

## Optimization-Maximization of Marketing Information Systems in Small and Medium Enterprises: A Linear Programming Approach

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### Abstract

*Small and medium enterprises (SME's) adopt software in the marketing area like sales, distribution, warehousing, customer relationship, marketing research, customer service, communications, strategic marketing planning and other areas. The implementation process followed is a need based hierarchy system. SME's fail to foresee the need for an integrated application development which can maximize the investment returns and can bring down the load on key resources like cost and time. The objective of the study is to throw light on most important factors of MkIS adoption among SME's and also develop a model for optimization-maximization of investment using linear programming. It was found that confidence on IT, top- management commitment; management expectations on returns, strategic advantage and creation of effective marketing platform will influence adoption of integrated IT. The model segments the integrated application into independent domain areas for which company specific or industry specific weightages can be allocated and the best possible investment combination can be derived for an integrated application environment. This model is a reference for managers who are on the decisive mode to invest on integrated functional software in marketing or general.*

**Keywords:** Marketing Information System, Small and Medium Enterprises, Optimization-Maximization, Linear programming

### 1. Introduction

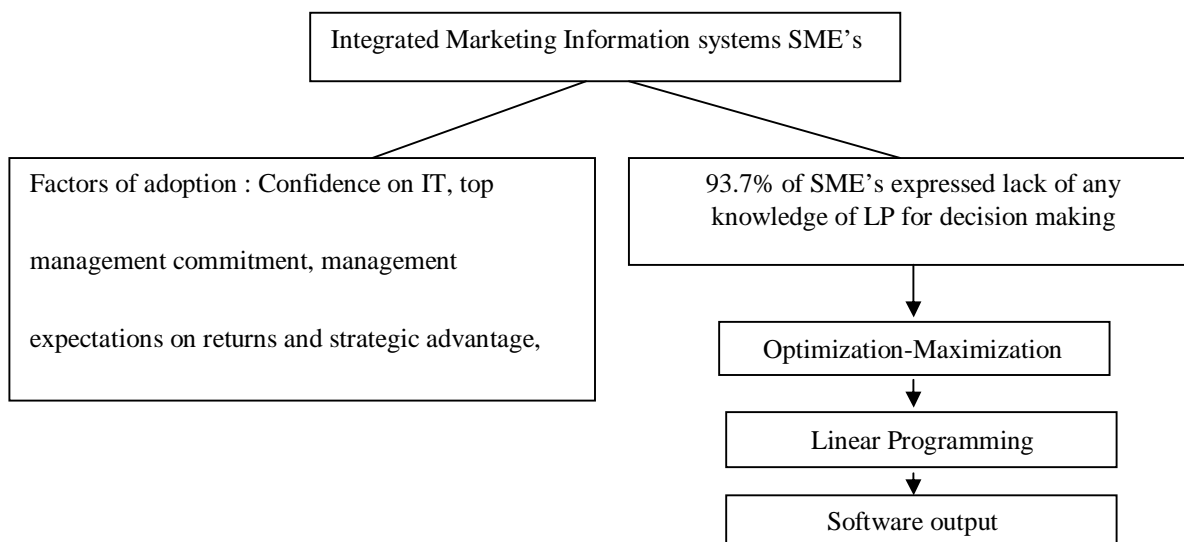
The way organizations manage both planned and unplanned marketing activities in the rapidly changing global open market environment is now one of the most fundamental challenges faced by the management of small and medium enterprises. The growing marketing activities through internet and computer applications forces them to survive, sustain and to create a corporate culture which enables them to face the future with integrated marketing information technologies(MkIS) (Saaksjarui and Talvinen,1992; Ravichandran and Liu, 2011). Gounaris et al, (2007) ; Spiros et al, (2007) have highlighted developing marketing information systems is central to improve the effectiveness of operational management systems, differentiating itself from its competition and deriving competitive advantage. Small and medium enterprises must be able to process a significant amount of marketing information (Levy and Powell, 2000). Without which they may not properly perform any of their required marketing functions hence adoption of IT(Fink, 1998). They must collect and blend a wide variety of marketing information, distribute and use it throughout operations, and generate accurate and timely outputs. Alan and Ewa. (1990) have discussed the role of MkIS supporting marketing decision making, coordination, and control. They also informed MkIS helps marketing managers and employees analyze problems, visualize complex subjects, and create new products. Consequently, it would be logical to assume that the main driver of change is marketing information system (MkIS) (Saaksjarui and Talvinen,1992).

