

Technology Assessment of Herbal Products Industry in Sri Lanka

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Abstract

Production of herbal product is not only a local business but also has global market opportunities. Therefore manufacturing with proven quality and consistency is an important aspect. The manufacturers should gain technological competence to ensure authenticity and efficacy, complying the quality and safety regulations, enhanced productivity and efficiency.

In the competitive market environment technology assessment is a tool which can be used in projecting future trajectories of technology as well as current performance level of the organization.

Out of the available models and frameworks for technological assessments, this study has used inputs from two models namely, the Technology Audit Model by Garcea – Areola and Outline of Innovation Management Audit by Tidd et al. these inputs have been used to develop a single model that can be effectively adaptable to herbal products industry.

There are two main objectives of the study. Firstly, develop a model which includes guide lines for technology assessment of the herbal products industry in Sri Lanka. Secondly, assessment of the level of technology position of LNP Ltd using the model and presenting recommendations for future improvements.

To accomplish the objectives, the study has identified five broad areas of technology, namely Technological Environment, Technological Strategy, Innovations and Technology Development, Technology Component and Technology Transfer, against which the LNP Ltd has been analyzed.

A check sheet to cover these elements has been used to guide through the assessment process. The elements using a three of the point scale ranging from High to Low (High -3, Low-1). The score of 3 for each element will represent the industry standard practice against which the other practices are measured.

Keywords: Herbal products, Sri Lanka

Chapter 1 - Introduction

Long before the establishment of the modern medical practice system, ancient and traditional medical system prevailed among different populations of the world. Apart from medicine, there are evidence that herbs were extensively used in traditional cosmetics for skin care, hair care and perfumes. It is estimated that 70-80% of the population of the developing countries are still rely on herbal medicine for treatment of their ailments (Wijesekara, 1991).

Most popular and well documented systems is the Ayurveda which was originated in India and Chinese system which is dominated in China and the neighboring region. Other traditional medical systems include Unani-Tibb system from ancient Arabic/ Greek civilization, medical theories of indigenous Amerindian people of Latin America and the Siddha system practiced in South India (Wiesekara, 1991).

Herbal healthcare products and cosmetics manufacturing now has become an industry which has a good prospects as a supplier of “danger free” and “environment friendly” products. The trend towards natural alternatives for medicine and cosmetics from the consumer end has produced a big market segment for manufacturers. (Mukherjee, 2002)

The herbal health care products that are based on traditional medicine systems can be categorized as generic pharmaceuticals, herbal personal care products and cosmetics mainly intended for external application.

In Sri Lankan context we can observe a number of manufacturers but most are small scale and do not indicate signs of developing to international level. Although the situation is such, there are few who have shown ability to follow a strategic direction towards a sustainable development and scale up to world class manufacturer.

Problem Identification

Herbal health care and cosmetics industry depends highly on obtaining quality natural herbs and achieve continuous supply while the cost being higher, supplier and customer regulations, substitute products, competitors, capacity for research and development.

Local manufacturers find it difficult to meet these requirements due to industry and country specific constraints such as lack of exposure and knowledge of the modern technology, financial constraints, and strict regulations for consumables including various regulations in different countries on natural products and individual preference of customer as well.

Therefore regular assessment of the current position is important to cope up with the rapidly developing competitive market. In order to achieve this, an organization can use “Technology Assessment” as a tool to measure and analyze current performance level as well as future strategies.

Objective of study

This study aim to address two objectives,

- i. Development of a model which includes guidelines for technology assessment of the herbal products industry in Sri Lanka.
- ii. Assessment of the level of technology position of LNP Ltd. Using the model and presenting recommendations for further improvements.

Scope of study

This study has been carried out considering the LNP Ltd, concerning its commitment to produce quality product, its capability and efforts to integrate modern science and technology with ancient medical wisdom and the organization visionary approach towards research and development and innovation to delight the consumer with safe and effective herbal remedies.

Successful assessment of technology requires identification of areas representing all aspects of technology which are significant for the industry. Thus following broad areas were selected.

- i. Technology Environment
- ii. Technology Strategy
- ii. Technology Development
- IV. Technology Component
- v. Technology Transfer

Each of above areas have been further divided into few elements and a checked sheet has been developed to organize the study for all these elements. Inputs were taken from various research literature, based on previous studies on this subject but not in the particular industry.

Significance of the study

Technology is vital to be correctly understood and applied for the herbal products industry as ancient technologies do not provide appropriate efficiency to sustain in the modern competitive environment. Therefore modern technology has to be adopted and utilized to improve the efficiency and quality production.

There hasn't been any previous study of this nature for herbal production industry in Sri Lanka. Most importantly, a model that covers all the vital aspects of technology hasn't been developed for the technology assessment of an organization engaged in herbal products manufacturing.

Chapter 2 - Literature Review

Technology is a term derived from two Greek words "Techne" and "Logia" which give the meanings "Skill" and "Study" respectively. The Oxford dictionary defined technology as 'scientific knowledge used practically in industry'.

