University - SMEs Collaboration to Support the Economic Growth: A Mauritian Case Study

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Abstract

Small and medium sized enterprises (SMEs) make a substantial contribution to economic growth and employment in most countries around the world including the Small Island Developing States (SIDS). Most countries have set up schemes to encourage creation of new SMEs as well as expansion of existing businesses. Many of the SMEs are family businesses and are managed by the owners/entrepreneurs. The SMEs usually face great difficulty when it comes to expansion as they lack the technical know-how to support the expansion plan and very often the cost of the equipment coupled with lack of financial support prevent many of these companies to even think of new investment. They are also not willing to share too much information about their companies due to

competition and tax evasion purposes. In many Small Island Developing States (SIDS) the market is very limited and it may be difficult for the SMEs to export their products, hence further limiting investment. The cost of state of the art equipment available off the shelf are usually very high and very often they are loaded with lots of functions that may not be required by the specific SMEs. Local Universities can support SMEs by designing low cost equipment to meet their needs. There must be a proper coordination and support between University, SMEs, an appropriate institution doing the link between University and SMEs and the funding institutions. The government, through the funding institutions, can provide a fraction of the funds to develop the prototype. Many small projects have already been considered by the University of Mauritius and two such projects are discussed in this paper. The design and implementation (in some cases) clearly show that there is a possibility of collaboration between Universities and SMEs together with the help of appropriate institutions in SIDS to support the sector.

Keywords: *Small and Medium Enterprises, University Collaboration, Small Island Developing States.*

**For correspondences and reprints*

1. INTRODUCTION

Small and Medium Enterprises (SMEs) play an important role in the development and employment creation in many countries. It has been recognized as a major force to help countries to grow especially during the recent economic downturn. Many of the Small Island Developing States (SIDS) depend on the SMEs for GDP growth and even encourage creation as well as expansion of the SMEs through funding and other types of support. Many of the SMEs start as family businesses using their house as the main premises and also other personal properties such as transport, computer etc. The SMEs which are family businesses usually face great difficulty when it comes to expansion as they lack the technical know-how to support the expansion plan and very often the cost of the equipment coupled with lack of financial support prevent many of these companies to consider investing in new equipment or even optimizing their businesses. They are also not willing to share too much information about their companies due to competition and tax purposes. The personnel are usually selected amongst trustworthy relatives who may not have the necessary qualifications and /or expertise in the field (e.g. Financial Manager) that they are working.

There is a variety of high technology equipment which have been developed and may be available off the shelf but the high cost of these equipment may restrict the investment only to large units with mass production. In many SIDS the market is very limited and it may be difficult to export their products which are not competitive on the world market due to various factors such as cost of production and freight. The best option is to be economically viable on the local market itself and then consider exports. In case, of heavy competition from companies from other countries, the local SMEs can still rely on the local market to survive.

The University which is responsible for the training of engineers and technicians to support the local industry can help the SMEs to identify or even design equipment that are customized to meet the needs of specific company. The cost of custom made equipment is usually very high and may end up being higher than the price available off the shelf. But very often the equipment available off the shelf are loaded with lots of functions many of which may not be required by the specific SMEs. The custom design will focus on the needs of the company and the design and implementation cost may be reduced considerably if the project is done in collaboration with existing Universities.

In many universities, the students have to do a final year project in partial fulfillment for the award of the degree. Students may end up doing interesting projects but not directly relevant to the industry. The Universities together with the SMEs may identify specific projects where the students will help in the design and implementation with no or minimal cost. The components will be provided by the companies through appropriate funding institutions and the final machine design or machine becomes the property of the company. The University will continue to provide support as and when required.

Many small projects have already been considered by the University of Mauritius and two such projects are described in this report. These projects are developed through the University and SME collaboration and very often once the projects are completed there is no follow up. Initially companies are reluctant to invest in the components required to build the prototype and the University has to provide most of the components. Given the fund constraints there is a tendency to go for low performance items which limits the functionalities of the equipment further. The prototype is partly completed and remains the property of the University of Mauritius.

The design and implementation (in some cases) of custom designed equipment clearly show that there is a possibility of collaboration between Universities and SMEs together with the help of appropriate institutions in SIDS to support the sector. In many of the schemes available to SMEs, the government, through the funding institutions, takes a certain fraction of the expenses e.g. training of personnel or purchase of new equipment or even feasibility study. There must be a proper coordination and support between University, SMEs, an appropriate institution doing the link between University and SMEs and the funding institutions. It must be understood that the machines may still need fine tuning after designs and testing. Much of the cost of developing new machines is already being borne by the University and a proper scheme will only allow the companies to take advantage of these custom designed equipment.

2. SMEs IN MAURITIUS

The SMIDO Act in 1993, which was itself part of the Industrial Expansion Act of the same year, was the key pointer in the promotion of SMEs in Mauritius. The SMIDO, being a parastatal body, aimed at expanding, enhancing the competitiveness, and developing further the modern SME sector in Mauritius. It helped in job and wealth creation, innovation, economic growth, poverty alleviation, and social achievement. However, in December 2003, the Government created a new Ministry to cater for the promotion of the SME sector, and, in 2005, the SMIDO merged with the National Handicraft Promotion Agency (NHPA) to become the Small Enterprises & Handicraft

Development Authority (SEHDA), which aimed at rationalising and optimising the use of resources dedicated to the small businesses in Mauritius. Moreover, in 2010, the SEHDA Act was replaced by the SMEDA Act, which caters for medium enterprises and the latest development with regards to SME policy framework in Mauritius.

There seems to be a lack of consensus and considerable variations in how to define an SME, as this definition differs from country to country. A discussion on how to define SME is beyond the scope of this work. The SME includes enterprises in all economic sectors. In order to avoid detailed sector-specific criteria, turnover criteria is used across sectors and for the purpose of this work, the official definition of SME in Mauritius as given by the SMEDA (Small and Medium Enterprise Development Association) has been adopted.

For Small Enterprises:

No differentiation between services and manufacturing sectors has been made for small enterprises, and the thresholds for small manufacturing firms also reflect small service firms. Small enterprises are usually characterised by their more

‘developmental’ level of operations. A Small Enterprise is defined as an enterprise which has an annual turnover of not more than 10 million MUR.

Medium Enterprises

Medium-sized enterprises needs are defined separately from small-sized enterprises as those enterprises require different support measures and have other objectives. Medium Enterprises are generally more sophisticated by nature and level of technology. A Medium Enterprise is defined as an enterprise which has an annual turnover of more than 10 million MUR but not more than 50 million MUR

Employment in SMEs

The number of registered enterprises has doubled from 2004 to 2012. A total of 7,068 enterprises were registered at the SMEDA in 2012. New sectors of activities have emerged from trade and commerce, professional vocation, handicraft, and business support services. According to Statistics Mauritius (2013) for year 2013, the total number of employed persons, including foreign workers, was estimated at 552,000 (348,300 males and 203,700 females) as compared to 535,700 (343,000 males and 192,700 females) in 2012. The number of persons employed in large establishments in 2013 stood at 297, 000. This number has considerably increased as compared to previous years. The Small and Medium Enterprises in Mauritius employed up to 47% of the workforce in 2013, accounting to 255,000 employees, hence showing the importance of SME's in creating jobs in the country.