MkIS inputs data, processes it and present the output among the activities. A chain reaction follows and the flow of data-information continues throughout the marketing process. The crucial part of this chain reaction is speed, accuracy, retrieval form, storage and maintenance of information (Alan and Ewa, 1990).

These parameters of MkIS can bring in edge in the competition and one way to make this is by integrating marketing activities by a single software application.

Discussing is easier than done as the SME's score low on readiness for IT (Anders et al, 2011). For integration application, investment is a constraint for small and medium enterprises (Gianfranco Walsh et al., 2010; Bhaskaran, 2013). Hence management should makeup its mind-set for fund mobilization, time investment, re-engineering internal process and many other factors (Fink, 1998; Levy and Powell, 2000; Somers and Nelson, 2001; Ravichandran and Liu, 2011). Among many factors money is the crucial and a constraint for small and medium firms. One of the way's to address this issue is identifying the most important activities in marketing. Important activities differ from one industry to another, from one firm to another. Planning the investment for important activities using decision making tools like linear programming (LP) help management to optimize and maximize their investment (Robinson, and Dilts, 1999). This will allow the firm to improve its profitability within the given investment availability hence the objective of the study (refer figure I) is to throw light on most important factors of MkIS adoption among SME's. Also develop a model of optimization-maximization for integrated information technologies for marketing, using linear programming for small and medium scale companies.

**Figure I: Study Flow-Chart**



(Appiah and Singh, 1998; Seyal and Rahim, 2000). In his study Eliud Dismas Moyi (2003) has identified that 40% of them express this opinion. He further revealed in his findings that entrepreneurs lack of confidence on IT is due to many factors like cost of communications/internet is very high, cost of accessing IT equipment is high, lack of awareness of IT systems existence (Appiah and Singh, 1998; Levy and Powell, 2000), it is useful only for large organizations. His investigation identified all these issues for a general IT environment, but they are also true for an integrated marketing IT environment (Alan and Ewa, 1990). Alternatively other studies by (Spiros et al, 2007; Princely Ifinedo, 2011; Maria et al., 2013) reveal that SME's are fully aware about the benefits of an integrated IT environment in marketing.

**Hypothesis 1:** Adoption of integrated application in marketing is independent of confidence on IT

Top management inclination towards IT in general or integrated marketing enterprise plays an important role. Since the decision makers should have commitment towards foreseeing a long run IT environment (Martin, 1989; Ravichandran and Liu, 2011). Alan and Ewa(1990) found management commitment is very important for MkIS. Bingi et al., (1999) in their study have found management commitment is critical in effecting ERP implementation. They reveal that ERP which is an integrated enterprise needs high end investment and sufficient management time hence their commitment is necessary. Somers and Nelson (2001) in their study found similar factors to be important for integrated IT environment. Also Princely Ifinedo (2011) in his study found that management support and commitment are crucial for acceptance and adoption of an complete IT system by a firm.

**Hypothesis 2:** Adoption of integrated application in marketing is independent of top management commitment.

As discussed investment is an important parameter of thought for management (Ravichandran and Liu, 2011). Small and medium entrepreneurs face difficulties in pooling the financial resources for integrated IT.

It is obvious their expectations to be high from the point of returns and strategic advantage. Gianfranco Walsh et al. (2010) in their study have investigated IT investment leading to strategic advantage. They have found that IT investment along with sufficient skilled human resources and other tangible-intangible resources can give growth in sales, improves financial performance, builds competitiveness and improves overall performance of the firm. Bhaskaran(2013) also found similar findings. Anders et al, (2011) in their study have discussed that management gets motivated only when financial and non-financial benefits are higher than the investment and they seek a low risk environment.