Khalil (2000) defined technology as all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing services. All the definitions for

technology presented by various scholars can be categorized to four major perspectives. (Ramanathan, 1994) The four major perspectives are,

- i. Technology as a transformer perspective
- ii. Technology as a tool perspective
- iii. Technology as a knowledge perspective
- iv. Technology as an embodiment perspective

Ramanathan(1994)based on the ‘technology as embodiment perspective’ definition, presented ‘polytrophic components of manufacturing technology’. Accordingly, manufacturing technology comprises of four components.

- i. An object embodied form ‘Technoware’
- ii. A human embodied form ‘Humanware’
- iii. An institution embodied form ‘Orgaware’
- iv. An information embodied from ‘ Infoware’

Innovation and competitiveness

The relationship between technological opportunities, technology management, output innovation and competitiveness has been discussed in different levels by both academic and professionals.

Wheelan and Hunger (2004) presented the relationship between the corporate entrepreneurship and organizing for innovation. Organizing for innovation has become important for organization that need to be more innovative. The new structural design presented by them require the support from management and adequate resources, together with risk taking employees and a culture that support new ventures.

Pholmann et al (2005) have studies the art of innovation management with the development of innovation system. According to them, the success of strategies of changing or establishing innovation system is indicated by scientific and technological innovation, the number of new products and patents, the prosperity of region and firms and creation of new jobs.

McPherson (2001) in the study on innovation performance of New York State firms in the medical devices sector, addressed the impact of academic linkage of the industry. It was attempted to study facilitation of innovation by knowledge spillover from academic research and whether close proximity to academics in order to capture knowledge spillover is essential for an industry to make linkages. The survey results suggested that innovation responds positively to academic interaction but the data was not strong enough to identify the causality. Furthermore, the data shows that in house R & D overshadows all other variables, suggesting a critical role for internal effort.

Tidd et al (2001) focused on number of key themes related to innovation management and came up with four clusters of behaviors which represent particularly important routines. Successful innovation is strategy based, it depends on effective internal and external linkages, requires

enabling mechanism for changes to take place and finally successful innovation only happens within a supporting organizational context.

Technology Assessment

Criteria for assessment of different aspects of technology have been developed by scholars either concerning all components of technology or only few aspects of technology.

Ford (1988) presented some key questions which should be answered through any effective technology audit.

- i. What are the technologies and know, how and which the business depends?
- ii. What is the technology position of company in the industry?
- iii. Where is the company's strength? On product technology, Process technology or both?
- iv. What emerging technologies affect company's technology position?
- v. What is the value of company technology usage to the customers?
- vi. Does the company has technological assets that it can share with other companies?

Khalil (2000) presented a comprehensive method of technology assessment in which all areas required to enhance are addressed. The model called TAM- Technology Audit Model has three main objectives, determining current technological status, stress areas of opportunity and make advantage of the firm's capabilities.

Another model for technological assessment was suggested by TDRI – Thailand Development Research Institute in 1989 covering industries including biotechnology, electronics and IT. As per this model technological capabilities can be measured in four categories such as Acquisitive capabilities, Operative capabilities, Adaptive capabilities and finally Innovative capabilities.

Chapter 3 - Research Methodology

Design of the study

The process of this study includes five main steps as follows.

- i. Model development
- ii. Preparation of check sheet
- iii. Preparation of indicators
- iv. Application of model to LNP Ltd
- v. Assessment and evaluation of LNP Ltd

Model for technology assessment

Herbal products manufacturing industry has unique characteristics which should be accounted in developing methodologies for its assessment. According to Wijesekara (2000) a new strategy should be developed concerning the herbal medicine industry. This strategy must address

situations like, factory produced traditional medicines with standardization and quality control, formulation of new products at economical prices and natural drug formation.

Based on the currently available two models, single model has been developed which can be effectively adapt to herbal products industry. The new model – Technology Assessment Chart (TAC) consists of Technological Environment, Technological Strategy, Innovation and Technology Development, Technology Component and Technology Transfer as main aspects.

The objective of this model is to enhance innovation capabilities and competence of the industry through assessment of available technologies and potential development of new technologies.

Two models used to develop new assessment model are

1. Technology Audit Model developed by Garcea-Arreola (Khaleel, 2000) to identify areas required for technology enhancement. Accordingly the criteria includes ,
 - i. Technological environment
 - ii. Technological categorization
 - iii. Markets and competitors
 - iv. Innovation process
 - v. Value added functions
 - vi. Acquisition and exploitation of technology

2. Outline of Innovation Management Audit presented by Tidd et al (2001), which identified following areas to assess innovation capabilities.
 - i. Strategic approach to innovation
 - ii. Establishment of external linkages
 - iii. Implementation mechanisms
 - iv. Supportive Organizational context
 - v. Learning organization with regard to innovation

This model has 49 specific questions covering five key areas for innovation management. The new model developed for assessment of technology, attempt to be more focused on the herbal products manufacturing industry while overcoming certain non-relevant aspects containing in the previous two models. Further this new model attempts to list the similar elements which are originally categorized under different areas in respective models under common titles.