3. PROBLEMS FACED BY SMEs

A common basis for examining the problems faced by small firms is to provide a taxonomy of growth constraints which distinguishes between problems associated with, respectively, general management, operations/production, finance and marketing (Vozikis, 1984; Poutziouris 1995). General managerial problems relate to a diverse range of factors, including poor time management,

failure to realize the benefits of specialization, resistance to modern management practices, human resource management limitations and poor assembly and analysis of information, as a basis for effective strategic planning (Poutziouris, 1993).

Internal constraints (Khisto, 2014; Ramsurrun et al., 2001). are mainly concerned with unavailability of skilled labour and raw materials, scarcity of technical skill, small domestic market, and competition with large industries. Ligthelm and Cant (2002) argued that, in SMEs, there is a lack of trained and skilled labour. Owners are unable to keep and encourage their staff and they often lose potential employees, which results in low productivity. Moreover, Hew and Loi

(2004) found that it is difficult for SMEs to find well- educated and experienced labour, consequently leading to the problem of mismatch on the labour market. Thus, recruitment of potential workers is the major problem of SMEs (Pansiri and Temtine, 2008).

SMEs also lack in terms of managerial skills and experience. The lack of planning and reluctance in setting goals and taking advices may have a negative effect on the progress of small businesses. Due to poor time management and insularity, they bypass training and development opportunities (Westhead and Storey, 1997). Poor labour management may also hinder SMEs development, according to Ligthelm and Cant (2002). SMEs were found to be more concerned with their survival on the market rather than focusing on development, innovative methods of production, technology adoption, and marketing skills to enhance the growth of their businesses [OECD (2010), Curran (1999), Gray (1998)].

The particular problems faced by small firms in relation to finance are well documented (Binks et al.,1991; Mason and Harrison,1994; Scott, 1992). The finance gap literature details a range of problems faced by small firms in their experience of capital markets. Important issues here include the typically narrow (and hence comparatively risky) product orientation of the small firms and the frequent absence of a 'track record'. The lack of significant collateral or expertise in articulating financial needs or offering credible financial forecasts also

disadvantages small firms in their dealings with potential financiers. Such limitations are important in explaining equity gaps, loan gaps and working capital problems and are reinforced by their conflict between realizing growth and retaining effective control of the firm, which is a central concern for many family-owned enterprises. Limitations in the internal management of company finance, perhaps due to the non-existence of specialist financial managers, compound the problem.

Levy (1993) reported that financial constraints are the biggest problem faced by SMEs when competing with larger competitors. Gurmeet and

Belwal (2008) found that it is difficult for SMEs to secure finance for the establishment and running of the business.The unavailability of financing, lengthy procedure, collateral requirement, and the high cost of raw materials and equipment are the major disadvantage of SMEs, and thus, they are as such reluctant to invest in R&D, innovation, and technology (Hossain, 1998). Moreover, it is also found that female entrepreneurs have more difficulty to get access to finance (Carter and Rosa, 1998). Furthermore, Roper and Scott (2009) described women as "discouraged borrowers". Besides, OECD (2010) found out that less than 3% of SMEs keep accounting records. According to Marlow (1998), poor finance results in managerial shortcomings.

One of the main constraints of associated with the marketing of small firms is the fact that they frequently develop from a craft-based set of skills (Watkins and Blackburn,1986) , where the natural focus attention is day-to-day survival and where longer-term strategic considerations may consequently be neglected. The penetration of market information systems, market research and forecasting techniques is typically highly limited in the small enterprises, while there is often a limited awareness of, or capacity to fund, advertising and promotional activity.

4. INSTITUTIONAL SUPPORT AND INCENTIVES TO SMEs

The Government of Mauritius through many institutions has set up schemes to support the SMEs to allow them to invest in new equipment and for exports. In his budget speech of November 2012, the Finance Minister of Mauritius, has

come up with several schemes and faculties to boost the SME sector. The schemes, since then are still available for SMEs to tap in, provided they know where to go and how to proceed, hence avoiding bureaucratic burdens and hurdles. The schemes were as follows:

To further democratize the economy:

- Banks will loan an additional amount of Rs 250m (USD 8.4m) annually and small enterprises with turnover less than Rs 10m (USD 0.35m).
- Interest rates will be capped at repo rate +3% (currently 7.9%).

- All processing fees and related bank charges will be waived.

To help SMEs reducing their financial cost , the following measures are being offered to SMEs:

- Interest rate for leasing equipment under a scheme known as LEMS (Leasing Equipment Modernisation Scheme) will be reduced from 8.5% to 7.25% on all new leasing facilities.
- With a view to reducing administrative costs, VAT registration threshold will be doubled from Rs 2m to Rs 4m (USD 60 000. to USD 140 000.)
- The development Bank of Mauritius Ltd will waive all loans for which the capital outstanding does not exceed Rs 20,000 (USD 650.) and which has remained unpaid for 3 years.

Regrouping and rationalizing of schemes for SMEs:

- Performance bonds will not be required for contracts of up to Rs 5m.
- Requirement to provide Advance Payment Guarantees will be considerably overhauled.
- Outcomes of tender exercises will now be displayed on the procurement portal for the contracts of Rs 5m (USD 170 000.) and above instead of Rs 15m. (USD 350 000.)
- Doubling the amount of refund to SMEs for participation in international fairs from Rs 100,000 to Rs 200,000. (USD 3 300. to USD 7 000.)
- Providing a grant for freight expenses of up to Rs 20,000. (USD 650.)

The Government of Mauritius has set up the Small and Medium Enterprises Development Authority (SMEDA) and the main objective of this new institution is to support SMEs to enhance their competitiveness.

The Small and Medium Enterprises Development Authority (SMEDA) is a parastatal body established under the Small and Medium Enterprises Development Authority Act 2009. This Act repealed and replaced the Small Enterprises and Handicraft Development Act 2005 under which the Small Enterprises and Handicraft Development Authority (SEHDA) was created following the merger of the Small and Medium Industries Development

Organisation (SMIDO) and the National Handicraft Promotion Agency (NHPA). The Small and Medium Enterprises Development Authority (SMEDA) operates under the aegis of the Ministry of Business, Enterprise and Cooperatives and is committed to support and facilitate the development of entrepreneurship and SMEs in Mauritius.

