

Technology Enabled Entrepreneurship under Poverty Alleviation Programme

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ABSTRACT

This paper talks about how technology can be used for generating livelihood in poverty alleviation programmes. Lending from microfinance to the farmers may not be utilized fully for production purposes. Lack of knowledge about the optimum price for their produce and the market where the produce has the maximum demand often drive the farmers to desperation. In their eagerness to sell the produce, they sell their products to commission agents or in the near by market which often, does not result in full market potential of their produce. This paper shows how farmers can invest in cellular phones and get the benefits of technology for getting the maximum profit and become entrepreneurs in a self-sustaining manner. To illustrate the viability of the approach, e-choupal has been used as an example. Using the same example, return on investment has been calculated which shows that the investment in technology actually results in surplus which helps in improving their living conditions and helps in poverty alleviation.

Key Words: *Small scale entrepreneurs, Livelihood, Mobile technology, Technology enabled livelihood, Poverty alleviation.*

INTRODUCTION

Technology has been changing its role. In the 1960s, organizations used to think IT as an overhead and spending on IT were critically appraised before getting the go ahead for investment. In the later stages, IT took an enabler role and helped the organizations to achieve their corporate objectives. In this decade, however IT has become a competitive tool and organizations have used IT to make strategic moves while introducing new products and services. In fact, in many industries, IT has made the organization to get competitive advantage over its competitors by simplifying the processes, re-engineering the entire business processes, introducing new business models and modifying the existing business models so that customer is delighted. Through automation of business processes, IT has helped to increase productivity with consistency which is sustainable and scalable resulting in satisfaction for all the stakeholders. Increasingly environment is becoming an important stakeholder in any business model and it becomes a critical factor that all the major players in environment are satisfied. In an agrarian society, rural citizens are important players as 'environment' stakeholders. However, due to various historical reasons, large numbers of rural citizens are economically backward and improvement of their living standard is necessary to improve the quality of various produce from rural areas and their purchase power. To ensure economic growth rate and market sustainability of produce, this player among other environment stakeholders needs to be integrated into the mainstream of development. In this research, IT has been used to arrive at a

sustainable and scalable model for helping farmers to improve their standard of living and purchase power.

In the above mentioned context, this research has been done to arrive at a sustainable and scalable business model for improving living standards of farmers and thus, provide justice to them bring in transparency into the business transactions which would improve credibility of the model have better control in project management which would help in consistency and predictability in all the projects.

BACKGROUND

India has a large agrarian population and post independence their importance has been challenged by industrial revolution. While the productivity from agriculture has increased, still it is far from being self sufficient. Exports from agriculture have increased, but still a vast population which depends on farming for its livelihood, has remained below poverty line. There are many factors that have contributed to their cause, notably among them are, (1) licence regime which has stopped the mass from thinking beyond their area of knowledge in farming, (2) and the farmers owning only small, often infertile and unproductive piece of land. Lack of literacy and lack of exposure to modern techniques in farming have compounded to their problems. In addition to this, the trade system in India has middlemen or commission agents (CA) who make most of the system by making money through unscrupulous means. For example, Soybeans is an important oilseed crop and is largely produced by farmers with small land holdings. The produce when harvested is sold by the farmers to traders or CAs. These transactions take place in a local market place called mandi; the prices of these transactions are usually decided by CAs in negotiation with farmers. However the farmers do not have full knowledge about the fair market price of the Soybeans and as a result

go by what the CAs decide. As a result, often innocence and lack of knowledge leads to less price realization for the farmers for their produce than what they could have got in a fair trading. So on the day of sale, the farmers accept the price offered to them by CAs in auction. As a result the CAs use the asynchronous knowledge between the farmers and market to exploit the situation and offer low price to the farmers.

The CAs however, make money by selling Soybeans in the city for consumption at a higher price and thus gain from the inefficiencies inherent in the trade system. The state of living standard does not change for the farmers as they do not get the possible fair value of Soybeans and in addition to this lack of knowledge about the modern farming techniques to improve agricultural productivity compounds their woes.

ISSUES WITH THE PRESENT SYSTEM

- The farmer does not have enough knowledge about the price and demand trend of Soybeans. Hence he does not know the right season to harvest the agro products so as to meet the peak demand season. At present the timing of the harvest and subsequent selling might not meet the consumer demand trend resulting in less realization of price.
- Mandis are local trading places used for auctioning of agro products. Mandis are usually located at distance from each other and cater to the demand of near by locality. The prices of agro products vary from one mandi to another based on several local conditions and farmers do not have knowledge of this variation of this price. As a result of this lack of knowledge about different pricing in different mandis, the farmers do not

travel and sell in the mandis where there could be greater realisation of prices.

- CAs exploit the situation at the seller side (farmers side). Asynchronous knowledge on the part of farmers related to fair market price, results in CAs buying the agro produce at a lesser price.
- On the other hand, CAs inflate the price while selling to the consuming organization (ex: ITC, Godrej or any other such organization which used this produce as an input for further processing). The buyer has no option but to accept the prices and the difference is pocketed by these middle men.
- Depending on the demand and supply, there could be fluctuation of price in day and this information related to intraday price fluctuation was available to CAs only. These CAs used it to their advantage it was not passed onto the farmers.
- The crop produced are usually of different grades, meaning in one harvest there can be a high grade of Soybeans as well as a lesser grade of agro produce. These grades need to be packaged separately by the processing organizations based on their grades as each grade need a different treatment. Subsequently the pricing strategies of these processing organizations are dependent on the quality or grades of the produce. This implies that the produce need to be packaged separately. In the present mandi system this is not possible. In mandi system, all the produce need to travel long distances through different CAs and this implies that from the beginning all the grades are mixed together and packaged together. At the end, this is not possible to unpack these produce and then again repack them as per

their grades. In addition this flaw in the system leads to incorrect realization of higher price for higher grades of produce for the farmers. So the farmer does to get motivated to produce high quality of produce.

- These flaws also ensured that there could not be direct interaction between processing organizations (end users) and the original sellers (farmers). As a result, end users did not have good knowledge about the issues faced by farmers, were not well versed with risks associated with the entire supply chain system. Because of lack interaction modern techniques could not be used for farming as there were no way these types of feedback from end users could reach farmers.

Because of these issues, the farmers could never benefit from their own farming and the living standard remained at the same level. The self sustaining entrepreneurship seldom became successful, which resulted in labour migration. In particular, where local knowledge was used such as handicraft etc., the business became non remunerative and the artisans, instead of becoming entrepreneurs, started looking out for jobs to earn livelihood.

To address these issues, solution from Microfinance was considered as an option of reducing poverty by providing requisite funds to the farmers as credit to sustain their business and making them independent through entrepreneurship ability. Throughout the developing countries, microfinance route has been taken as a poverty reduction strategy. Here, it is assumed that to increase living standards, there should be investment for productive purposes. The finance obtained from microfinance route should be used more for the productive purposes. Even though it can be argued that by using finance for consumption can result in investment in human capital and

this will help in the long run, still this paper addresses the reality of existence from a sustainable point of view. The sustainability implies that the investment in production helps in short as well as in the long term (Chavan and Ramkumar, 2001). These investments have the potential of income generation, providing self employment opportunities, which lead to poverty alleviation and entrepreneurships. Thus, a permanent improvement of living standard can be possible if the borrowed money is used for productive purposes and the investment is self sustaining.

Self sustaining investment helps to generate profit from business transaction which can be reinvested (Sisodia, 2007). This ensures that poverty reduction becomes self sustainable and farmers become entrepreneurs. The present study looks into e-choupal as an example. In this example, using the proposed framework, it has been shown that a farmer can become an entrepreneur if mobile technology is used as an aid. In a study, Khandker (1998) found that microcredit had a good impact on some of the small entrepreneurs, where the recipients of the credit could lift their living conditions and out of poverty level by investing in productive purposes. But the study also revealed that there was a question mark on the sustainability of these programmes. The reasons attributed to these were lack of knowledge related to market potential, pricing strategy and new technology. As a result, in the long run, poverty reduction through micro credit alone became difficult. Similarly, recovery rate of the loan becomes a deterrent in poverty alleviation and making farmers self sustaining entrepreneurs (Rahman, 1999). If the recovery rate is high, then the farmers take recourse to loan recycling, which increases their debt burden. This method goes into a vicious cycle and does not help in becoming entrepreneurs. If the farmers are able to sell their produce at the optimum price and at the market where there is a demand for their produce, and then there is a good chance that they would earn enough

profit to pay off their debts rather than recycle the loans. Similar views are also expressed by Hulme et al. (1996) and Mahajan (1997).

These discussions lead to the point that for self sustaining entrepreneurs, micro credit should be coupled with “knowledge enablers”. These “knowledge enablers” will provide sufficient information to the entrepreneurs so that they can develop their pricing as well as marketing strategy. This will provide opportunities to them for growth and make their investments profitable. The profitability will ensure that they can repay the loan and improve their living standards. A technology based framework can be developed, which will link farmers to the end users through usage of technology. The framework will also bring transparency in price by providing related information through computers. In earlier mandi system, the farmer travels all the way to mandi to find the price for his produce. The e-choupal system ensured that the farmer gets this information before hand so that he can take a decision related to choice of day for the sale of his produce. Thus, farmer’s transportation cost and handling cost reduce to a great extent and he is not at the mercy of CAs. In this case, the IT based model helped to achieve parity in the environment by helping the farmers to achieve a better living standard.

In the following section, issues involved with poverty alleviation are discussed so that root cause analysis of all the issues can be discussed. This will help in fine tuning the framework. In poverty alleviation programmes, there are different stakeholders, namely, Entrepreneurs (farmers), Government, Sponsors (who usually buy the produce from entrepreneurs), micro-credit agencies (who provide loans). In the present framework, one more stakeholder has been added, i.e. mobile service provider. At present all the stakeholders have different issues and problems. These problems are depicted in a fish bone diagram in Figure 1.

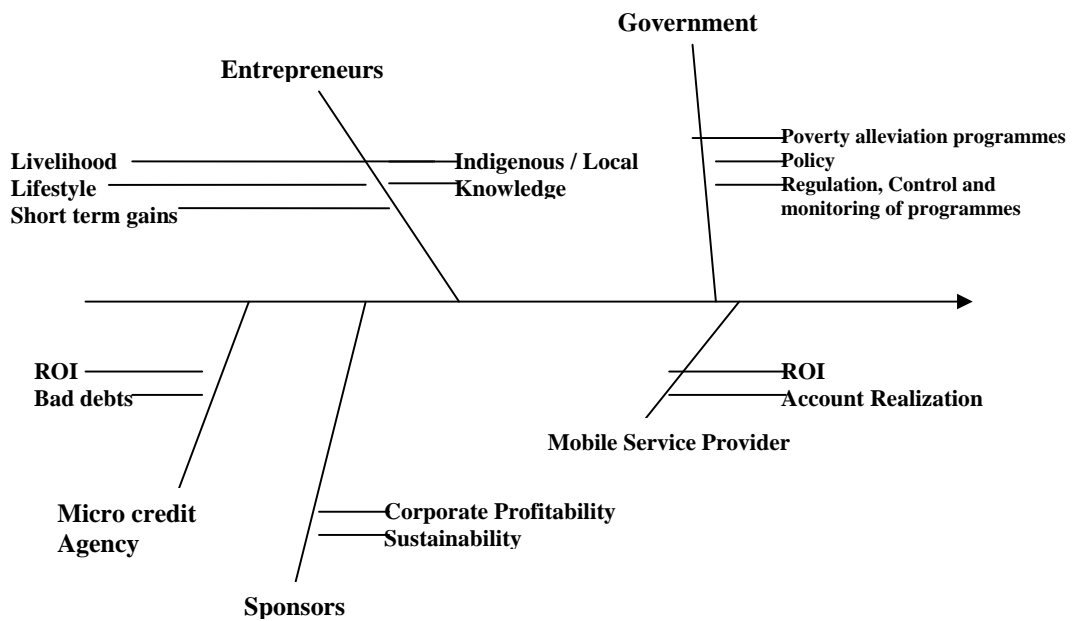


Figure 1. Causal analysis of issues with poverty alleviation

Each stake holder has problems which seem to be mutually exclusive, however in reality they are all inter linked. If a solution can be arrived which can take care of problems related to all the stakeholders, then the solution can be sustainable in the long run. In the following section an approach has been discussed as to the way the solution can have impact on all the stakeholders giving them benefits. This solution can be then replicated in different geographical locations with minor changes in the approach to suit the local culture and conditions.

THE FRAMEWORK

There lies a huge gap between the demand and supply of microfinance services in many countries. Successful microfinance operations in many countries have proved that lending in the rural India can be remunerative to the commercial banks, developmental banks and other financial institutions. Two broad types of lending strategies can be useful in the Indian context, asset based lending and cash flow based lending. Examples of asset based lending include advances against inventory, accounts receivable, saving deposits or shares of stock. The size of an asset based loan is determined by the value of the asset pledged as collateral. Cash flow loans are not based on collateral, although they are often secured to prevent the borrower from pledging assets to other creditors and as a test of the borrower's commitment to repayment. The size of cash flow loans is determined by the projected cash flow generated by the loan usage. The repayment capacity of the farmers is quite low. This poses a major threat for financial interventions in the rural India.

