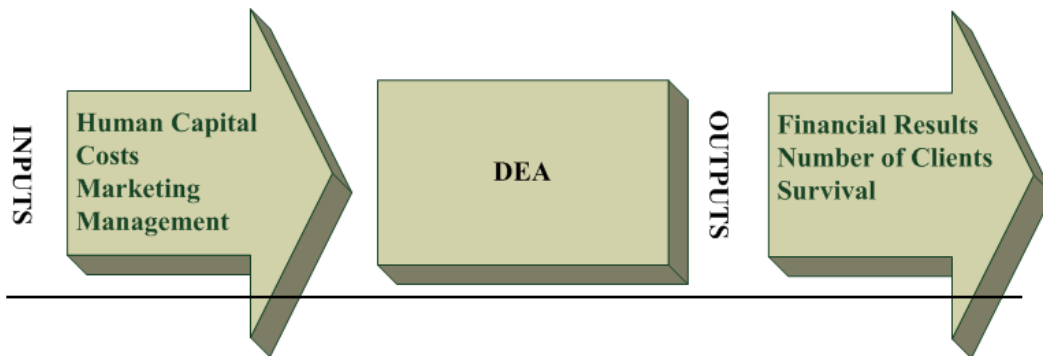
Figure1: The DEA inputs and outputs

Table 3 details inputs and outputs and illustrates how they were scaled in the questionnaire. Inputs and outputs are materialized by using one or more questionnaire items. For example the input of management contains three questionnaire items whereas the marketing input contains two questionnaire items. Table 3 reveals that human capital is measured as a combination of the respondents' answers to three dichotomist questions investigating: whether they were employed or self-employed before starting their business (1), whether their former work experience was in the professional field of their current business (2), and whether they had management experience before start-up (3). The answers to these three questions were coded so that a respondent who answered 'no' to all three questions received the score 1 (has no experience), a respondent who answered 'yes' to any two questions received a 2 (has some experience) and a respondent who answered 'yes' to all three questions received a 3 (has experience). For items costs, marketing and management we asked the respondents to which degree they engaged in the respective activities during the last 12 month. Recipients reported what happened during the last 12 month in terms of profit, number of customers, revenue, gross profit and family income trend. Finally the respondents indicate the business age.

Table 3: Materialization of inputs and outputs via the questionnaire

Inputs	Items	Measures
Human Capital	Human capital in terms of experience	1 = has no experience 2 = has some experience 3 = has experience
Costs*	Labor Cost reduction	1= low, 2 = medium, 3 = high
	General Cost reduction	1= low, 2 = medium, 3 = high
Marketing	Advertising	1= low, 2 = medium, 3 = high
	Other marketing activities**	1= low, 2 = medium, 3 = high
Management	Improvement of Product/ service	1= low, 2 = medium, 3 = high
	Management capability upgrade	1= low, 2 = medium, 3 = high
	Development of new product/service	1= low, 2 = medium, 3 = high

Outputs	Items	Measures
Financial results***	Profit	1 = decreased, 2 = remained stable, 3 = increased
	Revenue	1 = decreased, 2 = remained stable, 3 = increased
	Gross Profit	1 = income does not cover expenses, 2 = income covers expenses, 3 = income higher than expenses
	Family income trend	1 = family income decreased, 2 = family income remained stable, 3 = family income increased
Number of clients	Number of clients	1 = decreased, 2 = remained stable, 3 = increased
Survival	Age of business	1 = 0 – 2 years, 2 = 3 – 4 years, 3 = more than 5 years

*Respondents were asked about their extent of engagement in labor cost reduction during the last year. (to a low degree, to a medium degree or to a high degree)

**Public relations, events, exhibitions, sales promotion activities.

***Example question: When evaluating the profits of your business over the last year would you say that the profit increased, remained the same as previous year or increased?

Results

The DEA technique was performed within the entire 248 SMEs. Figure 2 describes the SME s' efficiency results distribution.

Observing the efficiency frontier distribution denoted in Figure 2 three categories emerge. Category 1 contains SMEs, which received the score of 100 percent, category 2 contains SMEs, which received a score between 81percent and 99.9 percent and category 3 contains SMEs, which received a score lower than 80 percent. The results reveal that 89 SMEs were found efficient, meaning that the weighted sum of outputs divided by a weighted sum of inputs equals 100 percent.We further investigated which input items determined the level of performance? In other words what characterizes SMEs in their respective efficiency categories? Table 4 reveals the taxonomy by presenting the categories versus the inputs. The table depicts the average answer for each input within each category. Therefore, it represents the SMEs' input within the category. For example, for the input "improvement of product /service" the average answer for each category was "to a high degree", thus all the SMEs' within all categories preformed this input with the same magnitude.