The objects of the Authority shall be to:

- Promote a conducive business environment and empower SME’s to emerge and grow;
- Promote a service delivery network which increases the contribution of SMEs in the national economy and enhances economic growth;
- Enhances the competitiveness of SMEs;
- Devise and implement development support programmes and schemes for SMEs;
- Facilitate, assist and provide the necessary support to SMEs to gain market access and business opportunities and to compete successfully in the national and international markets;
- Promote and develop entrepreneurship;
- Advise the Minister on policy issues regarding the development of SMEs.

Functions of Authority:

The Authority shall have such functions as are necessary to attain its objects most effectively and shall, in particular-

- Provide core support services, particularly entrepreneurship development, business facilities, counselling and mentoring services ;
- Implement and operate a registration scheme for SMEs;
- Facilitate access to industrial space, finance and other productive resources;
- Empower product specific and sector specific SMEs to enhance their delivery capabilities;
- Coordinate with other support organisations and stakeholders in the fulfilment of its objectives;

- Facilitate networking among SMEs and the development of linkages between large enterprises and SMEs;
- Promote technological and managerial capabilities of SMEs;
- Ensure that SMEs; in respect of which a registration certificate is issued, benefit from every incentive which the government grants to them, and assist them to obtain the incentives;
- Identify best practices and disseminate them to SMEs;
- Organise and encourage participation of SMEs in fairs;
- Conduct surveys in the SMEs sector and provide market intelligence for those enterprises, including providing reports on various economic indicators;
- Implement, coordinate and monitor assistance programmes provided to SMEs;
- Collaborate with other local and international agencies dealing with SMEs, to develop the local SMEs through-
- Skills enhancement programmes for their officers; and
- Participation in seminars, workshop and capacity building programmes;
- Identify projects for the development and promotion of SMEs;
- Facilitate and coordinate research relating to the development of SMEs;
- Sensitise the public at large on entrepreneurship;
- Provide incubator facilities for SMEs;
- Devise and review policies relating to SMEs;
- Coordinate initiative of public sector agencies and of the private sector relating to SMEs;
- Coordinate entrepreneurship activities carried out by public sector agencies and the private sector.

5. UNIVERSITY PROGRAMMES

The University of Mauritius has been set up in the late 1960's to support the local industry by producing graduates in relevant fields. The full time undergraduate programmes are free and the University is committed to offer a quality programme to meet the requirements of the local industries. The students studying for a B.Eng (Hons.) programme in engineering have to complete a final year project in level 4 of the programme related to their field of study. The University has encouraged industry based projects to give the students the most appropriate training to suit the local requirements.

The B.Eng (Hons.) Mechatronics programme was launched in 1997 and has been very popular among fresh school leavers. The students have been working on many projects with local companies and many of which have been implemented. The major problems encountered by the students is to find a potential organization where they could do their final year project. In many cases, the company refuses as they do not have staff with relevant expertise in the required field or their staff are too busy to discuss or follow up on the matter. The big companies do not often require the input from the University as they usually have the necessary funds and rely on international suppliers for their equipment. They can easily raise funds from funding institutions in a relatively short span and purchase required equipment urgently.

Despite the increased competition and decrease in profitability, the SMEs are reluctant to bring their problems to the attention of the University, probably due to lack of information. They do not have a R&D Department to consider possible enhancements to the machines or processes to make the system more efficient. University usually makes the first step towards the SMEs to assess their requirements and propose potential research area. Companies often agree to

provide the set up for the case study but they make it clear right at the beginning that they are not ready to provide funds for the proposed project. There has been cases where the University has agreed to work in close collaboration with them and at the end of the project the machine remains the property of the University. If the student or University does have any commitment with the company , the prototype is not transferred to the company due to lack of a formal link.

There is a widespread acceptance that the SMEs represent the future of the nation but it must not be limited to traditional local products relying heavily on manual workers. The competitiveness must be enhanced to allow the long term survival of the SMEs which has to adopt new technological reality. Government has supported the local SMEs by providing funds at low interest rate but there is a need to provide the necessary expertise not available in these companies. This is one issue where the local Universities can intervene as they have multi-disciplinary expertise as well as the facilities needed to effectively support the companies. The University will be able to help the SMEs to face the emerging challenges with the support of the Government and the funding institutions. The University of Mauritius must be a formal link in the chain and must be recognized as a prime partner for the development of the SMEs. The cost associated with the design, consultancy and development of proposed systems are already being borne by the University. If the projects already designed are implemented, it is a recognition of the University's effort to support the economic growth of the country and this ensures that all the effort of the students have not been wasted.

6. UNIVERSITY –SMEs COLLABORATION

University of Mauritius has cooperated with many SMEs on projects requiring the design of equipment. Two specific projects are discussed in this paper to show that University – SMEs collaboration can be very fruitful in even difficult areas and the cost of implementation need not be extremely high. The two companies have agreed to provide basic information to allow their system to be used as a case study to design an automated system to solve a real problem. The

first project deals with the design of a computer numerically controlled (CNC) Machine for a ship model manufacturing plant and the second one deals with the automation of some of the tasks in poultry farming.

6.1 Project 1 – CNC Machine for Manufacturing of Ship Models

This project has been performed in a ship model plant which requires skilled workers. This is a highly value added industry and the products represent one of the few real local handicraft. The products are very much fancied by visitors and cheap copies from other countries are not available. The ship models manufacturing process starts with the preparation of the different shapes from sheets and wood followed by assembly of the individual parts to give the final model. The task that can be automated is the cutting of the different parts of the ship models from thin sheets of plywood. Fig. 1 shows one of the parts of a specific ship model. The actual manual process is listed below and can take up to one working day to be completed;

- Search the required plans (available in printed form on A1 paper) in the set of plans
- Scale them to the desired dimensions using an A4 scanner
- Reprint them on paper at the new scale.
- Transfer the scaled hard copies on plywood by the method of manual tracing.
- Link the series of dots obtained on the plywood using a pencil to obtain the complete outlines of the plans on plywood.
- Cut the profiles to have the templates of the different parts in plywood, using a small hand- saw.
- Use the templates to trace and cut the parts whenever a new copy of the ship model is required.

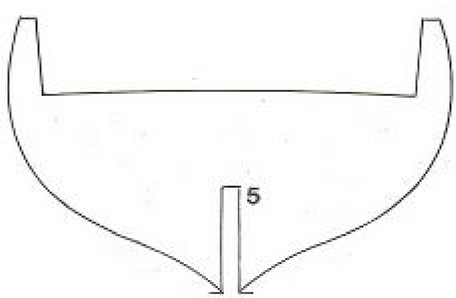

Fig 1: A typical ship model part

Many of the tasks mentioned above can be simplified and will not be required if the process is automated. The proposed model should be able to

- Draw or import plans (e.g. from the scanner) of the models on a computer
- Save, retrieve and modify the plans

- Send the plans to a CNC software which will convert them into machine codes
- Initialize the cutting process of the parts on a 3-axis CNC cutting machine.
- Control and monitor the cutting processes
- User friendly graphical user interface.