There are two distinct ways to deal with the problem of low repayment capacity: First, is to devise instruments for which the - repayment capacity is not prohibitively high and second more productive way is to enhance repayment capacity at the frontier. Grameen bank is an example of the first approach whereby it is providing credit to borrowers with very small capacity. Financial initiatives create debt capacity by lengthening term structures, by reducing transaction costs, by refining valuation process and by increasing the supply of loan-able funds by mobilizing local resources. In the given scenario, when there is likelihood of 'e' (Information Communication Technology) further penetrating in rural India. In this context, e-microfinance Business model can be considered as a strong business model, which a company like ITC can take forward and use for the development. Here, e hub

can be used for interacting with farmers on SHG issues. At the e-hub SHG members as well as field worker can come and avail the information available on health, education, technical knows of the product/services of their interest. e-hub again can act as procurement centre of various products which can be further packaged and sold in various domestic retail chains. Saving which is the forgotten part of microfinance can be taken care of by this initiative. A mobile handset can be provided for each SHG. This mobile can be used to get quotes and information from the e-hub; the quotes and information related to stock demand, rates at which the commodities are being sold, prices quoted by different buyers can be obtained through mobile. The updated information will help the SHG members to select the buyers for their produce and they can decide on the most profitable market players. This way the SHG can not only do away with the CAs (Commissioning Agents), but also will not be dictated by one buyer alone. However the paper suggests an approach called 'opinion leader' based approach which will ensure acceptability of the business practices through mobile based trading.

The solution suggests that each SHG appoints an opinion leader among them. The opinion leader is to be selected based on combination of factors, viz. experience, level of education, age, social standing. The process of selecting the opinion leader is to be completely decided by the SHG so that higher level of compliance to decision making process within SHG can be found.

The SHG will also appoint one 'mobile leader' who will be the person responsible for getting information related to demand for commodities, prices at which the commodities are being sold in different markets. This information is fed to the opinion leader for final decision making. The mobile leader is however is not a fixed position and is rotated among each SHG member every week; this not only results in

participation among each SHG member, each member is trained in usage of mobile, gets a feel of market and the prices, sees the bigger picture as to have his or her produce fit in. This way the member can also give his or her suggestion related to the product mix that can be sold in that week. Using these information and knowledge, the opinion leader will interact with outside agencies and would decide for the entire SHG as to the buyer to whom they would sell the entire produce, their credit policy. He can also take decision regarding the investment required for furthering their business and improve their lifestyle. The mobile handset will be provided by ITC at a subsidized rate and can be used for only receiving quotes and market related information thus reducing any chances of misuse and high monthly running cost. The quotes can be obtained from e-hub through SMS which has already been set up in e-choupal. However proper training on usage of mobiles should be provided by ISPs (which provides the network services to e-choupal); this will facilitate ease of use for mobiles for each SHG and can ensure effective utilization of mobiles for information gathering.

PILOTING THE MODEL

It is suggested that the model be piloted in one e-choupal and depending on the success the model can be replicated in all e-choupals. While piloting care will be taken to ensure that proper monitoring of the progress of the model implementation is carried out, success criteria for pilot implementation is defined and roles and responsibilities of SHG member is clearly communicated to the team members (SHG team). The pilot study should be conducted in a project mode with milestones being defined for every activity; also there should be defined project organization structure. Suggested project organization structure for pilot implementation is shown here.

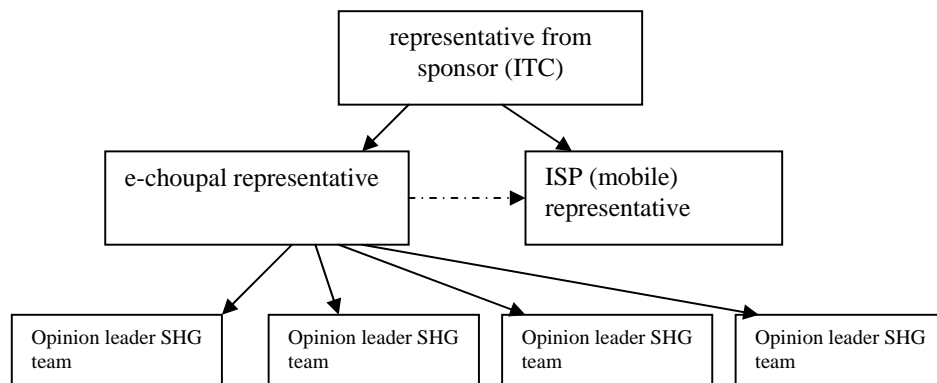


Figure 2. Organization structure for pilot implementation

As shown in figure 2, the sponsor representative controls and monitors the pilot implementation. The sponsor has the responsibilities of negotiating for getting the best deal on mobile, discussing with e-hub to decide on the mode of transferring rates, quantity and buyer information to mobile users (the mode of information transfer includes language of information transfer through SMS, mobile tariff plan, frequency of information of updates etc.). For the pilot project, he has to define success criteria. It is recommended that pilot success criteria takes care of behavioural aspect of SHG towards this model, finance viability of the model based on economy of scale and sustainability of the model in the long run based on the degree of control and monitoring required for the same. Some of the suggested pilot criteria can be acceptability of the model from all the SHG opinion leaders, improvement in the saving capacity of SHG members, comfort level of sponsors in terms of returns envisaged from economies of scale. He also has to ensure that e-choupal representative does the cost benefit

analysis for each SHG; this will ensure that the each SHG can have sustainable growth in the long run and improve its lifestyle. E-choupal representative on the other hand will not only look into the sustainability of SHG but also will work with opinion leaders to ensure that training on mobile usage is provided to SHG members, effective utilization of mobile technology is ensured. He will also address any specific concern or issues that the SHG would have and will interact with the sponsors to solve them. Opinion leader will have the responsibilities to make decisions related to selling their commodities to the correct buyer at the correct rate, making a decision on the product mix that would give the best margin and take decision on further investment in the business.

Here, what is suggested is players like ITC can distribute small loan to SHG members and can get the interest on small loans as well as can buy the product which is resultant of their ethnic wisdom and technical consultancy provided by ITC on website. It can lend to the farmers for activities like making pickles, papad (a type of Indian snack) etc. Through e-hub and the field agents' information can be disseminated to the farmers regarding the quality standards, markets, demand etc. Helping the farmers in such a way would make them self sufficient. In certain ways, it is likely to create self sustaining business for them. For performing such operations efficient field agents are required.

Here, it is appropriate to mention that currently loan size is not very big for SHG members, on an average it comes out to be Rs. 2000 per SHG members. Here the main issues to be handled are financial viability of this business, ensuring quality of products/services by SHG members, training of e-users and interest in ethnic products mainly foods and apparels. The proposed model would meet the daily needs of livelihood earnings as well as meet the need to improve lifestyle of the

SHG members. Even though the actual business output may vary depending different factors such as demand and supply, quality of output, still economies of scale show that this approach is sustainable in the long run. Economy of scale has been calculated based on simple assumption of normal business transactions and any exception to this assumption can affect the profitability (for example failure of crops and other natural calamities). The mobile hand set can be procured in a mass scale; a conservative estimate indicates that mobiles can be procured at Rs. 1200 per set per SHG. Rs. 1600 can be spent for investment in business out of the loan sanctioned for each SHG (loan amount sanctioned for each SHG member is Rs. 2000). Assuming 5% subsidized interest charged for the loan amount and assuming a conservative figure for average business life cycle of 30 days for the complete product mix and a return of 20% for each business life cycle, the net income for each SHG member turns out to be Rs. 1875 per month. The detailed calculation is shown here: the loan amount for each SHG member is Rs. 2000/-; the amount to be spent for business is Rs. 1600. For each member the interest cost per annum (assuming subsidized rate of interest at 5%) comes out to be Rs.100. The cost of mobile hand set has been assumed to be at Rs. 1200 per SHG (typically one SHG will have 8 members). Considering the life span of mobile handset to be 3 years, the cost of mobile handset when apportioned over each member turns out to be $(Rs. 1200/(3 \times 8)) = Rs.50$ per annum. The cost of using mobile (that is the subscription cost per mobile) is assumed at Rs 250 per month. So the cost of mobile subscription per member per annum is calculated as $(Rs. 250/8) \times 12 = Rs.375$. Hence total cost comes out to be Rs.100 (interest cost) + Rs.50 (mobile handset cost) + Rs.375 (mobile subscription cost) = Rs.525 per annum.

The average business cycle for the product mix has been observed to be one month cycle. The SHG members sell papad, Soya, candles, incense sticks (agarvati), and bakery products, tribal arts & paintings,

traditional sarees / apparels which when averaged can rotate the business every month. Hence in a year the business can be turned over 12 times. In practice, this could turn out to be a conservative estimate; however the purpose of the calculation of this economics is to show the viability of the model in the worst of business scenarios. Considering this situation, the business turns over of 12 times per annum with 20% return has been calculated as $\text{Rs. } 1600 \times 1.2 \times 12 = \text{Rs.}23040$ per annum.

The total savings per SHG member is thus $\text{Rs.}23040 - \text{Rs.}525 = \text{Rs.}22515$ per annum or monthly $\text{Rs. } 1875$ (approx.) is available for his household consumption. It is observed that this amount can be a good situation for making a healthy livelihood and maintain present lifestyle. With each year, this amount is bound to increase with increase in productivity, increase in business acumen of the SHG members. As the loan amount is squared off over a period of time, the SHG members can sustain on their own without any burden of debt on them.

In a recent report circulated by mobile marketing association (www.mmaglobal.com,2007), it has been found that mobile marketing is opening vast untapped potential. Interest in using mobile phones to receive content and services is steadily increasing. Most network carriers or ISPs can support mobile traffic to provide information based on a short code sent by the mobile user. The cost of sending the information can be billed directly to the mobile user through direct to account billing. By standardizing the mobile services based on short codes, the mobile users can receive information for prices for their commodities. This approach also allows customized information to be sent to mobile users. This helps in getting the right message (read right prices for exact commodities) at the right time. e-choupals will maintain e-hubs from where information can be broadcast and the

same can be received through SMS. The cost of technology and providing service to the SHG members through SMS service will be low as demonstrated by Bharati Telecom and Hutch in today's Indian market. With wide usage of SMS, this cost will be still less. Thus our proposition for using mobiles to get information will be the cheapest, fastest and accurate. This improvement in technology in mobile usage can be used effectively in e-choupal transactions and increase the viability and sustainability of the proposed model.

CONCLUSION

In this study, technology has been used for supporting poverty alleviation programs and enabling farmers in becoming entrepreneurs. Technology has played role of enabling the business and reduce cost of operations. The reducing cost of technology has helped to bridge the digital barrier and masses are able use technology for enabling their business models. Using technology, a framework with an approach for implementation has been illustrated with return on investment calculation to show the viability and sustainability of the framework. The framework attempts to understand and explain business alternatives. It also demonstrate the role of e-microfinance as an enabler to achieve symbiotic relationship between corporate and society. ROI has been calculated to show that technology investment males poverty alleviation programme a viable one. The present research can lead to further work on using technology for enabling entrepreneurs engaged in farming other agricultural products. The approach can be applied, with suitable modifications, for bottom of pyramid that are dwelling in both rural as well in urban areas.

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Optimization Model of Supporting the Small Business Enterprises

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ABSTRACT

This paper is investigated some credit allocation models for borrowers-representatives small and middle business and support problem of the poor part of these clients. The constructed algorithms are based on finding the optimal solutions of considering models. The model will be easily applicable to a similar situation that the management encounters.

Keywords: *SMEs, Credit allocation, Credit risk, Gibbs' Lemma, Maxmin problem, Dynamic programming, Penalty function method*

INTRODUCTION

In applying of mathematical methods for research financial operations in the Mongolia to confined the linear approach: linear programming and linear regression and etc. Necessary to use powerful facility nonlinear problem of mathematical programming and game theory. Great attention is paid to microfinance on the part of international financial organizations as well as with side governments. That is why necessary became question about construct and the researches to construct mathematical models of the rational conduct of microfinance operations in Mongolia [1,7,9].

It is possible has the problem of the distribution of credit money by bank-monopolist which is keen in maximization the incomes of the borrowers-representatives small and middle business, and when the purpose of credit organization or the project of supporting middle and small business consists in the support of the poor part of clients that we must decide maxmin problem. In above cases interests of borrowers and supporting creditors almost are coincided.

In this work are developed the decisions of the problems of the allocation resources with limitations. These algorithms are used for deciding of the various problems of maximization the summary income of borrower's the-representatives of small business and the problems of the minimization of credit risk. We have written two algorithms an optimal solution to the two problems when the total amount of the loan size is given and the loan size will accept as a collateral of small business enterprises and bounded upper;

- Optimal allocation credits of the small business enterprises when the maximal income depending on their received loan.
- Optimal allocation credits the maximal income of the small business enterprises with the smallest lowest income.

In these problems when they received loan size evaluated for R^+ we are using Gibbs expanded lemma, if the loan size evaluated for finite number of nonnegative and fixed values we are using a dynamic programming and penalty function method. These cases are named as continuous nonlinear resource allocation problem and discrete nonlinear resource allocation problem, respectively [3,5,10]. We have special case of common problem when constraints are linear, but utility functions are concave.

A. Algorithms For Continuous Nonlinear Resource Allocation Models.

In paper [10] is presented extensive survey on the continuous nonlinear resource allocation problem. The quoting paper surveyed the history and applications of the problem, as well as algorithmic approaches to this solution. The most common techniques were based on finding the optimal most often through use of a type of line search procedure [10,11, 12,13,14].

But our algorithms are finite and finding solution exactly for considering special problems. Necessary and sufficient condition for solution of continuous problem (9)-(10) is named as Gibbs' Lemma [3,10]. The name "Gibbs' Lemma" was coined by John M. Danskin [15]. The Lemma helps to find solution of problem (9)-(10) exactly, if utility functions are strong concave and growing. Maxmin problem as similar game but of a different origin than above allocation problem was utilized Gibbs' Lemma in the investigation of following form by John M. Danskin [15]:

$$\max_{x \in X} \min_{y \in Y} \sum_{j=1}^n v_j \left(1 - \alpha_j e^{-k_j x_j / y_j} \right)^{y_j},$$

where $X := \{x \in R_+^n \mid \sum x = b\}$ and $Y := \{y \in R_{++}^n \mid \sum y = c\}$, all constants

b, c, v_j, k_j are greater than zero and $\alpha_j \in (0,1)$. But transformation of

maxmin problem (11)-(12) to problem (9)-(10) is realized by J.M.Germeier [3].