Hypothesis 3:Adoption of integrated application in marketing is independent of management expectations on returns and strategic advantage

Small and medium enterprises equate sales with marketing. They do not differentiate much between sales and marketing, hence at the day's end integrated IT should give tangible results in the form of sales. Growth in sales is the first indicator of successful IT investment (Gianfranco Walsh et al., 2010). Rahul and Richard (2006); Spiros et al, (2007) have found factors like creating distribution efficiencies by cutting wastages and improving lead times, improving customer relations by right communication, enhancing customer service quality by eliminating errors in transactions and other factors create effective marketing for SME's. Seyal and Rahim(2000) had also found similar reasons for which IT is used by SME's. Hugh and Malcolm (2001) in their study concluded that marketing managers should be equipped with possible IT tools for effective decision making. IT tools will help them integrate the whole process of marketing. It will enable to amass the data and deal perfectly

Hypothesis 4:Adoption of integrated application in marketing is independent of creation of effective marketing platform

Complete enterprise integration is a big ticket option not acceptable to many small and medium enterprises. An integrated application with domain specific and catering ready-made needs of the firm is ideal route. SME's will not be able to afford application which needs large number of consultant hours. Hence they expect a ready to do application with minimum tailor fit changes. Somers and Nelson(2001) in their paper have discussed that quantum of customization directly effects project costs, time of implementation, post-implementation complications. Hence selecting a right vendor with suitable application is important factor to address customization issue enabling SME's opt for integrated marketing application. Robinson, and D. M. Dilts (1999) in their study had concluded that SAP and BAAN have developed solutions to optimize the customization issue. They identified that these software vendors have developed minimal customization procedures using operations research techniques to cut down cost and time of implementation.

Hypothesis 5:Adoption of integrated application in marketing is independent of need for customization.

Optimization and maximization is an important issue in integrated IT investment. Amir and Hamidreza (2011) in their study revealed optimization gives an opportunity to generate best possible combination of resources which are a constraint. They also identified resource allocation and further optimization is affected by uncertainties which are both controllable and uncontrollable. Using linear programming or other programming methods optimum combination can be achieved (Caine and Parker, 1996; Gul, 2010). Maximization helps the decision maker to maximize the returns within a given resources combination. Caine and Parker (1996) in their study have discussed that maximization as objective function can be achieved by including variables of decision making, and constraints which affect decision making.

## **2.1 Contribution to the Literature**

Majority of the past studies focused on studying the factors influencing integrated marketing information applications/integrated applications of IT. There are no major studies which have highlighted on how tools like linear programming can be used to optimize and maximize investment decisions in integrated IT in general or marketing. The major contribution of this study is :

1. To study the factors influencing integrated marketing information applications/integrated applications of IT. (followed the footsteps of past research contribution).
2. Identifying factors alone will not address the issue, hence a probable solution technique is also provided.
3. Through this study bring awareness about LP as a tool for decision making for integrated IT among SME's.

### 3. Method

#### 3.1 Dependent and Independent Variables

The dependent variable of the study is implementation of integrated application and independent variables were confidence on IT, top management commitment, management expectations on returns and strategic advantage, creation of effective marketing platform, need for only minimal customization.

#### 3.2 Sampling and Sample Size

Systematic random sampling was used to select the sample elements; database of small and medium scale companies was collected from Saudi chambers of commerce and industry. A sample size of  $n = 356$  small and medium scale companies responded, out of which 219 were small and 137 were medium companies. Sampling design criteria for selecting the sample elements was designed to select only those companies which were implementing information technology in one or more domain areas or implementing integrated information technology. In Saudi Arabia, 1200 (companies) respondents were e-mailed requesting for information between November and December, 2012.

#### 3.3 Questionnaire and Responses

Using the final questionnaire with Likert type nominal scale data was collected from the respondents during June and July, 2013. Out of 384 small companies for which questionnaire was sent, 219 have responded and out of 181 medium companies 137 responded. Chi-square was used to evaluate the hypothesis.

#### 3.4 Scope for Further Research

From the literature review it was found that there is not enough research done on optimization-maximization of implementing integrated information technologies in marketing area, there is a great scope for further research. This study can be extended to identify the weightages of sub-functional areas in marketing for their contribution in achieving the organizational objective across industries and organizations. This research can also be extended to develop an software application specific to achieve maximization of investment in integrated information technology for “n” variables. This study is restricted to only five variables.

#### 3.5 Data Presentation

**Table I : Pattern of type of Sector n= 356**

Type of sector	Paper product	Textile	Food processing	Electrical goods	Industrial goods	Petrochemical	Plastic goods	FMCG	others
Small units = 219	14	7	27	19	34	41	24	21	32
Medium units = 137	4	5	14	10	28	33	22	9	12
Number of Respondent companies	18	12	41	29	62	74	46	30	44

Table I details the categorization of small unit representation in the sample to be 61.5% and medium 38.5%. As per the latest report of chambers the number of small units achieving the status of medium scale has increased from 15% to 27% in last six years. The report says the small units which were established a decade earlier are growing and gaining on experience curve and market prospects. The sample respondent companies producing industrial goods represented 17.41%, petrochemicals 20.78%, and plastic 12.92%. In this study the sample representation is an good estimator of entire population. Companies in Saudi Arabia are dominated by these three sectors.