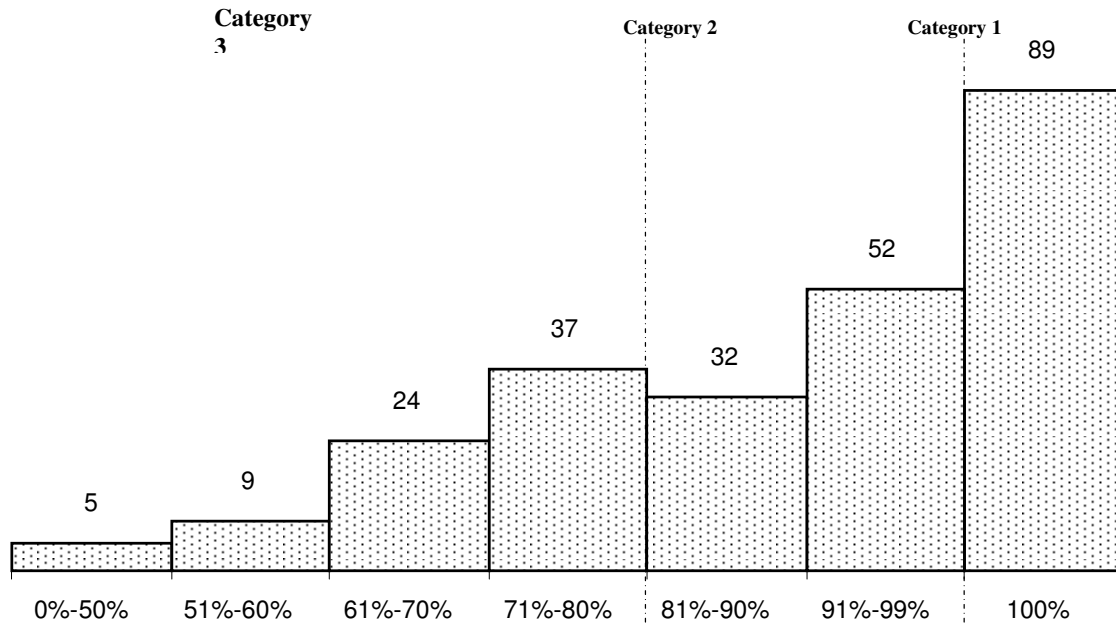**Figure 2: DEA Efficiency Results distribution**

Table 4: Taxonomy Results

Inputs	*Category 1*	*Category 2*	*Category 3*
Human capital	3	2	3
Labor cost reduction	2	1	1
General cost reduction	3	2	2
Advertising	2	2	3
Development of distribution channels	1	2	3
Improvement of product/ service	3	3	3
Management capability upgrade	2	2	2
Development of new product/service	2	2	2

Note: 1= low, 2 = medium, 3 = high

The last three rows in Table 4, indicating management practices, hold no differences. The first four rows can explain why the SMEs within category 1 are the most efficient ones. Human capital in terms of experience of the business owners is essential but not sufficient because the SMEs in category 3 are experienced too. The main differences between the categories are rooted in the owners' attitude toward financial management. Owners of efficient SMEs did not invest in marketing neither in advertising nor in development of distribution channels. Their main focus was on monitoring and controlling their expenditure. These results emphasize the different between an efficient managerial approach for SMEs and efficient managerial approach for large enterprises, stressing the importance of financial management. Therefore, an efficient SME should strive to reduce its expenditure while producing the same outputs.

Discussion and Conclusions

The Israeli definition of SMEs is: An enterprise employing up to 50 workers with a turnover up to $ 5 million and being at least 90 percent of private ownership. The study researched 248 SMEs in the production, retail and wholesale, professional and personal services and tourism sectors. The purpose of the study was to derive a novel taxonomy for mapping successful SMEs. The DEA methodology was employed as a tool for the development of the taxonomy. Based on the DEA efficiency frontiers results three categories of SMEs emerged. Category one denotes SMEs gained 100 percent while the other categories gained less than 100 percent. The taxonomy reveals that owners of efficient SME's concentrated on cost reduction activities.

Efficient SMEs owners did not invest in marketing activities. We found that the least efficient SMEs (category 3) invested in advertising and marketing activities more than the others. Our findings comply with research published on SMEs marketing. Market research indicates that entrepreneurial firms don't take the long term approach to meeting customer's needs, instead their marketing strategies often rely on crisis management, gut feelings and actions designed to deal with immediate competitive pressures (Tang et al., 2007). Compared to large enterprises, SMEs face many unique challenges including: a. limited resources and lack of experience in conducting formal market research and segmentation studies (Carson, 1990; Siu and Kirby, 1998; Bamforth and Brookes, 2002); b. their owners and/or managers lack of marketing skills and expertise (Carson and Cromie, 1990; Siu and Kirby, 1998) and c. the tendency of limiting their marketing to selling within their own industry (Carson, 1990). Because SMEs lack the resources to compete head-to-head with large rivals, it is questioned whether SMEs formally practice marketing at all (Gilmore, et al., 2001). In a typical argument, Hogarth – Scott et al. (1996), considered most marketing theories to be inappropriate for SMEs and not helpful in understanding their markets.

SMEs failed to understand why campaigns did not yield results, as they routinely did not employ appropriate controls and sufficient review procedures (Parrott, 2010). In his research it was observed that SMEs owners and/or managers demonstrated that despite their view that marketing was needed, they retained some degree of indifference to the operational effectiveness of marketing within their enterprise's development. In addition it was found that SMEs emply a "one size fits all" approach, thereby failing to differentiate their marketplace and failing to target and position their products and services as effectively as they could do. Stokes and Blackburn (1999) contend that, while traditional marketing is conceived of as a deliberate planned process which proceeds from a careful identification of market needs by formal research, and through purposeful development of new offerings to the market place, the small business deliberation involves informal, unplanned activities that rely on intuition and energy of an individual (i.e. owner-manager) to make things happen. Small business owners have a problem with marketing and appear to give marketing a low priority compared to other functions of their business.

In the light of our findings practitioners should focus upon budget allocation and handle their marketing efforts with tight control. The novelty of the paper is the usage of Data Envelopment Analysis for the investigation of SMEs efficiency. Based on this study and its methodology, further research should consider the investigation of various populations and business sectors.

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