The extended Gibbs' Lemma was formulated [10] for more common problem than continuous problem (18)-(19) where every x_i is bounded from above. For example, suppose that for $j=1, \dots, n$ the functions $\phi_j : R \rightarrow R$ and $g_j : R \rightarrow R$ are convex and differentiable and that $-\infty \leq l_j < u_j \leq +\infty$ holds. Let $b \in R$.

Then continuous nonlinear resource allocation problem has the following general statement:

$$\begin{aligned} \minimize_x \phi(x) &= \sum_{j=1}^n \phi_j(x_j), \\ \text{subject to } g(x) &= \sum_{j=1}^n g_j(x_j) \leq b, \\ x_j &\in X_j := [l_j, u_j] \quad j=1, \dots, n. \end{aligned}$$

Introducing the Lagrange multiplier $\lambda \geq 0$ for the problem we obtain the following conditions for the optimality of x^* in our problem:

$$\begin{aligned} \lambda \geq 0, \quad g(x^*) \leq 0, \quad \lambda g(x^*) &= 0, \quad x_j^* \in X_j, \quad j=1, \dots, n, \\ x_j^* = l_j, \quad \text{if } \phi_j^i(x_j^*) &\geq -\lambda g_j^i(x_j^*), \quad j=1, \dots, n, \\ x_j^* = u_j, \quad \text{if } \phi_j^i(x_j^*) &\leq -\lambda g_j^i(x_j^*), \quad j=1, \dots, n, \\ l_j < x_j^* < u_j, \quad \text{if } \phi_j^i(x_j^*) &= -\lambda g_j^i(x_j^*), \quad j=1, \dots, n. \end{aligned}$$

Indeed, Lagrange multiplier techniques for our problem are order, dating back at least to the mid 1950s, if not earlier: the earliest reference found so far is to [13], although the Lagrange multiplier

algorithm there in is a simple grid search method. In present time except of Lagrange multiplier techniques [17,18,19,20], we have so-called primal “pegging algorithms [21,22,23].

B. Algorithms For Discrete Resource Allocation Models

In this case every variable can take finite number of nonnegative values and so algorithms must be also finite and finding solution exactly. Such situation is characteristic for credit allocation problems. Their main computation method for resource allocation problem is dynamic programming [2,4,5,6,8].

Dynamic programming method is order, dating back at least to the mid 1950s, its application to our problem application with computation schema for resource allocation discrete models appears in almost literature of operational research methods in economics [1,2,4,5,6,8]. Discrete variant of problem (11)-(12), as we known, can be transformed to problem (14)-(15).

Concerning discrete variant of model (18)-(19), where every variable x_i bounded from above A_i , we well use penalty function method. Namely, assume that $\varphi_i(x_i) = -C$ if $x_i > A_i$, where C is sufficiently greater number. After this procedure we well use classical method of dynamic programming [8].

THEORY AND MOTIVATION

The General Statement of Mathematical Programming

Let $f_0, \dots, f_s : R^n \rightarrow R$ convex functions and $M \subseteq R^n$ the exclusive subset Euclidean spaces R^n . Then a following problem names the general problem mathematical programming.

$$f_0(x_1, \dots, x_n) = f_0(x) \rightarrow \max(\min), \quad (1)$$

$$f_j(x_1, \dots, x_n) = f_j(x) \leq 0, \quad j = 1, \dots, k, \quad (2)$$

$$f_i(x_1, \dots, x_n) = f_i(x) = 0, \quad j = k + 1, \dots, s, \quad (3)$$

$$x = (x_1, \dots, x_n) \in M \subseteq R^n. \quad (4)$$

Problems of Linear Programming

In case of when functions $f_0(x), \dots, f_s(x)$ are linear and $M = R_+^n$ a problem (1) - (4) name a problem of linear programming. The problem of linear programming can be solved completely, for example, by means of a simplex-method. In introduction we have resulted examples of known linear models of optimization, namely, two models of optimum planning of actives and one model of optimum planning of system of portfolios i.e. planning of actives and passives, which written as problems of linear programming. The general problems

$$f_0(x) = \sum_{i=1}^n c_i x_i \rightarrow \max(\min), \quad (5)$$

$$f_j(x) = \sum_{i=1}^n a_{ij} x_i \leq b_j, \quad j = 1, \dots, k, \quad (6)$$

$$f_j(x) = \sum_{i=1}^n a_{ij} x_i = b_j, \quad j = 1, \dots, s, \quad (7)$$

$$x_i \geq 0, \quad i = 1, \dots, n. \quad (8)$$

But the basic mathematical models of optimum control are formed by system of portfolios of bank-monopolist as a nonlinear problem of mathematical programming which in mathematical economy can be named problems of storekeeping. Especially it concerns optimum distribution of credits for financing small and middle business.

Problems of Optimum Allocation Of Resources

The problem of optimum allocation of resources which is a special case of a problem (1) - (4), has a following appearance [3,5,10].

$$f_0(x) = f_0(x_1, \dots, x_n) = \sum_{i=1}^n \varphi_i(x_i) \rightarrow \max, \quad (9)$$

$$\sum_{i=1}^n x_i = A; \quad x_i \geq 0, \quad i = 1, \dots, n, \quad (10)$$

Where x_i the quantity of a resource allocated for i -th sector, A - quantity of resources, $\varphi_i(x_i)$ -function of profitableness of i -th sector.

The problem of distribution of credit money bank-monopolist which has such kind is interested in maximization of incomes of the borrowers-representatives small and middle business. When the purpose of the credit organization or subscriber the project of financing middle and small business consists in support of a poor part of clients we should solve following maxmin a problem.

$$f_0(x_1, \dots, x_n) = f_0(x) = \min_{1 \leq i \leq n} \{\psi_i(x_i)\} \rightarrow \max, \quad (11)$$

$$\sum_{i=1}^n x_i = A; \quad x_i \geq 0, \quad i = 1, \dots, n, \quad (12)$$

where $\psi_i(x_i)$ - function of profitableness of i -th sector.

Though the problem (11) - (12) does not belong to a classical problem of mathematical programming (1) - (4), the theorem 1 shows, that it can be translated to a problem of type (9) - (10) by means of transformation

$$\varphi_i(x_i) = - \int_0^{x_i} \psi_i(y_i) dy_i.$$

Theorem 1. The set of leveling decisions of a problem (11) - (12) coincides with set of decisions of a problem

$$\min_x \sum_{i=1}^n \int_0^{x_i} \psi_i(y_i) dy_i,$$

$$\sum_{i=1}^n x_i = A; \quad x_i \geq 0, \quad x = (x_1, \dots, x_n), \quad i = 1, \dots, n.$$

The set of decisions of a problem which will turn out from (9) - (10) if integer functional (9) aspires to a minimum, coincides with set of leveling decisions of a problem

$$\max_x \min_{1 \leq i \leq n} \{\varphi'_i(x_i)\},$$

$$\sum_{i=1}^n x_i = A; \quad x_i \geq 0, \quad x = (x_1, \dots, x_n); \quad i = 1, \dots, n.$$

For the decision of a problem of type (9) - (10) use a following Gibbs' lemma, who is a basis for construction of algorithm of search of optimum decisions.

Lemma 1. (Gibbs' Lemma)[3,5,10] The vector $x^* = (x_1^*, \dots, x_m^*)$ is the decision of a problem (9) - (10) in only case when there is such number λ , that

$$x_i^* > 0, \quad \varphi'_i(x_i^*) = \lambda$$

$$x_i^* = 0, \quad \varphi'_i(x_i^*) \leq \lambda.$$

Now we shall result the assumption which carries the name a principle of equalizing of J.M.Germeier which can be useful to construction of algorithm of search of optimum decisions of a problem (11) - (12).

Lemma 2. The problem (11) - (12) has decisions of a kind

$$x_i^* > 0, \quad \psi_i(x_i^*) = \lambda \tag{13}$$

$$x_i^* = 0, \quad \psi_i(x_i^*) \geq \lambda.$$

Any vector $x^* = (x_1^*, \dots, x_m^*)$, satisfying (13) and to restrictions of a problem (11) - (12), is maxmin strategy of a problem (11) - (12).

Lemmas 1-2 for problems (9) - (10) and (11) - (12) can be used only when products infinitely allocated i.e. when everyone x_i can accept any non-negative natural value. But in many problems of distribution of resources, everyone x_i can accept only final number of non-negative values. It concerns quantity the goods and distribution of bank money.

In this case instead of (9) – (10) and (11) – (12) consider compliance problems

$$A. \quad \sum_{i=1}^n \varphi(x_i) \rightarrow \max, \quad (14)$$

$$\sum_{i=1}^n x_i = A, \quad x_i = y_{l_i}, \quad i = 1, \dots, n; \quad l_i = i_1, \dots, i_{p_i}. \quad (15)$$

$$B. \quad \min_{1 \leq i \leq n} \{\psi_i(x_i)\} \rightarrow \max, \quad (16)$$

$$\sum_{i=1}^n x_i = A, \quad x_i = y_{l_i}, \quad i = 1, \dots, n; \quad l_i = i_1, \dots, i_{p_i}. \quad (17)$$

y_{l_i} - the fixed non-negative numbers.

For the decision of problems (14) - (15) and (16) - (17) it is convenient to accept methods of dynamic programming about which it will be told in the following paragraph. In problems (9) - (10) and (11) - (12) quantities of resources x_i unbounded from upper. But in the majority offered in this work models they are limited from above by the set numbers:

$$f_0(x) = f(x_1, \dots, x_n) = \sum_{i=1}^n \varphi_i(x_i) \rightarrow \max, \quad (18)$$

$$\sum_{i=1}^n x_i = A, \quad 0 \leq x_i \leq A_i, \quad i = 1, \dots, n. \quad (19)$$

In this case the following lemma is fair

Lemma 3. (Generalized Gibbs' Lemma) [10,13,17] Vector $x^* = (x_1^*, \dots, x_n^*)$ the-decision of a problem (18) - (19) in only case when there is such number λ , that

$$A_i > x_i^* > 0, \varphi_i'(x_i^*) = \lambda$$

$$x_i^* = A_i, \varphi_i'(x_i^*) \geq \lambda$$

$$x_i^* = 0, \varphi_i'(x_i^*) \leq \lambda.$$

The Conversion Of The Problem Of The Allocation Resources To The Problem Of Dynamic Programming And Building Of Computational Scheme

Let problem (9)-(10) describes of problem the optimal distribution of credit money between n borrowers. Here are supposed fulfilled following conditions:

1. income received of borrower Z_k , is not dependent on another borrower ;
2. received income different borrowers, is expressed in similar units;
3. total income is equal to the amount of incomes received from the distribution of all money as to all borrowers.

We shall pass on to problem definition (9)-(10) in the form of the model of dynamic programming. The inner property of the process of the distribution of money between n borrowers let's to consider it how n -step process. For the number of k step shall accept the number of borrower whom are distinguished of money x_k . On first step distinguish to the first borrower of money x_1 , on second step to-second borrower distinguish of money x_2 from stayed and etc. It is evident that variable $x_k, (i = 1, \dots, n)$ it is possible consider how controlling variable ones. The initial state of system features the value of ξ_0 money being subject distribution. After allotment x_1 stays $\xi_1 = \xi_0 - x_1$ money and etc. Values $\xi_0, \xi_1, \dots, \xi_n$ characterizing the remainder of money after distribution on former steps, will consider how the parameters are of state. By equations conditions serve equalities [2,5,6]

$$\xi_k = \xi_{k-1} - x_k \quad (k = 1, \dots, n)$$

Summary income for n steps composes

$$Z = \sum_{k=1}^n f_k(x_k)$$

and presents the measure of effectiveness of process having, as it is obvious from this equality, additive form.

If to the onset of k step the remainder of money is equal ξ_{k-1} , then income which can be received on stayed $n - k + 1$ steps, will

$$\text{compose } Z_k = \sum_{i=k}^n f_i(x_i).$$

Maximal income for these $n - k + 1$ steps is dependent on that, how many of money remained from previous $k - 1$ steps, from value ξ_{k-1} .

That is why will be it to designate through $Z_k^*(\xi_{k-1})$. It is evident that $Z_1^*(\xi_0) = Z_{\max}$, $Z_1^*(\xi_0)$ presents summary maximal income for n steps. We shall consider any k step. It is evident that x_k can be chosen from condition $0 \leq x_k \leq \xi_{k-1}$. Significance x_k satisfying to this double inequality is called permissible. Principle optimization in this concrete case means that having distinguished value x_k and having received from k borrower income $f_k(x_k)$, we must to dispose stayed money by $\xi_k = \xi_{k-1} - x_k$ advantageous image and receive from

borrower Z_{k+1}, \dots, Z_n maximum income $Z_{k+1}^*(\xi_k)$. It is explicit that value g follows to determine from the condition of maximization amount $f_k(x_k) + Z_{k+1}^*(\xi_k)$. Thus, gain equation

$$Z_k^*(\xi_{k-1}) = \max_{0 \leq x_k \leq \xi_{k-1}} \{f_k(x_k) + Z_{k+1}^*(\xi_k)\}, \quad (20)$$

which presents Bellman's equation (5) for this problem (9)-(10) [8].