**Table II: Pattern of Software Application in Functional Areas**

Marketing information systems	Sales	Distribution	Customer relationship	Marketing research	Customer service	Communication	Strategic marketing	Other areas
Number of Respondent companies	356	311	54	74	58	21	46	48

Table II reveals the sales, distribution, warehousing, customer relationship, marketing research, customer service, communications, strategic marketing planning and other areas Today there are very negligible number of companies which are not using computer/computers, cent percent of respondent companies in this study have more than one computer in use, 100% of respondents are operating sales application and 87.3% are using IT for distribution activities. And for remaining activities IT is a low penetrator, it is company specific IT application, rather than universal application.

**Table III: Pattern of Information Processing Needs Met by Existing Software Application**

Information processing needs	YES	NO
Number of Respondent companies	74	282

Table III reveals 20.2% of respondents are satisfied with the existing software application meeting their information processing needs, the growing trend of use of IT in some sectors and in some markets is fuelling everybody to adopt IT and majority of the organizations are realizing the need for the change in their IT policy.

**Table IV: Pattern of Organization Believe in Integrated IT Implementation**

Believe on integrated software application	YES	NO
Number of Respondent companies	317	39

Table IV reveals 89.04% of respondent companies believe in Integrated Information Technologies, this is on a higher side.

**Table V: Pattern of Implementation of Integrated IT Application in Marketing**

Implemented integrated software application in marketing	YES	NO
Number of Respondent companies	0	356

Table V reveals no respondent company had implemented integrated IT in marketing. This is a huge opportunity for IT vendors.

**Table VI: Pattern of Implementation of Integrated IT Application in Any of the Other Area's**

Implemented integrated software application in marketing	YES	NO
Number of Respondent companies	54	302

Table VI reveals 15.1 % of respondent companies have Implemented Integrated Information Technologies, IT will play a crucial role in upgrading the small and medium scale companies in Saudi Arabia. Those companies which have awareness and believe in IT are going slow in the implementation, this trend needs force from outside for a change in attitude.

**Table VII: Pattern of Knowledge of LP in Decision Making**

Knowledge of LP	NO	YES
Number of Respondent companies	330	26

Table VII indicates 92.7% of respondent companies do not have knowledge of LP use in decision making. The managerial staff among SME's mostly expertise in operational issues and have less hands on strategic decision making tools.

**Table VIII: Cross Sectional Pattern of Responses for Factors Adoption and Adoption of Integrated IT in Marketing**

Factors of adoption	Adoption of integrated IT in Marketing	
	Yes(will adopt)	No(will not adopt)
<b>Confidence on IT</b>		
Highly confident	213	11
Some extent confident	47	28
Less confident	38	19
<b>Top management commitment</b>		
Will exhibit high commitment	189	18
Will exhibit some commitment	53	16
Will exhibit less commitment	42	38
<b>Expectations on returns and strategic advantage</b>		
Expect high returns and strategic advantage	247	9
Expect some returns and strategic advantage	49	11
Expect low returns and strategic advantage	16	24
<b>Creation of effective marketing platform</b>		
Will create an highly effective marketing platform	264	10
Will create to some extent effective marketing platform	23	18
Will create an less effective marketing platform	14	27
<b>Need for customization</b>		
It needs high customization activity	81	77
It needs some customization activity	41	47
It needs low customization activity	52	58

#### 4. Limitations of the Study

The factors of adoption found in this study are not exhaustive. The real time implementation is much more dynamic which is not addressed by this study. This study's model can be advanced with more complex programming techniques. This study gives basic idea of what are integrated information technologies, how LP is useful in decision making when there are many variables and constraints affecting investment decision.