6.1.1 Designs

After considering the requirements of the workshop, the main specification and characteristics of the CNC machine have been identified. The machine will have a gantry configuration and will make use of the bit cutting technique. The worktable must be 750 mm x 500 mm and the thickness of plywood that can be cut is 3 mm with a resolution of at least 1 mm.

The new system uses a computer as the controller and it will control the machine through its parallel port. The plans can be scanned or drawn using a computer aided drafting software. The drawings are then scaled to the desired dimension. An interface has been designed to allow the user to do the required set up and initialization of the machine. Once the set up is completed the process can be

started. The main advantage of the system, is that once the drawing has been created it can be saved and used indefinitely.

The overall concept of the project is depicted in Fig 2. The CNC machine has been designed and optimized on Solidworks® to reduce the size as well as the cost of the machine. Simulations have been carried out to check for any possible malfunctions or problems. Changes have been made based on the results and the components then have been sized and/or modified. The motors and other important components have then been selected.

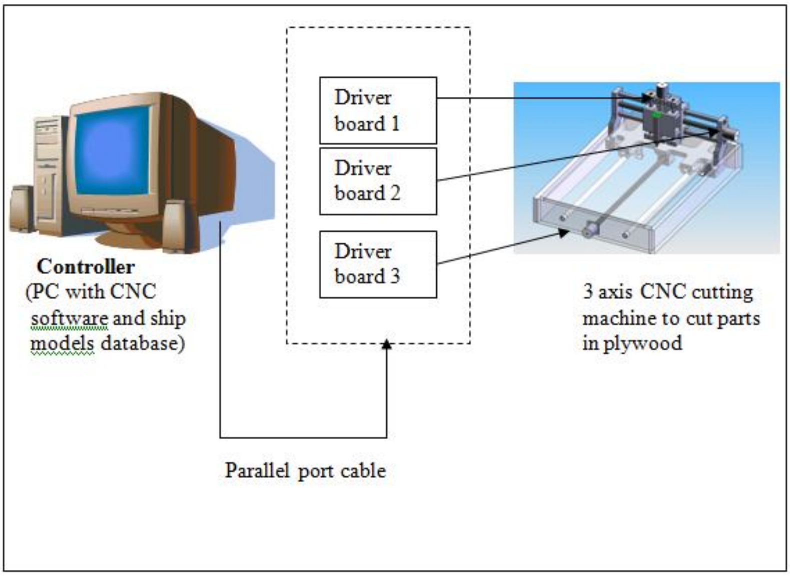

Fig 2: Concept of Project

Component selection was a major issue and one of the main objective is to achieve sustainable design by using components available from scrap machines. Raw aluminum from piston heads (from automobiles) , electronic components, limit switches and power supply from old PCs were collected. They were first tested and ensured that they meet the requirements of the machine. Some of the structural members of the machine have been manufactured using aluminum to reduce the weight of the system hence allowing smaller motors to be used. Wooden models of the parts of the machine were made which were used to manufacture the components by the sand casting process using scrap aluminum

obtained from local companies. The components have been provided by the University of Mauritius and machining and manufacturing of different structural parts have been done at the University workshop. The 3D model and the completed prototype are shown in Fig 3.

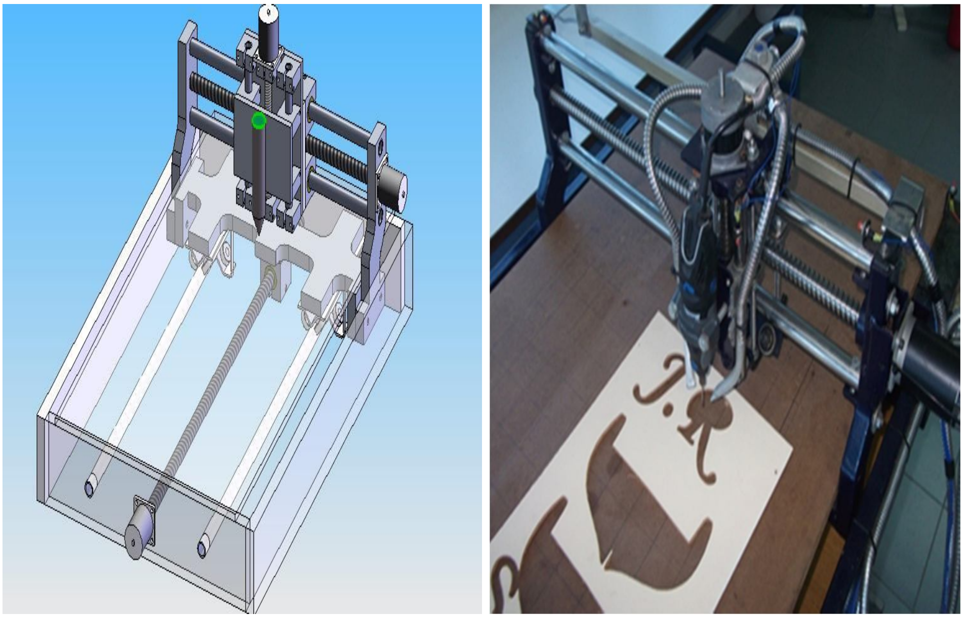

Fig 3 (a) 3D model of the Machine (b) Actual Machine

Given that the machine will be operated by technicians not necessarily having experience in information technology, the graphical user interface should be simple and easy to understand. The graphical user interface has been designed (Fig. 4) so that the operator can set the parameters and start the machine with minimum effort. The drawing is imported from file or scanned from an existing copy, and modified or scaled as required. The user can do do some settings and then start the machine. During the manufacturing process, the software monitor the machine can also provide feedback on the status of the job.