We shall pass on to computational scheme. We are interested in $Z_1^*(\xi_0)$; but if to begin with first step, from deciding of task h that necessary to

know $Z_2^*(\xi_1)$. In its turn, in identification $Z_2^*(\xi_1)$ necessary to know $Z_3^*(\xi_2)$ and etc. However there is step, for which no subsequent. Such is n step, on which are distinguished of money to last borrower Z_n . For him inequality (20) has aspect

$$Z_{n-1}^*(\xi_{n-1}) = \max_{0 \leq x_n \leq \xi_{n-1}} \{f_n(x_n)\}, \quad (21)$$

We will to consider that function of income $f_n(x_n)$ monotonously grows, that is why deciding of this task is provisory optimal control $x_n^*(\xi_{n-1})$, in which is achieved provisory maximum $Z_n^*(\xi_{n-1}) = f_n(x_n^*)$. Hence, to borrower Z_n are distinguished all stayed money ξ_{n-1} which brings income $f_n(\xi_{n-1})$. We shall return to previous, to $(n-1)$ step, at the beginning which there is the remainder of money ξ_{n-2} . Equation (20) in this instance will accept type

$$Z_{n-1}^*(\xi_{n-2}) = \max_{0 \leq x_{n-1} \leq \xi_{n-2}} \{f_{n-1}(x_{n-1}) + Z_n^*(\xi_{n-1})\}.$$

Here optimal choice x_{n-1} not so evident, how in deciding of previous problem (21). It is first of all having expressed from the equation of state ξ_{n-1} through $\xi_{n-2} - x_{n-1}$, shall receive

$$Z_{n-1}^*(\xi_{n-2}) = \max_{0 \leq x_{n-1} \leq \xi_{n-2}} \{f_{n-1}(x_{n-1}) + Z_n^*(\xi_{n-2} - x_{n-1})\}. \quad (22)$$

Both resign in decorative brackets-known functions being dependent on controlling variable x_{n-1} . Parameter ξ_{n-2} is initial state for this problem. Having fulfilled research on the maximum of function $Z_{n-1}(x_{n-1}, \xi_{n-2}) = f_{n-1}(x_{n-1}) + Z_n^*(\xi_{n-2} - x_{n-1})$ from one variable x_{n-1} , shall receive provisory optimal control $x_{n-1}^*(\xi_{n-2})$ and corresponding provisory maximum of summary income $Z_{n-1}^*(\xi_{n-2})$. In language of this problem this decision means that if before the accentuation of money to

borrower Z_{n-1} in our disposal there is remainder ξ_{n-2} , to then borrower Z_{n-1} necessary to distinguish of $x_{n-1}^*(\xi_{n-2})$ money. Where at the amount of incomes from borrower Z_{n-1} and Z_n achieves maximum.

Having ended deciding of problem (22), shall pass on to following from end to $(n-2)$ step, shall determine similarly provisory optimal control to $x_{n-2}^*(\xi_{n-3})$ and corresponding remainder ξ_{n-3} provisory maximum $Z_{n-2}^*(\xi_{n-3})$ and etc.

As a result passing step by step all steps from the end of the process of distribution to it onset, shall receive two the sequences of functions:

$$Z_n^*(\xi_{n-1}), Z_{n-1}^*(\xi_{n-2}), \dots, Z_2^*(\xi_1), Z_1^*(\xi_0)$$

and

$$x_n^*(\xi_{n-1}), x_{n-1}^*(\xi_{n-2}), \dots, x_2^*(\xi_1), x_1^*(\xi_0) .$$

This terminates the first and principal stage of computational process receiving the title of conditional optimization. Now proceed to the second stage of the computational scheme of unconditional optimization. At that stage of first of all knowing function $Z_1^*(\xi_0)$, as to given significance ξ_0^* determine $Z_{\max} = Z_1^*(\xi_0^*)$.

It is further on; apply to succession $x_k^*(\xi_{k-1})$ which passes from onset by the end of process. We distinguish to $x_1^* = x_1^*(\xi_0^*)$ first borrower; then for distribution stays $\xi_1^* = \xi_0^* - x_1^*$. As to this value determine the optimal quantity of money $x_2^* = x_2^*(\xi_1^*)$ distinguished to second borrower. Again find $\xi_2^* = \xi_1^* - x_2^*$, after what determine x_3^* , and etc. While will not be determined being looked for optimal up $(x_1^*, x_2^*, \dots, x_n^*)$.

AN EXAMPLE APPLICATION

Maximization Of The Total Income Of Small Business

In this paragraph one simple model of maximization of the total income small business and it is illustrated is offered as problems such are solved by means of a method of dynamic programming.

Statement of Mathematical Model

Let N is available representatives of small and middle business who require financial support. We shall admit, that any credit organization took for credit these businessmen, having allocated thus sum M of money. Usually such work is carried out on target to the program or under the project that to credit the organizations let out the same products. Let k -th borrower, having taken on loan in quantity x_k , can let out production in cost $f_k(x_k)$, having spent thus $(c_k + \mu)x_k$ money, where $\mu > 0$ the credit rate average, for credit term. We shall be limited to a case when the price of capitals /or we here to consider is known, that potential borrowers have opportunities to substitute something or to receive a guarantee of reliable sponsors and etc./, substituted on the security of borrowers E_k , $k = 1, \dots, N$. Then we shall have a following problem of optimization.

$$\sum_{k=1}^N [f_k(x_k) - (c_k + \mu)x_k] \rightarrow \max, \quad (23)$$

$$\sum_{k=1}^N x_k = M, \quad 0 \leq x_k \leq \alpha \cdot E_k, \quad k = 1, \dots, N,$$

where $\alpha > 0$ it is set by the credit organization. This problem at natural can be solved by means of the algorithm using generalized Gibbs' Lemma. In case of when accepts final number of values, it is necessary to use a method of dynamic programming. Applications of a method of dynamic programming demonstrate on a following example.

A Numerical Example

In practical activities credit the quantity of given out money can accept the organizations only multiple, means, final values. Because so it is more convenient as to the creditor, and borrowers. Therefore in this item the example similar to volume is resulted, that us was is investigated and solved.

Let the credit organization allocates 3million.tug for credit four organizations small business. We shall be to consider, that money can allocate only in the sizes 0, 0.5 million, 1 million, 1.5 million, 2 million, 2.5 million, 3 million. Through x_i we shall designate quantity of credit money, issued for i -th borrowers. $f_i(x_i)$ - function of utility i -th borrowers which represents a difference between the net profit $R_i(x_i)$ and expenses $C_i(x_i)$, connected with commercial activity and borrowers payment of credit percent. Let functions of incomes and expenses have following kinds

$$R_1(x) = 5x_i^{0.1}, C_1(x) = 0.3x_i$$

$$R_2(x) = 4x_i^{0.2}, C_2(x) = 0.37x_i$$

$$R_3(x) = 2x_i^{0.4}, C_3(x) = 0.4x_i$$

$$R_4(x) = 3.5x_i^{0.1}, C_4(x) = 0.2x_i.$$

Then for corresponding functions of utility it is had

$$f_1(x) = 5x_i^{0.1} - 0.3x_i$$

$$f_2(x) = 4x_i^{0.2} - 0.37x_i$$

$$f_3(x) = 2x_i^{0.4} - 0.4x_i$$

$$f_4(x) = 3.5x_i^{0.1} - 0.2x_i.$$

Let's admit, that value of function of utility of everyone borrowers depending on the credit received by it is set following tables.

Each of functions $f_i(x_i)$ is convex and is had a unique point of a maximum x_i . Simple calculation shows, that maxima are reached

accordingly in points $\bar{x}_1 = 1.75$, $\bar{x}_2 = 2.62$, $\bar{x}_3 = 5.07$, $\bar{x}_4 = 1.86$. i -th borrowers to receive the credit x_i which is more than \bar{x}_i thoughtless as the same income can be received at the smaller credit. Therefore \bar{x}_i it was possible to consider upper as a limit of the credit which can to receive i -th borrowers. On the other hand, upper the limit of the credit depends on a condition of a fixed capital borrower, or from the size, the capital substituted in the mortgage.

Table 1. Each of functions $f_i(x_i)$

	$f_1(x)$	$f_2(x)$	$f_3(x)$	$f_4(x)$
0	0	0	0	0
0.5	4.5	3.3	1.3	3.16
1	4.7	3.6	1.6	3.3
1.5	4.756	3.78	1.75	3.34
2	4.758	3.85	1.83	3.35
2.5	-100	3.87	1.88	-100
3	-100	-100	1.9	-100

We shall admit that upper limits A_i of the credit for borrowers are equal to following values:

$A_1 = 2$ million, $A_2 = 2.5$ million, $A_3 = 3$ million, $A_4 = 2$ million.

Above we have a following problem of allocation of money:

$$\sum_{i=1}^4 f_i(x_i) \rightarrow \max;$$

$$\sum_{i=1}^4 x_i = A = 3, \quad 0 \leq x_k \leq A_i, \quad i = 1, \dots, 4. \quad (24)$$

This problem from considered in (24), variables x_i bounded from above numbers A_i . At construction of the computing scheme we should consider it. It is reached by use of a so-called method of "penalty".

Table 2. Results of calculation with optimum distribution (k = 3, 2, 1)

$k = 3, 2, 1$		Step 3 ($k = 3$)				Step 2 ($k = 2$)			Step 1 ($k = 1$)		
ξ_{k-1}	x_k	ξ_k $=\xi_{k-1}-x_k$	$f_3(x_3)$	$Z_4^*(\xi_3)$	$Z_3(\xi_2, x_3)$	$f_2(x_2)$	$Z_3^*(\xi_2)$	$Z_2(\xi_1, x_2)$	$f_1(x_1)$	$Z_2^*(\xi_1)$	$Z_1(\xi_0, x_1)$
1	2	3	4	5	6	7	8	9	10	11	12
0.5	0	0.5	0	3.16	<u>3.16</u>	0	3.16	3.16	0	3.3	3.3
	0.5	0	1.3	0	1.3	3.3	0	<u>3.3</u>	4.5	0	<u>4.5</u>
1	0	1	0	3.3	3.3	0	4.46	4.46	0	6.46	6.46
	0.5	0.5	1.3	3.16	<u>4.46</u>	3.3	3.16	<u>6.46</u>	4.5	3.3	<u>7.8</u>
1.5	1	0	1.6	0	1.6	3.6	0	3.6	4.7	0	4.7
	0	1.5	0	3.34	3.34	0	4.76	4.76	0	7.76	7.76
	0.5	1	1.3	3.3	4.6	3.3	4.46	<u>7.76</u>	4.5	6.46	<u>10.96</u>
	1	0.5	1.6	3.16	<u>4.76</u>	3.6	3.16	<u>6.76</u>	4.7	3.3	8
2	1.5	0	1.75	0	1.75	3.78	0	3.78	4.75	0	4.75
	0	2	0	3.35	3.35	0	4.91	4.91	0	8.06	8.06
	0.5	1.5	1.3	3.34	4.64	3.3	4.76	<u>8.06</u>	4.5	7.76	<u>12.26</u>
	1	1	1.6	3.3	4.9	3.6	4.46	8.06	4.7	6.46	11.16
2.5	1.5	0.5	1.75	3.16	<u>4.91</u>	3.78	3.16	6.94	4.75	3.3	8.05
	2	0	1.83	0	1.83	3.85	0	3.85	4.758	0	4.758
	0	2.5	0	-100	-100	0	5.05	5.05	0	8.36	8.36
	0.5	2	1.3	3.35	4.65	3.3	4.91	8.21	4.5	8.06	<u>12.56</u>
3	1	1.5	1.6	3.34	4.94	3.6	4.76	<u>8.36</u>	4.7	7.76	12.46
	1.5	1	1.75	3.3	<u>5.05</u>	3.78	4.46	8.24	4.75	6.46	11.21
	2	0.5	1.83	3.16	4.99	3.85	3.16	7.01	4.758	3.3	8.06
	2.5	0	1.88	0	1.88	3.87	0	3.87	-100	0	-100
3	0	3	0	-100	-100	0	5.13	5.13	0	8.54	8.54
	0.5	2.5	1.3	-100	-98.7	3.3	5.05	8.35	4.5	8.36	<u>12.86</u>
	1	2	1.6	3.35	4.95	3.6	4.91	8.51	4.7	8.06	12.76
	1.5	1.5	1.75	3.34	5.09	3.78	4.76	8.54	4.75	7.76	12.51
3	2	1	1.83	3.3	<u>5.13</u>	3.85	4.46	8.31	4.758	6.46	11.22
	2.5	0.5	1.88	3.16	5.04	3.87	3.16	7.03	-100	3.3	-96.7
	3	0	1.9	0	1.9	-100	0	-100	-100	0	-100

The idea consists in when value of a variable x_i surpasses A_i value $f_i(x_i)$ we shall enough consider small, for example, it equally-100. Below two tables are presented, which are used in the computing scheme.

Table3. Results of calculation with optimum distribution (z = 4, 3, 2, 1)

ξ	Step 4		Step 3		Step 2		Step 1	
	$Z_4^*(\xi_3)$	$x_4^*(\xi_3)$	$Z_3^*(\xi_2)$	$x_3^*(\xi_2)$	$Z_2^*(\xi_1)$	$x_2^*(\xi_1)$	$Z_1^*(\xi_0)$	$x_1^*(\xi_0)$
0.5	3.16	0.5	3.16	0	3.3	0.5	4.5	0.5
1	3.3	1	4.46	0.5	6.46	0.5	7.8	0.5
1.5	3.34	1.5	4.76	1	7.76	0.5	10.96	0.5
2	3.35	2	4.91	1.5	8.06	0.5	12.26	0.5
2.5	-100	2.5	5.05	1.5	8.36	1	12.56	0.5
3	-100	3	5.13	2	8.54	1.5	12.86	0.5

As a result calculation we have received following optimum distribution of credit money for borrowers: $x_1^* = 0.5, x_2^* = 1, x_3^* = 1, x_4^* = 0.5$. At such distribution the total income borrowers is maximal and equal

$$\text{to } \sum_{i=1}^4 f_i(x_i^*) = 12.86.$$

Support of A Needy Part of The Population By Means of The Micro Credit

In last year, in our country more and more wide scope get so-called micro financial services poor to a layer of the population. In such activity are engaged not only the bank organizations, but also not bank financial organizations and credit cooperative societies. Environments of micro financial services the main place borrow needy i.e. poor parts of the population. And in this question the state gives the most serious attention. Confirmation to that organized the national congress on

micro financing in November, 2004, in Ulaanbaatar. Here we shall briefly characterize these terms using works of the Mongolian researchers [9].