#### 5. Results and Discussion

Hypothesis one results show that  $\chi^2=57.76$  with degrees of freedom 2 at  $p<.05$  indicates that adoption of integrated application is not independent from confidence on IT. Chi square distribution results show confidence on IT influences implementation of integrated application. This exhibits entrepreneurs confidence on IT to be important. Similar argument was presented by Princely Ifinedo (2011). It can be said that low confidence on IT will off-set management accepting and later implementing integrated IT. Entrepreneurs need to be educated with successful stories detailing the achievements of those who have implemented integrated IT and reaping its benefits (Appiah and Singh, 1998). Seminars with experts will upgrade the knowledge of entrepreneurs in understanding the need for integrated IT. Bingi et al, 1999; Princely Ifinedo, 2011 have revealed adoption of integrated application in IT is dependent on top management commitment which is similar to the results of hypothesis two  $\chi^2=54.31$  with degrees of freedom 2 at  $p<.05$ . Entrepreneurs who lack knowledge of what IT is, what it can do for them (Eliud, 2003) and what role integration play's in improving the business are less favorable towards IT. When entrepreneurs are favorable they can pool-up commitment for themselves and their team (Martin, 1989). Hypothesis three results show that  $\chi^2=104.27$  with degrees of freedom 2 at  $p<.05$  indicates that adoption of integrated application in marketing is no independent of management expectations on returns and strategic advantage (Gianfranco Walsh et al, 2010; Anders Haug et al 2011). Timeframe of expected returns by small and medium entrepreneurs is short. They expect to derive a sea change advantage in short-run hence one of the major constraints for the managements is investment and in addition investing in IT is seen as a secondary investment. On the other hand primarily manufacturer views investing in machinery, raw-material gives straight benefit and tangible in nature. On the other hand investing in IT is looked as indirect investment which is expected to benefit them in long run and intangible.

Hypothesis four results  $\chi^2=134.35$  with degrees of freedom 2 at  $p<.05$  indicates improvement in the marketing results affects entrepreneurs accepting integrated IT. Previous studies (Hugh and Malcolm, 2001; Rahul and Richard, 2006) indicate similar results.

Though the hypothesis is accepted and has the support of past research like (Hugh and Malcolm, 2001) but with SME's it's difficult to believe. The major factor in the marketing is sales. Small and medium entrepreneurs being short sighted are ready to accept integrated IT if it can deliver increased sales. Since SME's depend on immediate profit making they cannot wait for long term benefits from marketing. Hypothesis five  $\chi^2=0.658$  with degrees of freedom 2 at  $p<.05$  confirm adoption independent of customization. Past research (Robinson and Dilts, 1999; Somers and Nelson, 2001) found that when customization-time and cost of new application is low client acceptance is more favorable and vice-versa. The trend of the result is due to lack of awareness of IT application benefiting the business process. Small and medium enterprises are traditionally brick and mortar style entrepreneurs. Firstly the intake of technological input is low hence customization is a far cry issue for them.

## 6. Conclusions and Strategies

The growing global competition demands to be more competitive in integrating the sub-functions within the marketing. Real-time updating with information about customers, competitors, substitutes, new opportunities and suppliers is necessary to be competitive. In developed economies large number of companies including small and medium enterprises are fully implementing integrated information technologies and driving the competitive edge in the global market place (Zhenyu and Prashant, 2001; Maria et al., 2013).

Confidence on integrated IT is one of the most crucial factor for SME's to adopt new applications (Saaksjarui and Talvinen, 1992). The study hypothesis also proves the same argument. The way out is to build confidence among entrepreneurs that integrated IT will deliver the benefits on par with the investment done (Porter and Miller, 1985; Fink, 1998). Confidence on integrated IT being the stepping stone will indirectly help management develop commitment towards new applications (Eliud, 2003). Growth of small and medium enterprises is important for economy and employment. The role of government departments is to bring SME's on to IT platform. Organizing seminars, workshops, offering IT subsidies, free IT services, IT linked sops Bhaskaran (2013).

IT investments need high level commitment of top management (Levy and Powell, 2000). The gestation period of IT implementation is short hence managements misinterpret the timing of results to be short losing sight of IT project. They need to be ready for a long-run commitment as both tangible and intangible returns will be felt after few operational cycles (Martin, 1989). Commitment is needed for constant tracking the project implementation, motivating the implementation team, frequently attending the group meetings, helping in troubleshooting the operational issues (Martin, 1989; Ravichandran and Liu, 2011). To make managements commit to integrated IT they should be offered IT achievement rewards, awards and should be recognized with special status. Help of experienced consultants should be offered as a supplementary service for improving sales. IT along with sales expertise will be successful combination.