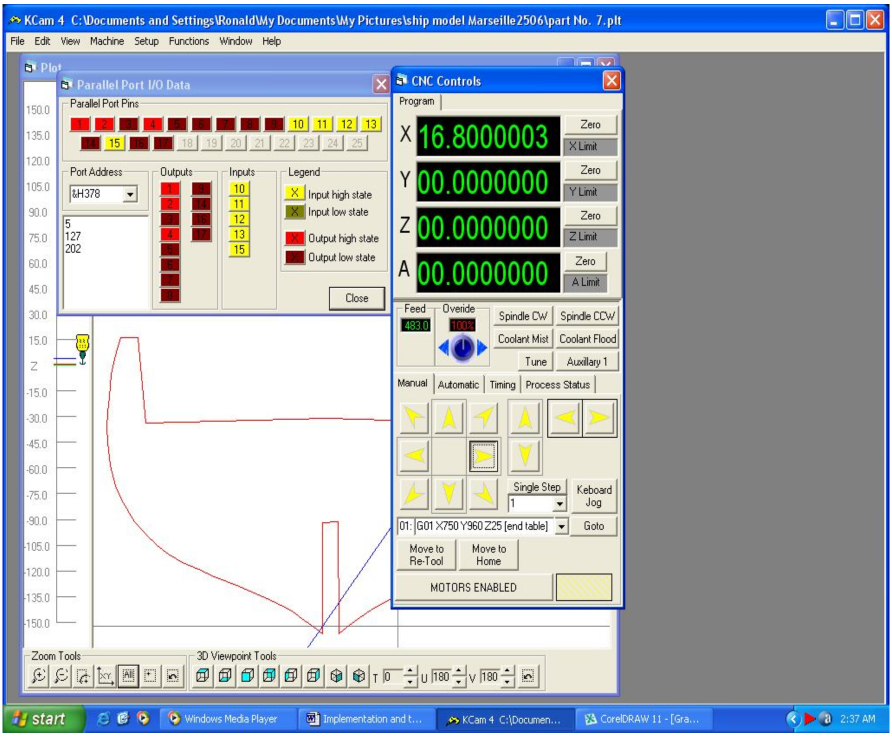

Fig 4: Parallel port testing using manual jog keys, port monitoring

6.1.2 Costing and implementation

The total cost of the machine is USD 5500.00 including design, development and manufacturing costs which amounts to USD 4500. This amount can be waived as it represents the contribution of the local University to the scheme. The structure of the machine has been manufactured using metal, steel and aluminum, obtained from scrap at reduced cost. The cost of the computer and scanner are not included as these are already available at the company.

The system is currently being used by the University for labworks for students of the undergraduate programmes. Given that all investment has been made by the University, the final design remains the property of the University as there is no proper mechanism to transfer or sell the equipment to the private company.

6.2 Project 2 – Automation of Poultry Farming System

Many small scale poultry were set up at the beginning of the 1980's to support the local industry. Mauritius went through a rapid industrialization during that period causing in a rapid increase in poultry products. The small companies were encouraged as they could easily start production with small investment usually in partly completed buildings in isolated fields. With time the cost of production has increased drastically and labor is becoming a major problem as there is a shift from basic manufacturing industry to financial services and ICT sector. Many companies are looking forward to increase their efficiency and productivity while decreasing cost of production. There are many automated systems/equipment available off the shelf. These are not designed for small systems and are relatively expensive especially for small markets like Mauritius. The layout and building may have to be modified to allow the equipment to be installed. Recently, the Small and Medium Enterprise Development Authority (SMEDA) together with the Agricultural Research and Extension Unit (AREU) have set up strategic plan for the crop diversification and livestock sector. A situational analysis carried out by the Ministry of Agro-Industry and Fisheries (2007) showed that significant opportunities exists in the poultry industry and hence they have taken great initiatives to boost up this sector.

One local company decided to consider the feasibility of automating some of the tasks in its poultry farm to reduce the variabilities introduced by human operators as well as reducing the cost of energy in the factory by appropriate controls. The automation must be designed to operate in the existing building. The company purchases one day old chicks which are then bred until they reach their point of lay called layers. The layers are then transferred to the Laying Department for egg production. The company started with 100 layers in 1983 and has reached 7000 layers in 2010.

All operations are manual and regular intervention of operators are required to ensure that the water is still clean and has not been soiled with feed residues. The breeding temperature of the pullets is a very important factor because it proves to give excellent performances in production. Heating is provided by incandescent bulb of 50 Watts each but there is no temperature monitoring in the shed. According to ISA Poultry (2009) the interior of the building should be in the range 31^{0}C to 33^{0}C and the temperature should be reduced by 3^{0}C every week until a temperature of 22^{0}C is attained after 28 days. The failure to provide the correct temperature for the day old pullets leads to high mortality rate and hence to ensure a good breeding environment, the automated system will consist of appropriate actuators to regulate and maintain the correct temperature. The incandescent lamps remain on even when the ambient temperature is within the desired range. Given the small size of the company, there are no proper records as to the death rate of pullets during the breeding. Although a constant temperature is required, it can be seen (Fig. 5) that the temperature varies continuously being in the desired range only a few hours during the day.

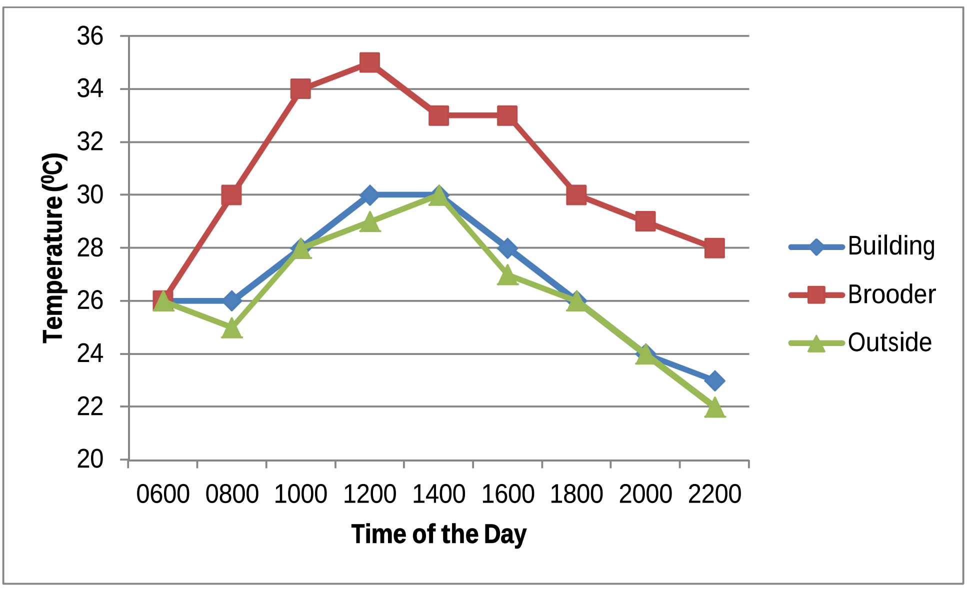

Fig 5: Temperature Variation on a Specific Day

The company employs three full time and two part time workers. The routine tasks of the workers are to feed the pullets, provide them with clean water for drinking and ensure proper lightings to control the breeding environment temperature, clean and remove the manure from the pullet cage.