Micro Enterprise

96 % from organizations of our country engaged by business are made by representatives of medium and small business, and they make 60 % GDP. In turn, the majority of them is engaged in micro business, so they work only to have a financial source for maintenance of the family with the most necessary needs. Save up surplus money they cannot and consequently not only not in a condition to expand the business, but often get in difficulty with a turn of the capital. Results of interrogation show, the majority representatives of micro business considered that they are on a poverty line or engaged in the service which is not demanding greater work and the capital. However, the majority in a country side is engaged in animal industries, agriculture, hunting, etc. On the basis of results of public opinions, in work the following recommendation for distinction of micro business from medium and small business in present economic conditions of Mongolia is offered.

The main parameters are the number of workers and the revenue that is accepted in a world practice. It is offered to define micro business as follows.

- a. The business carries out individually, or within the limits of family, or the number working does not surpass 10.
 - b. In all questions of business itself owner (head) of facilities accepts direct participation.
 - c. The weight does not surpass the capital of facilities 55000 \$.
 - d. The volume of the industrial capital does not surpass 10000 \$.
- According to this definition, the overwhelming majority of economic units of Mongolia represent micro business.

Table 4. Business characteristics

Kind of business	Branch	Concrete kind of work	Number of workers	The revenue
Microbusiness	Trade	Retail and wholesale trade	to 2	to 6
	Service	Repair, work on service family or persons, transport, small hotel or cafe.	to 5	to 5
	Agriculture	Agriculture	to 5	to 5
small and medium business	Service	Repair, service of family or the person, service in social or medical spheres, work of the manager in warehouses, in small finance, in transport, in formation, in hotel and café	to 20	6-8
	Trade	Retail and wholesale trade	to 10	6-24
	Manufacture	Almost all kinds of manufacture, especially in mining and light industry	to 30	to 120
	Agriculture	Animal industries, agriculture, hunting, preparation wooden	to 20	4-48
	Construction	Construction, repair, roads	to 50	to 240

Microfinance

In a broad sense microfinance covers the various financial services rendered poor and poor parts of the population. Therefore in following definition was accepted. Complex service, such as the savings, the credit, computing for payment, translation, insurance, leasing and others which are intended for poor and low income parts of the population, refers to microfinance.

The Micro Credit

If above named service is carried out in the form of the loan it name the micro credit. According to the interrogation, the poor layer of the population lead the environment in 2005, the majority interrogated considers that it is favorable to them to take the credit at a rate of 1-2 million.tug. For 1 year, but the main thing barrier is the high credit rate. Among foreign sponsors for support microfinance, including the micro credit in Mongolia it is possible to name the following organizations: USAID, Word Bank, CGAP, ADB, IFC, JICA, GTZ, IFAD and UNDP. And the state policy of support microfinance is carried out mainly through Монголбанк.

When the project provide is carried out under the governmental program or under the initiative of any foreign organization of good will most of all the attention is given a needy part of medium and small business to micro business. Thus speech does not go about decrease in credit rates and granting of other privileges needy, and have in view of support of commercial activity of those who most of all requires it. Usually poor men have no capital which could be pawned, but is quite capable to lead commercial activity. At such statement of a question, we should solve following maxmin problem.

$$\min_{1 \leq k \leq N} (f_k(x_k) - (c_k + \mu)x_k) \rightarrow \max, \quad (25)$$

$$\sum_{k=1}^N x_k = M, \quad 0 \leq x_k \leq \alpha \cdot E_k, \quad k = 1, \dots, N,$$

where x_k - the quantity of the credit allocated to k -th borrower.

Here E_k - quantity of the capital of k -th borrower, $0 < \alpha < 1$ a share of the capital E_k , such, that the credit organization cannot give k -th borrower of more money, than αE_k .

Now we shall consider a problem of distribution of credit money for support low income parts of four borrowers.

$$\begin{aligned} \min_{1 \leq i \leq 4} f_i(x_i) \rightarrow \max; \\ \sum_{i=1}^4 x_i = 3, \quad 0 \leq x_i \leq A_i, \quad i = 1, \dots, 4. \end{aligned} \tag{26}$$

According to a principle of equalizing of M.Germeiera, the problem (2) will be transformed to a problem of type (26) to next images

$$\begin{aligned} - \sum_{i=1}^4 \int_0^{x_i} f_i(t) dt = \sum_{i=1}^4 F_i(x_i) \rightarrow \max; \\ \sum_{i=1}^4 x_i = 3, \quad 0 \leq x_i \leq A_i, \quad i = 1, \dots, 4. \end{aligned}$$

Such as, all over again we should find primary $F_i(x)$ from functions $f_i(t)$, then use computing the scheme from the previous item. For primary we have formulas

$$\begin{aligned} F_1(x) = 4.54x^{1.1} - 0.15x^2, \quad F_2(x) = \frac{10}{3}x^{1.2} - 0.185x^2, \quad F_3(x) = \frac{10}{7}x^{1.4} - 0.2x^2, \\ F_4(x) = \frac{35}{11}x^{1.1} - 0.1x^2 \end{aligned}$$

At $x_i > A_i$ we shall considered, that $F_i(x_i) = -1000$. Then for $F_i(x_i), i = 1, \dots, 4$ it is had the following table

Table 5. Computing scheme

	$F_1(x)$	$F_2(x)$	$F_3(x)$	$F_4(x)$
0	0	0	0	0
0.5	-2.08	-1.4	-0.49	-1.46
1	-4.39	-3.15	-1.23	-3.08
1.5	-6.75	-5	-2.07	-4.74
2	-9.13	-6.92	-2.97	-6.42
2.5	-1000	-8.85	-3.9	-1000
3	-1000	-1000	-4.85	-1000

Applying the computing scheme from the previous item, we have found, that optimum is allocation (0.5, 0.5, 1.5, 0.5) with corresponding prizes (4.5, 3.3, 1.75, 3.16). At such distribution the total income borrowers is maximal and equal $\sum_{i=1}^4 f_i(x_i^*) = 12.71$.

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The Ethical and Unethical Dimensions of Marketing

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ABSTRACT

Marketing is a discipline that provokes much debate. In fact, it has been accused of being used for unethical purposes. Opponents of marketing make the accusation that marketing encourages materialism, increases the final price of the product, allures consumers into buying products they might not really need, etc. Other research studies have argued that the very core of marketing is in contrast with

the doubt and criticism that is expressed by its opponents because customer satisfaction is marketing's ultimate goal. This paper critically discusses the opposition's and supporters' views of marketing as an unethical science.

Keywords: Customer Satisfaction, Ethics, Marketing

INTRODUCTION

Considering all of the management fields, marketing has taken the most criticism and carried the most doubt concerning moral and social responsibility issues (Kennedy and Lawton, 1993). Marketing critics point to false or misleading advertisements, extravagant pressure on consumers, and pricing tactics that deviate from morality and honesty limits (Nantel and Weeks, 1996). Malliaris (2001) summarized the basic points of criticism against marketing as follows: (1) It encourages materialism, hedonism, and eudemonism; (2) It generates stress on consumers for the acquisition of goods; (3) It pollutes the natural environment; (4) It contributes to the exhaustion of natural resources; (5) It creates an increase in the product's final price due to the high production cost, which must be paid by the consumer; (6) It deceives consumers by projecting imaginary or no quality differences on the products; (7) It allures consumers into buying products that they might not really need; (8) Advertising is many times of bad taste and offends the masses; (9) The involvement of too many intercessors during product distribution raises product prices; (10) Personal sales sometimes become too pushy and oppressive, thereby compelling the consumer to make buying decisions under pressure.

Kotler (2000) defined marketing as follows: "Marketing is the human activity aimed at satisfying needs and wants through the process of

transaction.” According to the previous definition and most other published definitions as well, the core ideology for marketing is customer/consumer satisfaction. The definition of marketing then is in contrast to the assertions of its opponents. If customer satisfaction is the ultimate goal, one would have a hard time questioning its morality (Rao and Singhapakdi, 1997).

Thus, there are two points of view, one that criticise as being unethical, and another that denies the ethicality of marketing arguing that customer satisfaction is marketing’s ultimate goal. The objective of the current paper is to critically present the arguments of the opponents and advocates of the marketing ethicality. The presentation of the arguments is based on the detailed review of the relevant literature.

ETHICS IN MARKETING

Ethics are embodied in marketing practices in terms of social marketing. While not ignoring profit as a business’s main goal, the central idea of social marketing is the existence of justice in society and among consumers. Social marketing refers to correct practices in terms of the consequence for society (Piacentini et al., 2000). Social marketing emphasizes achieving balance among business profit, consumer needs and desires, and society’s long-term concerns.

Kotler and Zaltman (1971) were the first to advocate the embodiment of social and moral dimensions in marketing science. The social marketing sense was developed by encouraging marketers to benefit society with the inclusion of social ideas and causes in the marketing campaigns. Kotler (2000) indicated that the aim of social marketing surpasses that of marketing, at least based on its traditional definition. That is, it surpasses the element of “lasting customer satisfaction.” The goal of social marketing is the well-being of society. In other words, the

idea of social marketing causes marketers to embody social and moral issues in their practices, thereby extending the definition and purposes of traditional marketing.

Although social marketing has been around since the 1970s, its moral basis remains underdeveloped. Crane and Desmond (2002) suggested that even though social marketing has yet to make an intense appearance in academic research, it is applied in companies and even more so in non-profitable organizations. The main moral problems reported in the marketing frame will be discussed subsequently.

The Study of Consumer Behavior

Since the scientific field of consumer behavior aims at gathering the determinant factors for human needs in order to better direct market to them, its importance cannot be questioned since theory becomes practice. For example, let us ponder how the theory of perception has been used by many marketing executives to guide consumers into thinking that the sale of four products for the combined price of four Euros is a good opportunity even when each product's separate price is one Euro (Murphy and Laczniak, 1981). Singer et al. (1991) suggested that the hazard that comes with the knowledge of consumer behavior is that consumer needs may be guided by the businesses themselves.

Product and Services Management

Product and services management, which consists of a basic marketing activity, may also cause doubts in terms of the ethics of marketing. Laczniak and Murphy (1985) mentioned that some corporations import extremely short lived products in the market in order to benefit from the repurchase of that same product. The same thing applies to products that have been purchased by customers after being stimulated by advertising even though the products do not satisfy their actual needs and expectations.

Advertisement

Advertisement is primarily marketing's most powerful instrument. It is, however, also the means that has suffered the strongest criticism and restrictions by legislative frameworks (Nwachukwu et al., 1997). The differentiation between "law-abiding" and "moral" practices is more clearly seen on television. For example, during the last few years with the appearance of products containing lower cholesterol or environment-friendly products, the case of ethics in advertising, which had been forgotten during the previous time, has been reopened (Landler, 1991).

A greater understanding of the process of information flux to the consumers has led to the creation of messages that are dangerously efficient. A classic example is those commercials where the product's benefits are projected onto the person starring in the commercial. Such are the cases where popular actors or glorified or where actors participate in a low value product's television commercial. This practice has gone one step further with the creation of "infomercials." These commercials last from thirty minutes to up to two hours, and they are presented more as a television program or documentary than a commercial. Many animated television series aimed at children were developed simply to promote toys and other similar products (Nantel and Weeks, 1996).

Marketing Research

Although marketing research has been characterized as being generally "objective," some questions concerning its moral side remain unanswered (Smith and Quelch, 1993; Hunt et al., 1984). Some researchers (e.g., Tybout and Zaltman, 1974) have suggested that marketing research is an intrusion into personal data and consumers' private lives. Opponents have also accused marketing research as being a pretence or means for product sales.

Pricing

Among all of a product's characteristics, price is most important to the consumer. The consumer's aim is to maximize the quality to price ratio (Nantel and Weeks, 1996). Although the legislative framework on pricing is specific and often strict, some businesses are not restrained from trying to fool consumers. Such practices are often encountered during the sales events where the offered discount is sometimes not real and is subtracted from a fictional initial price that is actually larger than the normal price.

International Marketing

The practices of international marketing have also been questioned in terms of moral issues. For example, when the time came for major tobacco industries to launch an advertising campaign in the USA to discourage teenagers from smoking, these companies themselves were investing huge amounts of money into the spread and development of tobacco purchases in Asia and Africa. In order to promote their expansion to these markets, they were also using a free cigarette distribution technique. Many of these "free samples" were given to minors (Levin, 1991). In addition, many businesses exploit the inexpensive working force of underdeveloped or developing countries.

Table 1 summarizes the main moral problems that have been mentioned in regards to marketing. In summary, a reasonable conclusion suggests that while marketing benefits are well-known, marketing could be more effective by including a moral approach that may move beyond utilitarian purposes (Murphy and Laczniak, 1981). Nevertheless, according to some researchers, marketing that focuses entirely on customer satisfaction generates problems for the consumers themselves and society in general (Nantel and Weeks, 1996).

Table 1. The moral problems in the marketing field

Marketing Area	Main Bibliography Sources	Allegations concerning Moral Issues
Consumer Behaviour	Murphy and Laczniak (1981), Singer et al. (1991)	A risk exists that the knowledge of consumer behavior might lead to consumer needs being guided by the businesses themselves.
Product Administration	Murphy and Laczniak (1981)	Some businesses import products with a short life in the market in order to benefit from the future repurchase of that same product.
Advertising	Landler (1991), Nantel and Weeks (1996), Malliaris (2001)	Dangerously effective messages can be found in advertisements, and the creation of infomercials has effectively deceived the consumer.
Market Research	Smith and Quelch (1993), Hunt et al. (1984), Tybout and Zaltman (1974)	Market research consists of an intrusion into personal data and consumers' private lives. Also, it is a pretence or means to sell products.
Pricing	Nantel and Weeks (1996), Malliaris (2001)	Pricing can mislead the consumer through fictional discounts.
International Marketing	Levin (1991)	Companies exploit underdeveloped countries' inexpensive work force

Regarding this issue, the cigarette example is revealing. An individual desire is fulfilled in the short term, but the satiation of that desire results in damage to the consumers' health in the long run. For society's sake, somebody has to consider the constant effort that is required to balance the needs and desires of everyday life with the environment in which we live.