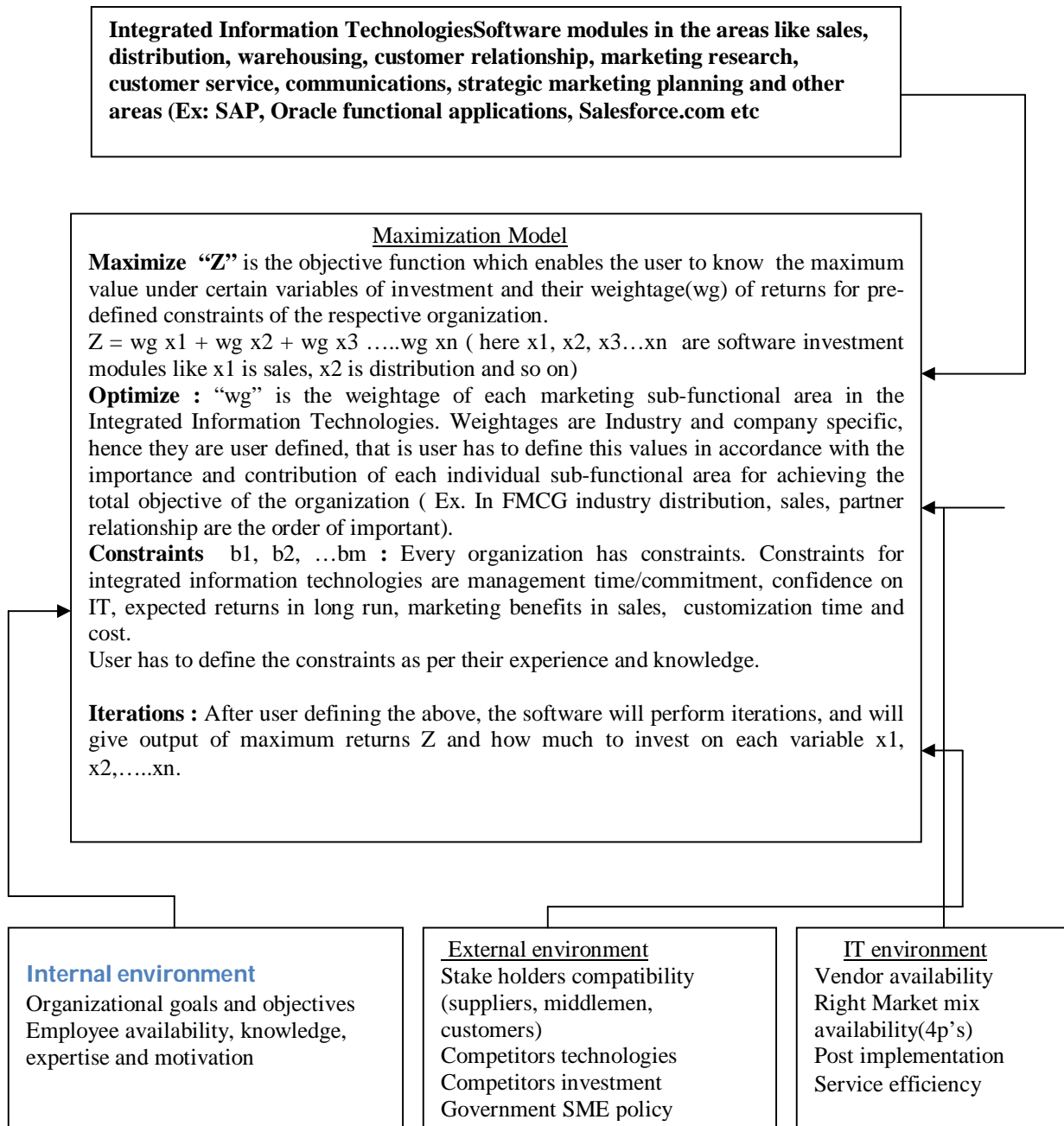
SME's expecting financial returns is justified. Since investment decision is crucial from the point of financial constraint. Returns on investment (ROI) in integrated IT projects cannot be immediately achieved. The visibility of financial advantage on balance-sheet needs two to three financial years of successful implementation of IT project. Maria et al., (2013) in their study concluded that all the constraints need to be addressed like in the implementation like project not matching the present operational needs, changes in the operational needs after implementation, lack of understanding in running the project, unable to access the IT consultant services on time, escalation of project cost, lack of technical manpower in running the project and many other factors. The role of IT vendors in educating the SME's on financial returns will be helpful in understanding the issue of returns. Since returns are an immediate issue with entrepreneurs, cost of investment should be minimized by financial assistance or soft loans.