At present, the amount of feed is monitored visually by looking into the feeders and any faults occurring during the absence of the workers are not instantly acknowledged. Hence, during this period, there might be several problems which could decrease the effectiveness and efficiency of the whole breeding process. Some of the main problems that are frequently encountered are discussed below:

- Manual feeding does not provide any control over the amount of feed to be supplied and the build up of fine residues leads to high feed wastage.
- Water often becomes soiled with feed residues and need to be cleaned at least thrice per day.
- Time consuming manual processes and unavailability of labour
- Pullets are sensitive to temperature change and these influence their feed consumption.
- Tedious manure cleaning procedure eventually this leads to a high rate of mortality and low feed consumption among the pullets.

6.2.1 Proposed design for the feeding system

A survey was carried out to identify tasks that can be considered for automation. The issues that need to be considered as well as other implications were discussed with the management and the final consensus was to automate some of the tasks and to leave those that require high investment. Some tasks can still be performed manually as a minimum number of operators will still be required.

The tasks that will be automated are:

1. Design an automatic chain feeding system where the chain drive will specifically be designed to provide constant, accurate and rapid feed flow with correct sprocket engagement.
2. Design of an automated system to transport feed from silo to hopper
3. Design of an automated system to select the feed type and to monitor the feed level in the silos.
4. Design of a temperature monitoring and control system for the breeding area.

The following tasks are considered to be too expensive to implement and not critical;

1. Automation of the manure removal system will not considered because major modifications to foundation of the existing shed will be required.
2. Cooling of shed to low temperatures will not be provided as an air conditioning system will be required which is too expensive. The Journal of applied Poultry Research (2008) recommends that appropriate ventilation be provided to mitigate the effect of high summer temperatures and humidities in the brooding area.

6.2.2 Designs

The high cost of labor and the complexity of the tasks involved in manual operations are limiting the production to 1500 pullets per 16 week period. The area available in the poultry is not being used efficiently and automation will allow a more judicious use of the floor area. Based on static and dynamic anthropometric data (Sanders & Mc Cormick, 1993) for human operators and the stocking density and housing conditions for the pullets (ISA Poultry, 2009), new pullet cages and poultry layout were proposed. With the new cages and with the help of automation, the production capacity is expected to reach 6000 pullets per 16 week period. The pullets will be transferred to the laying section of the same company and extra pullets may even be sold to other SMEs.

The farm has been divided into sub systems and each has been considered separately before integration at the end. The different components to be automated have been designed and sized. All electric motors, sensors, controller and mechanical parts have been designed/ sized and they have been integrated together. The designs for the different sections of the automated mechanisms are shown in Fig. 6 below.

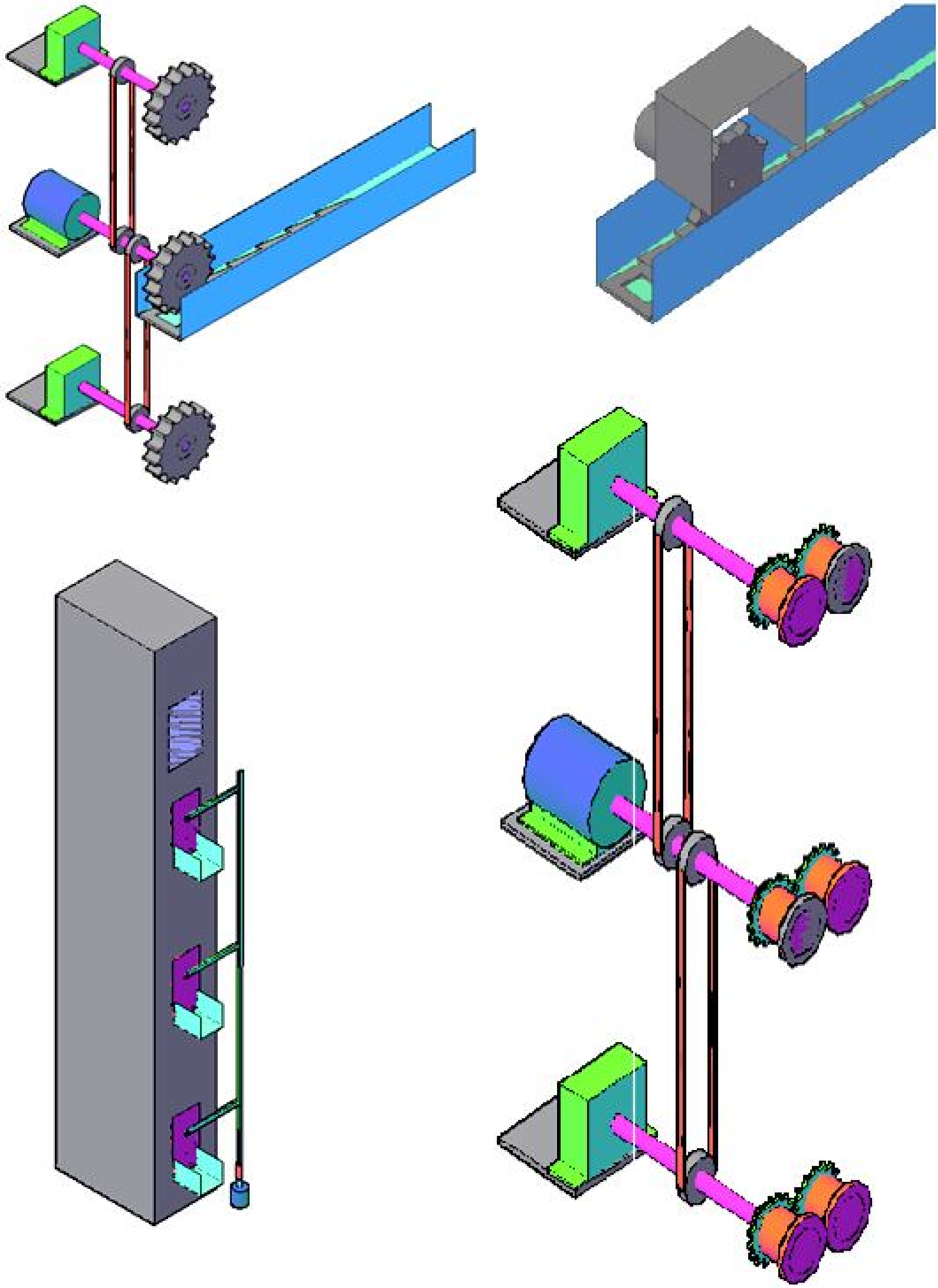

Fig 6: Designs of the individual components required for the automated plant

System was not available for implementation due to cost implications and the different sections of the plant had to be simulated. Fine tuning will still be required when the actual system will be implemented. The overall proposed design is shown in Fig 7. The numbers of pullets that can be bred at one go will increase due to automation and a more efficient use of the existing facilities and this will help to reduce the payback period. The additional pullets can be transferred to the laying section or sold to other small companies or individuals.