Although marketing cannot be directed by a single organization, countless codes and organizations, like the American Marketing Association, are intended to frame marketing with a sense of ethics. For the business sector, the Better Business Bureau (BBB) has its own moral codes. According to those codes, a business should respect the legislative framework concerning businesses, business actions, and practices and offer information on the products and services in a way that can easily be understood by the average consumer. Also, a moral business should show respect to everyone without exception or effect on its obligations towards the customer. Moreover, moral businesses should avoid unfair competition, treat customer complaints in a fair way, and avoid false or misleading advertising. As many studies have shown, the existence of codes does not ensure that a business's actions will be more moral. In fact, many executives have reported that, although codes of conduct exist, their content is sometimes completely ignored (Singhapakdi and Vitell, 1990).

The research of Chonko and Hunt (2000), which focused on 1,076 marketing executives, resulted in some basic conclusions regarding marketing and ethics. The main moral problem that was mentioned by the participating executives was bribery. Other problems that were mentioned included justice, pricing strategies, and personal decisions. The basic "moral conflict" that they mentioned is the need to strive for balance between the business's demands and the consumers' needs. According to this research, the marketing executives do not believe

that immoral behaviours lead to success. Finally, the researchers discovered that the existing moral codes are not associated with the moral problems in marketing practices.

CONCLUSIONS

Ethics have been recently embodied in the marketing field. Businesses that show social and environmental sensitivity are considered to have a competitive advantage (Strong, 1996). At the same time, consumers' interest for moral consumption is increasingly growing (Aarosan, 2002). A typical example is that of the Body Shop. In this example, the display of great social sensitivity led the company profits to dramatically rise (Strong, 1996).

The opponents of marketing accuse it for being unethical, ruining the natural environment, attacking the public with absurd advertisements and encouraging materialism in many ways. On the other hand, marketing policies and practices have been largely responsible for the high standard of living today. The advocates of marketing also points out that the ultimate goal of marketing is customer' satisfaction. It is difficult to get a clear conclusion and to specify precisely whether marketing is ethical or unethical. The intense accusations could be only accepted as a belief of demarketing. Demarketing is the activity that tries to reduce the demand for a product or service on a temporary or permanent basis. It aims to the reduction of consumption, as it believes that marketing leads to the distraction of the society.

Marketing is a balanced serving of the combined interests of sellers, buyers and citizens. It has to be admitted that marketing does not support all the accusations for being unethical as there are no evidence for proving these statements and additionally there are research studies and arguments that confirm the opposite. The modern

consumer is well-informed and well-educated and has the ability to choose and judge marketing practices. However, despite these view, marketers should try to promote more the ethics of marketing. Social and environmental issues could be more widely incorporated in business's products and services. Companies should adopt ethical strategies because the benefits are numerous. Additionally, ethics would improve their market position compared to their direct competitors. On top of that, ethical strategies could improve the society's welfare and make a better world to consume.

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Impact of Technology Diffusion on the Innovation Capacity and Competitiveness of Automotive Components SME's in South Africa

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ABSTRACT

The automotive industry is an important bellwether for the manufacturing prowess of a country. Key to a globally competitive automotive industry is the presence of innovative, technology driven component manufacturers to provide inputs to the automotive assemblers and manufacturers. In this paper an empirical assessment of the innovative capacity of as well as efficacy of government funded instruments to enhance the innovative capacity of automotive component manufacturers, many of them Small and Medium sized Enterprises in South Africa is presented. The results show that most of the automotive component manufacturers are neither focusing on any in-house research, new to the market innovation activities nor seek assistance from these publicly funded instruments to improve their competitiveness through technology diffusion or intelligence. The long

term implications for these firms are that they could lose their place in the automotive supply chain in an industry where rationalization and global sourcing of technology inputs by automotive assemblers and manufacturers are fast becoming strategic imperatives.

Keywords: *Technology diffusion, Innovation, Small and medium sized enterprises (SME's), Automotive components*

INTRODUCTION

Central to global economic growth is the development of innovative Small and Medium sized Enterprises (SME's). It is for this reason that governments worldwide are putting in place policy instruments to facilitate the development of SME's to spur economic growth and employment creation. At a time when large multinational companies, for a long time a source of lifelong employment are shedding jobs due to rationalization and streamlining, SME's are now viewed as one of the few alternatives for sustainable employment and wealth creation. For example, in OECD countries over 95% of the companies fall under the category of SME's (up to 500 employees) and they account for well over 70% of the employment in these countries (OECD, 1996; OECD, 2000; Pike, 1997).

The influence of technology and innovation on SME growth and competitiveness is well documented. For example, the rapid growth of SME's in the Asia Pacific region where at least 90% of all enterprises are SME's is largely credited to technology assimilation by SME's (Schive, 1995). SME's in countries such as Taiwan laid the foundation for the country's economic growth in part due to them embracing technological innovation leading to the production and export of high value goods and services. These SME's have and continue to show

remarkable capacity to innovate and generate leading edge technologies over and above their flexibility and ability to withstand outside challenges such as changing market conditions and global competition (Roper, 1997). To have and sustain this growth, successful SME's worldwide have consistently shown remarkable capacity to embrace innovation. The innovation in this case encompasses the following:

- Technical improvement of existing products and processes
- Development of new and competitive products, processes and services
- Enhanced organizational, operational and marketing expertise

For technology based assistance to SME's to have the desired impact it must be appropriate for the needs of the SME's. Due to lack of capabilities and limited resources to closely monitor technology development, Rouach (2003) recommended that there is a need for sufficient internal or external resources for SME's to acquire, integrate and implement new technologies. For example, amongst industrialised countries, old traditional industries have seen a serious decline in activity in the advent of globalization. Innovative solutions were sought, at least in some areas in Europe where the traditional industries such as mining, steel and metals have fallen by the economic wayside. These include policy instruments focusing on improving the competitiveness of SME's through skills development and technology diffusion from local academic institutions (Kaufmann and Todtling, 2000; Hassink, 1996).

SME DEVELOPMENT THROUGH TECHNOLOGY DIFFUSION OR TRANSFER

The impetus for economic growth through innovations and technology transfer from higher educational institutions (HEI's) to SME's is

supported by the evolving regional policy imperatives in some of the industrialized countries. The involvement of HEI's in regional economic development is based on the realization by policy makers in these countries of the need to nurture high growth, technology intensive SME's. Globally, factors that are central to the development, growth and sustainability of these firms include spatial proximity to institutions engaged in Research and Development such as universities and publicly funded research institutions (Naretto, 2002).

As mentioned above, interest in this was due to the remarkable success of industrial regions such as Baden-Württemberg (Hassink, 1996) where the involvement of local institutions and technology centers (e.g. Steinbeis Centers) have been successful in assisting innovative SME's and start-ups through technology diffusion and transfer. The enhanced participation of universities in regional development is thought to have the same economic relevance as physical infrastructure (Chatterson and Goddard, 2000). Furthermore, the university-industry linkages have been promoted by some governments in the European Union to reduce inter-regional economic disparities in countries such as England (see for example Potts, 2002).

Technology Diffusion can be described as the spreading or usage of a technology within a society, organization or group of individuals (Rouach, 2003). Technology Transfer, which is often used interchangeably with Technology Diffusion, refers to the development of a technology in one setting before being transferred for use in another setting. Technology Diffusion is usually from higher educational institutions and other publicly funded institutions via some intermediary organizations. The use of Technology Diffusion from these institutions is based on the assumption that knowledge and technology generation and subsequent diffusion can enable industry (specifically SME's) to bridge the technology divide (Kaufmann and

Todtling, 2000). Although some of these are nominally independent agencies, for the purpose of this paper, the focus is on those which are linked to HEI's and are wholly or partly funded by regional or national governments.

Perhaps the most well known technology driven instruments linked to higher education institutions are the German Steinbeis Centers. Established in 1971, their most celebrated and widely acknowledged contribution in the regional growth and innovation of SME's in Baden Wurttemberg, the automotive heartland of Germany (Cooke and Morgan, 1994). This region continues to be the prime exemplar of a network based innovation system where educational and social institutions are central to the enhanced competitiveness of local SME's (Raco, 1999).

SME DEVELOPMENT IN SOUTH AFRICA

In South Africa the imperative for rapid economic growth is even more acute hence the focus on SME development to address unemployment and economic disparities. However, just as in other countries, SME's in South Africa face a myriad of challenges at a macro economic level. Some of the challenges include but are not restricted to, bureaucratic red tape in terms of setting up and registration of businesses, lack of finance and un-coordinated government support programmes. Furthermore, SME development in South Africa is specifically hampered by low levels of technical and managerial skills as well as inadequate investment in new technology. South Africa's political isolation until 1994 has also adversely affected SME development as most of these firms were not exposed to developments in technologies and manufacturing expertise over the years. Specifically, the political and economic isolation of South Africa has also led, especially in the

manufacturing sector, to low levels of investments in high technology and expertise by SME's recent years (Fridge, 2005).

Compounding the situation was the deliberate exclusion of a majority of the citizens because of their race by the previous whites-only government from engaging in mainstream economic activities which has also greatly retarded entrepreneurial activity in South Africa. As a result, a number of South African government instruments have been initiated to address these challenges using higher education institutions as well as state funded research institutions to accelerate SME competitiveness in Africa's largest economy. For an overview of South African SME supporting instruments see (www.thedti.gov.za)

GLOBAL AUTOMOTIVE INDUSTRY- AN OVERVIEW

The importance of the automotive industry in the global economy is well documented. This is also evidenced by global automotive makers who are moving from their traditional base in Triad economies (namely, North America, Japan, Western Europe) to set up manufacturing centers in emerging markets (Humphrey, 2003). This has in turn led to intense competition and changes in the industry, profoundly altering sourcing and manufacturer-supplier relationships in the automotive industry (von Corswant and Fredriksson, 2002).

It is for these changes that small firms down the supply chain from the Original Equipment Manufacturers (OEM's) have been forced to enhance their in-house technological expertise and innovations to be competitive (Oakes and Lee, 1999). Some of the demands include OEM's outsourcing more of their designs and development work to component suppliers (Modularization) as well as sourcing from single rather than multiple suppliers (global sourcing).

Modularization in this case refers to the supply of complete systems or modules which are slotted onto platforms at the assembly lines of the automotive manufacturers (Humphrey, 2003). This is even more significant as the centralization tend to squeeze SME's out of the supply chain if they are uncompetitive or their product quality is deemed to be below standard. The trend for global sourcing using the same suppliers has also limited growth opportunities for most component suppliers, especially in the developing countries where centralization of procurement initiatives at the cost of local component production (ITC, 2004; Humphrey and Menedovic, 2003; Humphrey, 2003).

In response to these trends, SME's in this industry are now forced to look at enhancing research and innovation functions as well as strengthening regional technology support networks to remain competitive (Pike, 1997). This is anticipated to force move automotive component suppliers and SME's to move towards more value adding manufacturing underpinned by design, engineering, product diversification, technological innovation as well as cost reduction strategies to enhance their competitiveness and sustainability (Singh et al. 2004).

The challenges of globalization and the accompanying attributes such as competition from low cost countries and single sourcing are also faced by SME's operating in well established global automotive centers of production such as Baden-Württemberg in Germany, Wales in the United Kingdom and Michigan in the United States. In Britain, the core of the British automotive and related industry is the west Midland area which accounts for over 20% of the UK's employment in manufacturing in 2001 (Bailey, 2003). Within this region, small family owned SME's have also experienced difficulties due to globalization and consolidation by OEM's (Tilson, 2000).

In many of these traditional automotive and component producing regions, the issues of skills development and collaboration of the industry with academic institutions for technology diffusion or transfer is becoming more important. The ultimate challenge for automotive component suppliers, especially in middle income countries such as South Africa is their ability to compete for supply contracts in the global automotive value chain. In this context, according to Singh et al. (2004), firm competitiveness refers to the ability to design, produce and/or market products or services superior to those offered by competitors considering price and non-price qualities.

Although there has been an exponential increase in the production of automotives in emerging, low cost economies such as China, India and Thailand, these countries are also faced with challenges. Poor quality of automotive components as well as lack of appropriate technology has put a damper on the export potential for automotive components of SME's in these countries (Velooso and Kumar, 2002). This is important as the drive for competitiveness and export also bring to the fore global product standards and production practices for SME's in the automotive supply chain (Quadros, 2007).

Government Support Programmes For Automotive Industry

Globally, governments with nascent or established automotive industries have devised programmes and incentives to improve competitiveness of automotive component suppliers, due to their importance in job creation and economic growth. Singh et al. (2004), has made the case that governments must provide for inputs such as testing and product development facilities, in light of the financial and resource constraints by SME's in emerging markets such as India. Another cited example of publicly funded program is the developments in the Styria region in Austria (Kaufmann and Todtling, 2000; 2002). Long reliance on industries such as iron, steel and other metals, a

general decline in these sectors led to a marked reduction in economic activity and employment opportunities in the region. The regional restructuring and revival in the context of Regional Systems of Innovation (RSI) was underpinned by key research institutions which supported and provided key technological inputs for the automotive industry in the region (Autio, 1998). Driving and coordinating these industry supporting activities is the Styrian Development Agency which provides funding for innovation projects, incubators and technology centers (Todtling and Trippl, 2004).