Data from operational level will take a year or two (Porter and Miller, 1985; Levy and Powell, 2000). Connecting to partners is also an important issue. Effectiveness of IT in marketing can be assessed on how well it helps in strategic activities like planning of marketing activities and budgets (Hugh and Malcolm, 2001; Spiros et al 2007). SME's do not prefer customization of software to their specific needs rather they like to implement a software which is like a mass product. They want minimal or no customization changes in the software. Large number of customization changes need more consultant hours escalating the cost of project.

The probable ways of dealing with this situation are a software which meets average needs of SME’s or cloud computing which allows them to use software for a subscription fee.

Investment in IT needs a planned approach with a focus on optimization and maximization. To address optimization-maximization a model is developed ref fig II which is sketched into three levels. First level defines

**Fig II: Model for Maximizing the returns on Integrated Information Technologies by Small and Medium enterprises**



Integrated information technologies, Second level details the maximization model of investment on IT for small and medium enterprises and Third level throws light on three environments which will directly or indirectly influence the integrated information technologies. A simplex method algorithm (given at the end) is developed to optimize the investment with return maximization. Further a pilot software code was written generating three screen shots. Once the values are feed into the screen shots it will give maximized return value. For practicing managers there are many advanced decision making software’s like the one developed in this study.



In the global competitive environment, implementation of integrated information technology will give edge over competitors and strength to sustain the competitive heat (Porter and Miller, 1985).

IT investment by an organization must have a rational policy, which keeps in view parameters like competitors, organizational needs and other possible parameters which influence IT investment shown in the model. Success of integrated marketing IT project will be felt immediately at operational level. Entry level and front office transactions will enable in understanding the IT advantage. For strategic level advantage amassing of large

## 6.1 Simplex Method Algorithm

### 1) Declaration of Variables

- Declare an array of weightages [] of size as 6 as type Double to store the weightages of in the Equation.
- Declare an array  $Z_j$  [] of size as 6 as type Double
- Declare an array  $Z_{cj}$  [] of size as 6 as type Double
- Declare an array  $X_{i+1}$  [] of size as 3 as type Double.
- Declare an integer variables pivot column, pivot row to store the index of pivot column element, pivot row respectively
- Declare a double variable Key Element to store the key element of iteration in the solution table.
- Declare a two dimensional array of 3 x 6 size to construct a simplex table array.

This screen shot is to input the values in Z function in terms of Weightages, they are Industry and company specific, hence they are user defined, that is user has to define this values in accordance with the importance and contribution of each individual functional area for achieving the total objective of the organization under constraint conditions which are also user defined as detailed in the model above.

The screenshot shows a window titled "Equations" with a light orange background. It contains the following text and input fields:

Z =  x1 +  x2 +  x3

x1 +  x2 +  x3 <=

x1 +  x2 +  x3 <=

x1 +  x2 +  x3 <=

(x1, x2, x3 >= 0)

At the bottom, there are two buttons: "Submit" and "Reset".

Note 1 : Algorithm, software code and screen shots are presented in the paper to demonstrate IT skills, value addition to the paper, and give an idea to the reader how the software and its output looks in reality.

- 2) Assigning all the values of weightages [] to  $Z_{cj}$  [].  
// Using do-while looping
- 3) Obtaining pivot column index by calling the method Max (.) by passing argument as  $Z_{cj}$  [].
- 4) Obtaining pivot row index by calling the method MinRat (...) by passing argument as MinRat [].
- 5) Calculating Key Element of solution table and assign it to Key Element
- 6) Performing the row transformation on the Solution table and calculating  $X_i$  [].
- 7) Initializing  $Z_j$  to 0 and Calculating  $Z_j$
- 8) Calculate  $Z_{cj}$ .
- 9) Checking the condition for continuing the next iteration.  
If any  $Z_{cj}$  [] value is greater than zero  
Continue the step from step – 3
- 10) Calculate  $Z_{max}$ ;
- 11) Printing  $Z_{max}$  and  $X_i$  Values

This screen shots will display the Maximum Z value and Variable values



Technology: Dot.Net

Language: C#(C-Sharp 5.0)

Framework: Windows 3.0 onwards

Operating System: Windows XP

Requirements to run the application: Framework 3.0 onwards

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