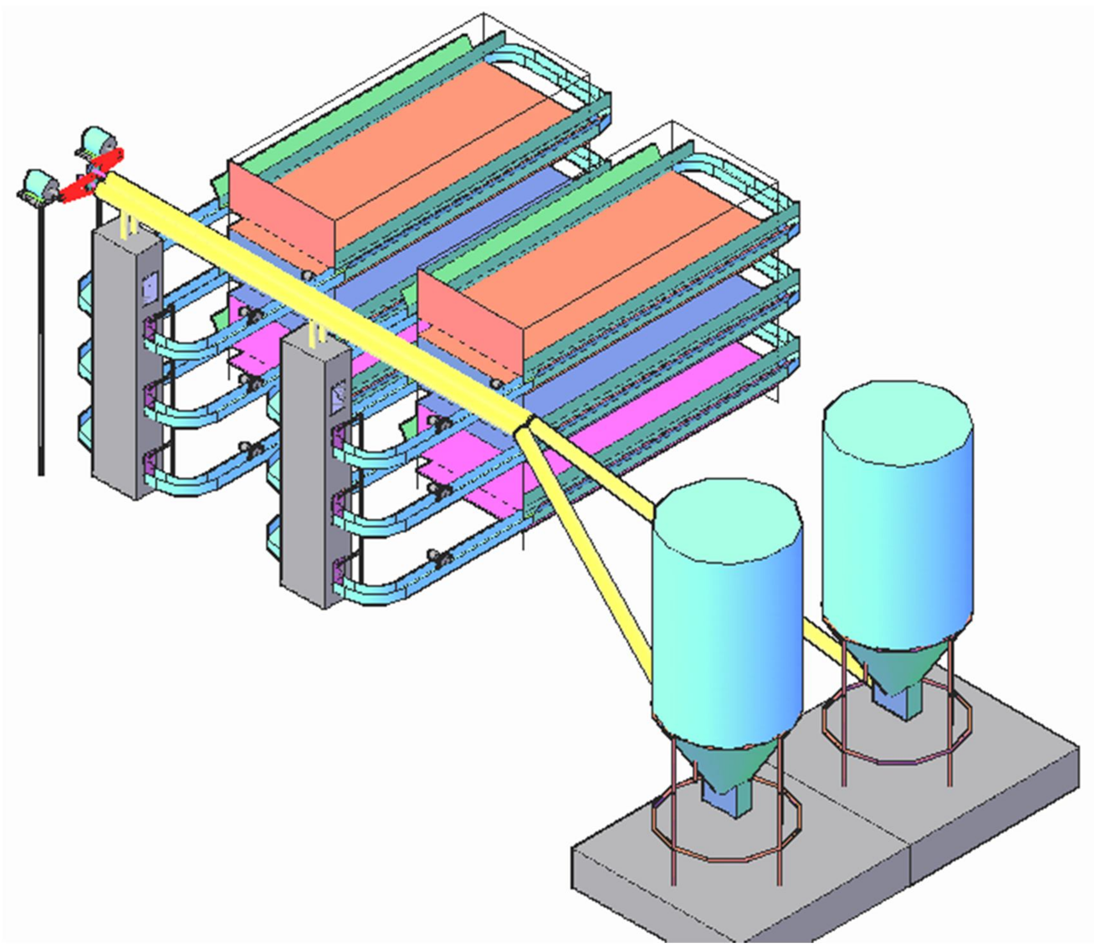

Fig 7: 3-D Layout of Proposed System

6.2.3 Implementation and Testing

The company forms part of the Small and Medium Enterprises and as discussed with the management, the company may not be able to implement this project at one go due to its financial constraint. Therefore, the company will be using this project as a guide for future implementation of the automated system. The project has been designed as independent modules which can be integrated together in stages. This is a very good opportunity for the company to expand the laying section further as the breeding section will have an increased capacity due to the new cages and layout designs.

Table 1: Cost Benefit Analysis of Proposed System

Item	Actual (USD)	Proposed (USD)
Output per cycle (16 weeks)	1500 pullets	6000 pullets
Equipment Cost	Not Applicable	64750.
Feed	5690.	19285.
Labour	3440.	775.
Water	80.	80.
Electricity	604.	1675.
Maintenance	170.	670.
Revenue	10000.	40000.
Profit	16.	4565.

The cost of the proposed system is compared to the cost of the actual system (Table 1) and it is clear that the company will benefit if it adopts new technologies. The consultancy, design and development fees are USD 7200, which consists of the use of University facilities and is not included in Table 1. This cost is the contribution of the University of Mauritius to the SME support scheme. The equipment cost includes the rate of interest for the system over five years and the break even is slightly less than 4 years. The amount of the loan is Rs. 1.7m (USD 56 000.) with an interest rate of 6% per year over 5 years.

The pullets are not sold but are rather transferred to the laying section where they will be producing eggs. The cost of one pullet if purchased from the regular supplier is USD 6.7 and this price has been used to determine the revenue of the

company if all pullets were sold. The most appropriate means to measure the effectiveness of the system is using the cost of producing one breeder which is decreasing from USD 6.7 to USD 5.9. This represents a considerable saving (given the increase in production) and confirms that there are plenty of scopes with custom designed automation.

7. DISCUSSION

The main objective of the project was to automate the existing system in order to increase productivity and provide a safe and healthy breeding environment for the pullets. The newly automated system was successfully designed to ensure that the feeding, drinking and temperature control process of the pullets are carried out efficiently and allow rapid fault detection by using appropriate alarms in case of any failure.

The design of the nipple drinker line and the chain feeding system will reduce the water and feed wastage respectively. Hence, this will decrease the operating cost of the breeding farm. The temperature set points of the breeding area will be changing automatically as the pullet grow and this will thus provide a good breeding temperature and reduce the pullet mortality rate.

A financial analysis has been performed and the cost of producing one pullet for the breeding section is being reduced from USD 6.7 to USD 5.9 and the savings achieved will enable a payback period of about 4 years. The breeding capacity is being increased fourfold from 1500 to 6000 (per cycle) and excess layers can be sold to other egg producers. Hence, this shows that small and Medium Enterprises can still upgrade their system to improve their efficiency by implementing such designs.

8. CONCLUSION AND FUTURE RECOMMENDATION

The Government wants Mauritius to be a knowledge hub which is not working as planned. The cost of education is relatively high and the field studies proposed do not meet the expectations of the students. The new fields mentioned are aeronautical engineering, light engineering, medical schools etc.. but there is no rush to set up such institutions as these sectors are virtually non-existent in the country. The sector that has shown rapid growth up to now and is still showing enormous potential for growth in Mauritius is the small and medium enterprises.

There must be a major shift from traditional products to high technology sectors. The SMEs must only not come from the young unemployed with no tertiary education background but also from the young graduates with new start ups in technologically advanced fields. The graduates must be involved in the process right at the start of their tertiary education and not at the end. Innovation must be inculcated in their minds as a means of survival for them and the nation. With the setting up of an appropriate technological park or centre, all projects and mini projects can be related to the local industry.