In the United Kingdom, the North East region has a vibrant automotive industry which also faces huge challenges. According to Pike (1997), for automotive component suppliers (SME's) to further enhance their competitive edge against foreign competition and rationalization they must constantly upgrading their Research and Development activities as well as establishing strong linkages with technology support infrastructure to meet these challenges. This has been highlighted by the strategic grouping of regional universities in this region of the United Kingdom to enhance design, engineering and technology upgrades among automotive component suppliers.

Specifically, in England, policy driven imperative to stimulate growth in poorer regions has focused on strengthening University–Industry linkages (Potts, 2002). This again highlights the importance of Technology Transfer from Universities and other Academic Institutions to SME's to enhance their competitiveness. In the Baden-Württemberg region, the government has established and strengthened linkages between SME's and regional support instruments such as the Fraunhofer Institutes and the Steinbeis Technology Transfer Center to strengthen the competitiveness of local SME's in the automotive industry in times of global competition and OEM rationalization.

The South African Automotive Industry

The South African Automotive Industry is the third largest sector of the economy after mining and financial services and contributes over 29% of the country's manufacturing output (DTI, 2002; Lorentzen, 2005). While it ranks 18th by size in the global automotive market, it still accounted for about 85% of the African continent's vehicle output in 2005 (MPL Consulting, 2005).

According to the National Association of Automobile Manufacturers of South Africa (see www.naamsa.co.za), there are twenty one full automotive assembling members on their registry. Included in the list are eight of the world's major motor vehicle manufacturers (OEMs) with their automotive assembly plants concentrated in three of the country's nine provinces. These OEM's include BMW, Nissan (which also assembles Fiat) and Ford (incorporating Mazda) which are operating in the province of Gauteng. Volkswagen, DaimlerChrysler and General Motors are based in the Eastern Cape Province while Toyota has a manufacturing base in the KwaZulu-Natal Province. Seven of these eight OEMs are wholly-owned subsidiaries of their parent companies, while Toyota is majority foreign-owned (i.e. It is partly owned by local South African investors (~25%). Other global companies, notably Renault, Peugeot-Citroen, Hyundai, Kia, Subaru, Daihatsu, Tata, Mahindra, Proton and Porsche import complete vehicles into South Africa. The automotive industry is also an important bellwether for other basic manufacturing activities in the country namely, steel and aluminium processing, rubber, textiles, plastics and paint and precious metal beneficiation (e.g. Platinum in catalytic converters).

Locally assembled vehicles and manufactured automotive components were exported to over 100 countries in 2006. Overall, Europe and specifically Germany, remains the automotive industry's main trading partner followed by Japan, the United States, the United Kingdom and

Australia. The EU accounts for almost 70% of component exports in value terms. After Germany, Spain, the United Kingdom, the United States and France and sub-Saharan Africa are the leading destinations for automotive components.

In line with national imperatives to establish competitive and sustainable industries in South Africa, the South African government through its Department of Trade and Industry (DTI), launched an ambitious programme to improve the export competitiveness in the automotive industry. The programme called the Motor Industry Development Programme (MIDP) focuses on a number of issues to accelerate the growth of the industry which for decades benefited from protective but unsustainable policies (Barnes and Lorentzen, 2004; Black, 2001). These include (a) Reduction in Import Tariff protection to encourage international competitiveness and Incentives to upgrade capacity of the auto industry in all production spheres referred to as Import-Export Credit Scheme (Barnes and Morris, 2004). The MIDP programme and its intended benefits is however not unique to South Africa. Worldwide, government policies aimed at promoting competitive local production and assembly of vehicles impacted or influenced the investment strategies of automotive companies in other emerging markets such as Brazil and India (Humphrey, 2003). The implication of these MIDP provisions for the local automotive components has been extensively reported (Barnes and Kaplinsky, 2000a; Barnes and Lorentzen, 2004; Black, 2001, Barnes and Kaplinsky, 2000b).

During the pre-1994 apartheid era, the South African government legislated local content provisions to protect the domestic component manufacturers from international competition. This was done through the imposition of high tariffs on full vehicle and component imports. In the MIDP era, the components suppliers are obliged to produce

globally competitive products or the OEM's could simply source their components elsewhere in the world. Underpinning these products are stringent requirements such as quality, cost, flexibility and innovative processes. Secondly and perhaps even more importantly, is the export drive of the South African government for automotive components, making the over reliance on local sales for their survival no longer viable. Barnes and Kaplinsky (2000a) have highlighted how local component suppliers are being squeezed out of the automotive supply chain in light of the changes in policy regarding trade barriers and tariffs.

Globally, there has been a marked decrease in the number of suppliers in the sector as SME's are either forced to move to high technology niches to survive or simply close down their operations resulting in huge job losses. Ulusoy et al. (2001), have estimated that of the 30 000 plus auto parts suppliers world wide in 1988, only about 4000 were still in business today. Furthermore, local SME's will not only have to produce world class products designs or services to have sustainable businesses, but they will be also be forced to use the OEM's not just as recipients of their output but also as conduits to facilitate the export and acceptance of their components in a highly competitive global market.

Although the disagreements about the benefits of the MIDP to South Africa still persists, what is generally agreed upon is that the South African automotive components suppliers remain internationally uncompetitive (Kaplan, 2004). This is highlighted by the fact that even with the MIDP, there has been a marked decline in local content with OEM's relying heavily on global sourcing, putting considerable pressure on local suppliers. Secondly, as the hallmark of any competitive manufacturing industry is the export of high value, high technology products, it is noteworthy that the bulk of South African

automotive exports (up to 62%) are made up of low technology catalytic converters and stitched leather goods (Kaplan, 2004).

Considering for example that a typical motor vehicle consists of up to 12 000 individual parts which are provided by a network of suppliers (Autio, 1998), There are hence huge opportunities for South African SME's to enter the Global Value Chain for high value components to expand their product portfolio. This however requires that SME's move up the innovation value chain to capture any new opportunities in light of the industry's rationalization.

PROBLEM STATEMENT

The focus of this study is to look at the influence of Technology Diffusion to enhance SME competitiveness in the automotive industry and help identify bottlenecks to further enhance their sustainability. Although Technology Diffusion and Transfer from higher education institutions in South Africa is gaining currency there has not been any empirical study about the Impact of Technology Diffusion from these institutions on SME development and growth. In its White Paper on Science and Technology (DACST, 1997), the South African Government identified an inadequate use of the existing science and technology infrastructure at higher educational institutions as a major impediment for product and process innovation among South African SME's.

The Automotive component sector was specifically selected because of its unrivalled contribution to the economy as well as its inherent linkage to key sectors of the economy. In this paper an assessment of SME's in Automotive Component sector in South Africa, their technology requirements, linkages with universities and other research organizations is investigated. Although extensive work on the

technological prowess and the challenges the automotive component suppliers in South Africa face has been reported (see for example Lorentzen, 2005, Barnes and Kaplinsky, 2000a, Barnes and Lorentzen, 2004), there has been no empirical study of the efficacy of state funded Technology Diffusion initiatives in enhancing the competitiveness and innovative capacity of SME's in this particular sector.

Questions to be addressed by the Research

The research focuses on the impact of technology on SME growth as well as the view of the sector related to Governments Technology Intervention Instruments for SME competitiveness. The knowledge and understanding of SME's with regards to Technology Diffusion initiatives from Government agencies was also investigated. The last part of the survey looked at obstacles that stifle their growth and competitiveness.

As mentioned earlier (AIDC, 1999) none of the bodies in the automotive component sector has taken the primary role of harnessing the technical resources available within South Africa. There also appears to be little or no research on the impact of technology and innovation (be it in-house or via technology diffusion from higher educational institutions and publicly funded research entities). There are over 350 firms producing automotive components for both domestic and export markets (see for example, Black, 2001; www.naacam.co.za) the questions and issues which need to be addressed in this regards are what are the challenges in terms of in-house capacity, technology and skills to meet the needs the OEM's.

Methodology

Of the three hundred and fifty (350) dedicated component manufacturers in South Africa, a number of them (about 120) were subsidiaries of multinational firms and their reluctance to respond is

most likely because the targeted companies depend on their international partners as far as technology and innovation is concerned. The support from parent companies in terms of product and process innovation could also distort their response to questions and hence these were eliminated from the survey. Thus only 200 locally owned and managed firms were considered.

A total of one hundred and twenty (120) supplier based questionnaires were distributed via e-mails to automotive suppliers in the four key automotive centers in South Africa namely Pretoria, Durban, Port Elizabeth and East London. In some cases, one on one interviews with the owners or managers of the automotive suppliers were conducted. Although the responses to questionnaires was only 34%, it is felt that the opinion and trends expressed in this report reflect the status prevailing in the larger community of the SME's operating in this sector. In order to eliminate any bias a sample of twenty respondents was compared with that of twenty non-respondents. There was no difference between the two sampled groups. Furthermore, the twenty non-respondents were then contacted telephonically to establish the kind of products, their tier level within the industry, customers, employee skills levels as well as reasons for not responding to the questionnaires. Again no discernable difference between respondent and non-respondent firms. The major reason for not responding was due to time pressures.

RESULTS

Following is a summary of responses to the key questions posed to the automotive component suppliers who participated in the survey. The questions were classified according to two categories: Technology and its impact on SME growth in the automotive sector as well as the

efficacy of government interventions on SME competitiveness in this sector.

Question 1: How do SME's view Technology and its impact on their growth?

The question was aimed at ascertaining the percentage of companies involved in high end innovation and technology development as well as their views on how these influenced their growth.

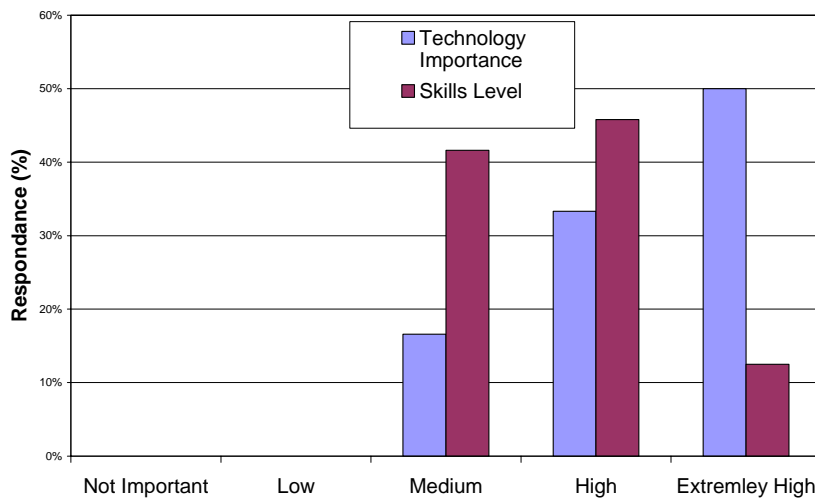


Figure 1. Importance of technology to the success of a business and the current skills level in the business

As shown in Figure 1, all the companies which responded consider technology and skills medium to highly important to sustainability and competitiveness. Furthermore these companies consider their staff at least in the medium to high skill level while few consider their staff extremely highly skilled.

Question 2: Do you have technically qualified people in your company i.e. designers, engineering graduates?

At least 95% of the companies surveyed indicated that they had technically qualified people employed and these people were all engaged in some form of development or research. This is to some extent encouraging as the presence of skilled personnel can accelerate the absorptive capacity of a firm, an important lynchpin for innovation and competitiveness. However, the in-house skilled personnel appear to focus on incremental, demand driven product improvement rather than new and radical innovations.

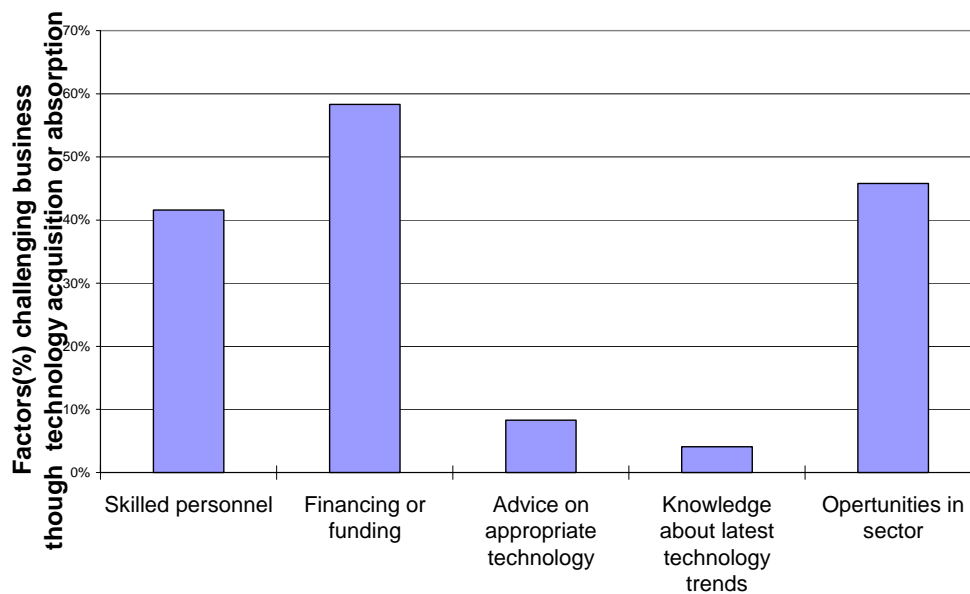


Figure 2. Major challenging to improving business through technology acquisition or absorption

The key challenges identified by the SME's related to skilled personnel, funding for business expansion and contract opportunities in the sector (Figure 2). Although the level of the workforce had already been identified as being skilled, it is evident that there was a lack of cutting edge skills such as designers and researchers among the SME's. The issue of high end skills is important as additional skilled personnel would be required to manage the acquisition, implementation and exploitation of new and radical technologies and innovations demanded by the OEM's. Furthermore both the lack of funding and lack of opportunities in the sector were shown to be limiting the development of the industry. The advice available on the technology as well as the lack of knowledge about the latest technology trends does not appear to be a factor in hindering growth.

Question 3: Do you engage any Government or publicly funded agency for technology or innovation based assistance?

Government appears to have had some success with the impact on SME development, particularly the smaller enterprises, however, the consensus is that there appears to be a perception that government, in spite of its industry friendly policy efforts does not fully understand the challenges faced by the small businesses (Figure 3). 50% of those SME's surveyed view the impact of government on SME development as low while 58% of the SME's felt that government, in spite of myriad of technology intervention measures do not understand the technological needs of SME's. More worrying, most businesses are not aware of all the avenues available to them, however some are aware but have no idea how to access the particular programs from government.

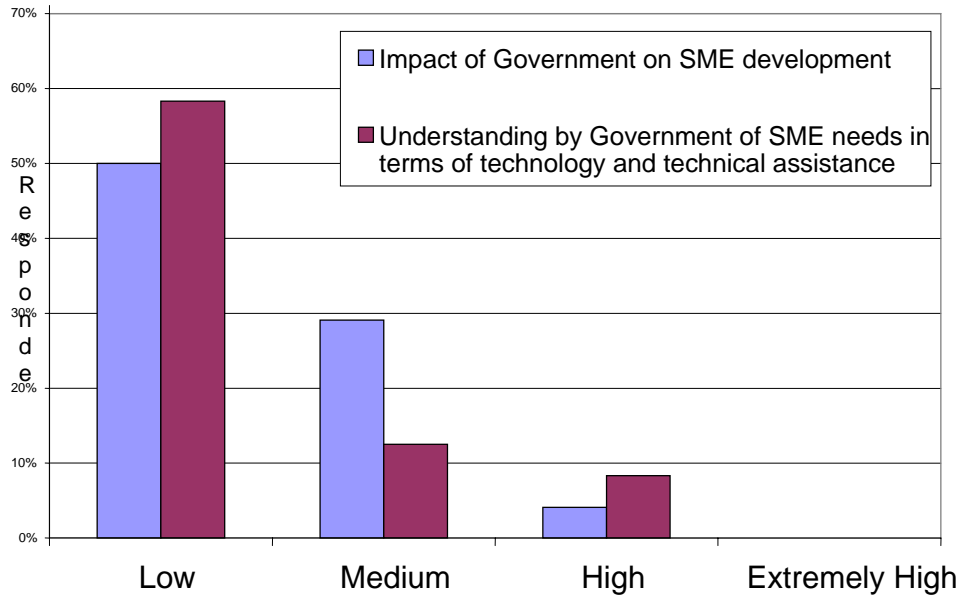


Figure 3. Government technology instruments to enhance business

Question 4 Are SME's specifically aware of publicly funded technology transfer instrument in the Automotive and related sectors?

From the survey, only 20% of the businesses questioned were aware of any private or public technology assistance centres in the automotive sector. However a large majority of SME's operating in the Eastern Cape were in general aware of the existence of the Tshumisano Trust's automotive specific Technology Transfer Center. The Tshumisano Trust is an agency of the national Department of Science and Technology set up to enhance the innovative capacity and competitiveness of SME's in areas of national priority (www.tshumisano.co.za). The Trust was modelled alongside the

German Steinbeis Foundation. The Trust and its activities focus on a number of industries including chemicals, automotives, plastics, metal processing, tooling, clothing and textiles among other focus areas. This particular center, called Automotive Components Technology Station (ACTS) is situated at a local University in Port Elizabeth, one of the aforementioned automotive manufacturing epicentres in South Africa.

Question 5: Government understanding of SME needs in terms of technology and technical assistance?

Only 45% of the businesses questioned had a relationship with a government funded Technology Transfer Center depending on their requirements. Most of the SME's (85%) who had a relationship with a Technology Transfer Center were all satisfied with their service and assistance. The centers had an impact on the businesses questioned with the following findings being evident. Over 70% of the businesses who responded and who had engaged with Technology Transfer centers said they benefited from technology advice, skills development or general consultancy services.

Question 6: What form of technology assistance did you obtain from any government funded Technology Transfer Centers?

Figure 4 shows the diversified assistance which was offered by the Technology Transfer Centers and that the type of advice offered is valued. The concern is that few companies are involved with new product development initiatives probably due to the lack of additional personnel with high end skills. This supports the conclusion in Question 2 where there appears to be less focus on new product development and more on incremental product or process improvements in response to the immediate needs of the OEM's (product upgrading than innovative, new to the market products).

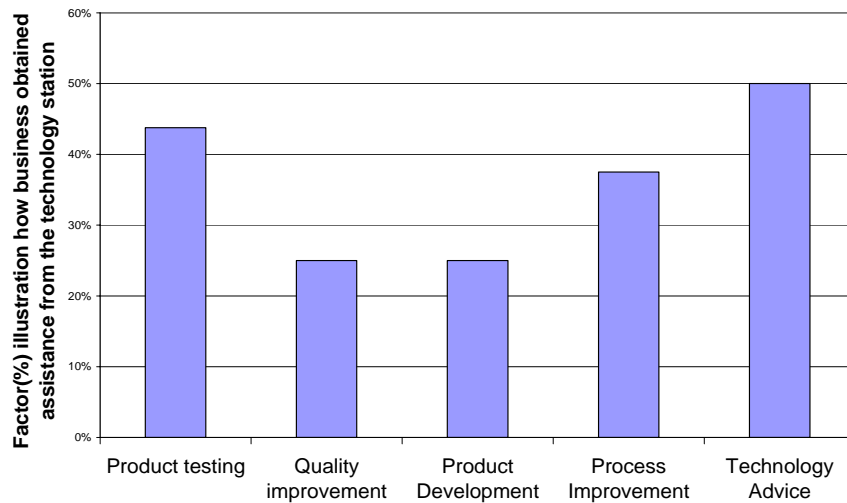


Figure 4. Types of assistance obtained by SME's from technology transfer centers

Question 7: What was the outcome of the intervention from government funded Technology Transfer Centers?

About 20% of the respondents who benefited from this interaction have seen some tangible benefits be them in terms of new supplier contracts form OEM's or increased product export contracts (Figure 5). Only about 6% of those firms surveyed indicated any employment creation as a result of the assistance they obtained from the centers. An appreciable number (about 43%) of the SME's said they interacted with the centers said they have benefited from product improvement assistance provided. These trends are specifically as a result of clear improvement in the quality of the products manufactured, which make the SME outputs acceptable in the market. As expected, none of the SME's reported any effect on their turnover. As privately held

companies, they are not obliged to report on their financial performance to the general public.

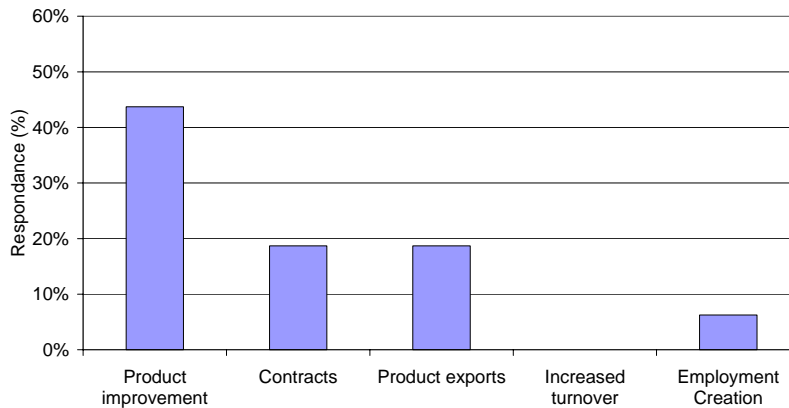


Figure 5. Outcomes of the intervention and assistance by technology transfer centers.

DISCUSSION

For South African automotive SME's to enhance their global competitiveness over and above the MIDP incentives, there is a need to enhance the technology infrastructure such as those under the Tshumisano Trust. This can only help with enhancing innovation and advanced skills to meet the stringent requirements of OEM's (Deniozos, 1994). As stated by Hassink (1996), only SME's who engage in Research, Development and Innovation initiatives are able to meet the stringent customer demands such as quality and rate of delivery. Not surprising, most SME's seem to view financial assistance to be of great importance than technology or innovation for their business. Also SME's do not view government support in a favourable light. This apparent lack of faith in government driven interventions is of concern

in light of policy instruments such as the MIDP. This should be addressed as any investment in infrastructure to assist SME's is not worthwhile if SME's themselves are reluctant to use them for assistance.

The results also points to a lack of ground breaking product or process development or radical innovations among most SME's in this important, technology driven sector. Most of the SME's, especially those assisted with focus on incremental innovation as opposed to innovative, "new to the market" product development crucial in a competitive industry such as automotive manufacturing. This is underscored by the absence of any R & D initiatives at most of the surveyed firms. This is a challenge for South African automotive suppliers considering the competition from low cost manufacturing hubs in Asia which continue to undercut the local SME's production outputs.

For SME's in South Africa to thrive amidst these challenges, it is imperative for them upgrade their technology base to produce innovative products, processes or services to the industry. With the in-house constraints faced by the SME's, strong external linkages to facilitate this technology and skills upgrade will become more important. This is illustrated by the reported success in the growth of automotive component suppliers in regions such as Baden-Württemberg.

The desired output of this study was twofold. Firstly, to assess the innovative activities of automotive suppliers in South Africa against increased rationalization and global sourcing by the OEM's. Secondly, to gauge the efficacy of Government funded instruments in assisting SME's in this critical sector for technology based solutions. Based on the results, the authors argue for the expansion and marketing of

Technology Diffusion initiatives in recognition of the inherent challenges faced by small firms in terms of technology and skills in South Africa and other countries (Oakes and Lee, 1999). Investments in local production infrastructure, although welcomed is not the panacea for improving SME innovation and competitiveness. Sourcing of local components will provide technological opportunities only to the firms with adequate in-house capacity to absorb new knowledge and practices.

The lack of enthusiasm for government funded programmes is noteworthy considering the challenges faced by automotive component suppliers in the lower tiers of the industry. This is however not unique to South Africa. Studies on high growth firms have shown firm owners and external resource providers invariably believe that government and its role either have a limited or no influence to play in rapid, high technology firms (see for example, Fischer and Reuben, 2003). Although globalization and access to new markets offer opportunities to these suppliers, it also opens up challenges in terms of management competencies and technological capabilities. The SME's appears not to be enthusiastic about engaging universities and publicly funded institutions for assistance. This is important as local "embeddedness" within a geographic set-up or cluster of SME's and related institutions such as regional universities has been highlighted as critical for the growth and sustainability of the firms in terms of access to new innovative ideas or technologies (Keeble et al. 1998). Hoffman et al (1998) have further noted that because SME's do not necessarily innovate in a formerly recognized way, some tend to use external linkages to enhance product and process linkages.

The key questions addressed by this study is important in that even in established economies such as Austria, SME's rarely interact with universities and Technology Transfer Centers to improve their

innovative capacity and competitiveness (Kaufmann and Tödttling, 2000). These trends have also been highlighted by Hassink (1997) where the efficacy of Technology Transfer Agencies in Western Europe was questioned as most SME's rank customers and suppliers much more important than universities and other research institutions in enhancing their innovative capacity.

The approach taken with this paper is in recognition that public technology support for SME's adopting a top down, supply push approach has proven to be less effective (Romijn, 2001). The research was hence more demand driven to gain an understanding of what industry wants and its views. This is even more critical as in the absence of tariffs and open global markets, South African based OEM's are able to pick and choose their suppliers anywhere in the world. Conventional wisdom is that they will focus on cost, reliability and quality of supply. This feeds into the Super Component Suppliers ideal where economies of scale and scope mitigate any supply risk and the installation of specialised and state of the art equipment can only be justified by large orders (Ulusoy et al. 2001).

CONCLUSIONS

This paper's main aim was to assess whether automotive component suppliers in South Africa engage government agencies in their quest to enhance their innovative capacity and competitiveness. The observations from this study are important from a government policy perspective. For example, among newer initiatives, the government through Tshumisano Trust has recently launched three Institutes for Advanced Tooling (IAT's) as part of the response to curb the decline in the innovation and skills decline in the South African Tooling Industry, a key input into the automotive component sector. At present, South

Africa is a net importer of tools costing the country over hundreds of millions of U.S. dollars a year in foreign exchange (Fridge, 2005). Key recommendation is that technology based support instruments should make a concerted effort to market their offering and expertise, especially amongst SME's which lack internal capabilities to pursue research and innovation products. SME's themselves should move away from incremental product innovation and leapfrog to more new, first to the market products and processes. This will not only be informed by adequate absorptive capacity of the SME's, but also enhanced linkages with external innovation sources such as universities and institutions where adequate laboratories, skilled scientists and experts are available for developing, testing and certifying high value products (Lorentzen, 2005).

This is important as Kaufmann and Tödtling (2002) noted that SME's in general have latent strategic, organizational and technological shortcomings which they are unfortunately not aware off. This can have long term adverse effect on SME's when changes in requirements from OEM's cannot be met. The success of these newly established centers, which focus on design, Research, Development and Technology Transfer for SME's in this sector will only be enhanced by knowledge of the needs of the industry. Going forward, there would be a need to enhance technology diffusion activities around automotive and related industries to encourage innovation. As SME's focus on meeting these requirements, they are forced to upgrade the quality of their outputs to meet the stringent OEM requirements, especially if their intended products are for the export market. This will have other long term benefits for the automotive component industry.

Over and above the industry buy-in required for Technology Diffusion initiatives to be optimised, the Technology Transfer agencies must also employ properly trained and experienced managers. The results

presented here clearly show that technology driven interventions, whether by public or privately funded instruments can enhance product development and innovation for the relevant SME's. Concerted efforts are hence required for these kind of initiatives, based on sector specific needs, should be expanded if key SME's in critical sectors such as automotive manufacturing are to grow and strive in an increasingly competitive global economy.

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