The University – SMEs collaboration can help in reducing the investment cost on new machines by a substantial amount. The proposal is to include the university as a full fledge member of the program which may result in the setting up of a innovation & SME support center to provide the necessary support services to the sector. The consultancy, design and development costs borne by the University in the projects discussed above are in the range USD 4500-7200. The cost will depend on the complexity of the problem but it does represent a major share of the project for services usually not available to the SMEs. This can be the contribution of the tertiary institution to the support the SME development scheme. The costs of components and manufacturing will have to be borne by the company with the support of the government through appropriate mechanisms. But a proper channel must be set up to formalize the link to include funding organizations to support the research and development which can lead to the design and manufacture of more efficient systems. The companies benefit from low cost custom made machines and the students of the University of

Mauritius benefit in terms of appropriate Engineering project related to their trade.

The automation system proposed can be used by the company to prepare their business plan for loan applications as well as planning for further expansion. As can be seen, from the Poultry case, the automation will have to be followed by an expansion of the laying section or sale of layers to other companies.

Successful implementation of automated systems or machines can be transferred to the companies if they have secured the loans but this has to be a win-win situation. The companies have to invest in the basic components during the design stage to allow the satisfactory completion of the project/s.

On an ending note, the University of Mauritius can also take the lead with the support of the Government to create an independent entity that roof all the projects related to innovation and technology. Funds can initially be provided by the Government and if this works out properly, the center can be become self-funding manage its own projects. Those students having worked on a project leading to the development of an innovative design can choose either to continue to work in that entity to fine tune the design and hence help in implementing same in the SMEs. This will help in creating and building working links/relationships with the SMEs. This will also help in fostering a research and innovation culture among the youngsters in Mauritius.

9. REFERENCES

BINKS, M. & ENNEW, C.T. (1991), Bank Finance to Small Businesses, Bolton Twenty Years On: The Small Firm in the 1990s, J. Stanworth & C. Gray (eds), Chapman, London.

CARTER, S. & ROSA, P. (1998). The Financing of Male- and Female-Owned Businesses. *Entrepreneurship and Regional Development*, 10, 225–241.

CURRAN, J. (1999). The role of the small firm in the UK economy: hot stereotypes and cool assessments. *Small Business Research Trust, Milton Keynes*: Open University.

GRAY, C. (1998). Enterprise and Culture, *Routledge, London*.

GURMEET SINGH, RAKESH BELWAL, (2008) "Entrepreneurship and SMEs in Ethiopia: Evaluating the role, prospects and problems faced by women in this emergent sector", *Gender in Management: An International Journal*, Vol. 23 Iss: 2, pp.120 – 136.

HEW, D. & LOI, N. W. (2004). Entrepreneurship and SMEs in Southeast Asia, *Singapore: Institute of Southeast Asian Studies.*

HOSSAIN, N. (1998). Constraints to SME Development in Bangladesh, *Paper Prepared for Job Opportunities and Business Support (Jobs) Program, mimeo*.

ISA POULTRY (2009). *General Management Guide for ISA Brown Commercial Layer*.

KHISTO M. (2014). Barriers to Growth in SME – The Case of Mauritius. *Research Journal of Economics and Business Studies,*Volume 9.

LEVY, B. (1993). Obstacles to Developing Indigenous Small and Medium Enterprises: An Empirical Assessment. *The World Bank Economic Review*, Vol. 7, No 1, 65-83.

LIGTHELM, A. A. & CANT, M. C. (2002). Business success factor of SMEs in Gauteng: A proactive Entrepreneurial Approach. *Bureau of Market Research*.

MARLOW, S. (1998). Self employed women- Do they mean business? *Entrepreneurship and Regional Development*, Vol. 9, No 3, 199–210.

MASON, C. & HARRISON, R. T. (1994) The Informal Venture Capital Market in the U.K. in Financing Small Firms, A. Hughes & D. J. Storey (Eds), pp. 64-111, Routledge, London.

MINISTRY OF AGRO INDUSTRIES AND FISHERIES, *Strategic Options in Crop Diversification and Livestock Sector (2007-2015. Viewed on 10 September 2011*, http://www.areu.mu/files/pub/areunssp.pdf.

MINISTRY OF FINANCE, MAURITIUS (*2012) National Budget Speech*.

OECD. (2010). Globalisation, Entrepreneurship and SMEs, *Report by the Working Party on SMEs and Entrepreneurship*, OECD, Paris.

POUTZIOURIS, P. (1995). The entrepreneurial profile of small-scale manufacturing in Cyprus', 25th European Small Business Seminar: Excellence in Small Business Management, Limassol, Cyprus, 20–22 September 1995.

POUTZIOURIS, P. (1993). A growth model of small manufacturing firms in Cyprus, unpublished PhD thesis, Department of Economics, School of Management and Finance, Nottingham University.

PANSIRI, J. & TEMTIME, Z.T. (2008). Assessing managerial skills in SMEs for capacity building, *Journal of Management Development*. Vol. 27 No. 2, pp. 251-260.

RAMSURRUN B. & DALRYMPLE J. F. (2001). Global Competitiveness within Small & Medium Manufacturing Enterprises in Mauritius. *Centre for Management Quality Research at RMIT University.*

SANDERS & MC CORMICK, (1993) *Human Factors In Engineering And Design*, Seventh Edition, McGraw Hill, New York.

SCOTT, A. J. (1992), The Collective Order of Flexible Production Agglomerations: Lessons for Local Economic Development Policy and Strategic Choice, Economic Geography, Vol. 68, pp.219-233.

SMEDA Website: http://www.smeda.mu/English/Pages/default.aspx (Accessed 20 April 2014).

STATISTICS MAURITIUS (2013), Mauritius in Figures 2013, Ministry of Finance & Economic Development, Republic of Mauritius.

THE JOURNAL OF APPLIED POULTRY RESEARCH (2008). Vol. 17 No. 2, *On Farm Ventilation Fans Performance Evaluations and Implications [Online]*. Available from: http://japr.fass.org/content/17/2/283.abstract [Accessed on 24.03.12].

VOZIKIS, G.S. (1984). A strategic disadvantage profile of the stages of development of small business: an empirical investigation', Review of Business and Economic Research, vol. 20, no. 1, pp. 86-110.

WATKINS T. & BLACKBURN R. (1986) . The Role of Marketing in the Small Firm: Evidence from a Regional Survey, *Marketing Intelligence & Planning*, Vol. 4 Issue 4, pp.26 – 38.

WESTHEAD, P. & STOREY, D. (1997). Training provision and the development of small and medium sized enterprises. *Department for Enterprise and Education Research Report*, No 26, London: HMSO.