The new model, TAC (Figure 1) includes a combination of relevant important aspects of above two models and these aspects are further divided in to more specific elements. A check sheet to cover these elements has been used to guide through the assessment process which transformed to a quantitative evaluation using three point (High -3, Low-1) scale. Data collection was done via annual reports, questionnaires for functional managers, interviews with CEOs, websites and publications. Case analysis method has been used to assess technology level of the organization.

Technology Assessment Chart (TAC)

| | | | | |
|----------------------------------|----------------------------|--|------------------------------|----------------------------|
| Technological Environment | Technology Strategy | Innovation and Technology Development | Technology Components | Technology Transfer |
| Leadership | Formulation | Research & Development | Product Technologies | Exploitation |
| Organization Structure | Direction | | Process Technologies | Acquisition |
| Culture | Code Competence | Innovation | | |

Figure 1 - Model for Technology Assessment

Technological Environment

Technological literacy and capability of an organization play an important role in developing its technological environment. The board of management should consider ways to improve these qualities in the organization in order to make information decisions in an increasingly technological corporate environment. (Khalil, 2000).

Wheelan and Hunger (2004), describe innovation organizations as having entrepreneurial culture, developed by top management. Such an organization must be flexible and accepting change with the willingness to withstand a certain percentage of products failure on the way to success. They have identified seven characteristics in cultures of innovative organizations.

- | | |
|-----------------------|-----------------------------------|
| i. Positive attitudes | ii. Decentralized decision making |
| iii. Complexity | iv. Informal structures |
| v. Interconnectedness | vi. Organizational slack |
| vi. System openness | |

Leadership

Leaders should have clear understanding as what technologies are appropriate and what capacities are required to handle them successfully. They should involve constructively in technology related issues.

Organizational Structure

Technology management has been considered as an influential position in the organization. A chief technology officer, who may hold any senior designation has formal authority to guide the organization towards right technology with a team which facilitate between exports in Ayurveda, chemical science and management involving technological issues.

Culture

Learning culture is facilitated at all level of organization by creating knowledge transfer avenues. Change is considered as a challenge not a threat. Organization adapts to changes in both internal as well as external environment by establishing methodologies which are in place to gear up for technological changes and demand changes.

Technology Strategy

Technology strategy has been considered as vital for gaining sustainable technological advantage that provide competitive edge. Technology leaders depends heavily on R & D while technology extenders use transferred technology to a greater extend and little R & D.

Formulation

Organization has identifies all distinct technologies and sub technologies in its value chain as well as potentially relevant technologies that exist in other industries. Cost of improvements has been understood and strategy is clearly selected with technologies, production and markets that required to achieve competitive advantage.

Direction

Customer needs, different categories of customers who benefits from the industry as well as external environment such as competitors, suppliers, new entrants etc. are identified and considered deciding the technological development of the organization. There are significant turning points where the strategic direction of technology has been changed according to the changes in business strategy of the organization.

Core competence

Organization's core competencies are maintained as distinct advantages among other players in the industry. Core competencies are used throughout the product portfolio. There are clear indicators available for enhanced competitiveness in the market sue to core competencies.

Innovation and Technology Development

Understanding the market situation is of prime importance in developing technology portfolios. Perrino and Tipping (1989) proposed following characteristics of technology development, in relation to markets.

- i. Technology continue to develop in pocket of innovation for the global market
- ii. Companies can get more out of their research by linking it more closely to market needs and customer requirements rather than by increased expenditure
- iii. The global network model is the wave of the future which implies supporting technology core groups in each major market

Research & Development

Cross functional teams are in charge of periodically assign the core competencies, current technological status and prospective future technological development of competitors. Organization utilized and controls the technologies effectively with correct designing of and managing materials. The organization has successfully set industry standards with its products which have significantly contributed to outdate the earlier established products in the market. It uses formal tools and techniques in the product development process.

Innovation

Periodical observation of best technologies available in any similar industry, thereby compare and prepare plans to reduce the technological gap. At the same time identify and work along with the lead customers and external stakeholders to enhance innovations. There is a clear set of criteria for selecting partners and policies for outsourcing, licensing in and licensing out of technologies. Potential innovation advantages are derived from local and foreign environment.

Technology Component

Technology, in broader sense can be classified to hardware technologies and software technologies, (Chase et el, 2003) Hardware technologies perform labour intensive tasks by means of computer controlled devices that can be applied to manufacturing processes. (E.g. automated material handling system, flexible manufacturing systems etc.)Software technology aid in the design of products and analyzing and planning of manufacturing activities.

Ford (1988) describes components of technologies of an organization can be broadly identified in three layers including distinctive technology as the core where basic technologies as the middle layer and external technologies as the outer layer. Distinctive layer provides with a distinctive competitive advantage for organization or product. At the same time basic technology is necessary for an organization or product to be competitive and survive in the market where external technology is supplied by external parties as the requirement of the market.

Product Technologies

Organization has clearly identified the core technologies that are incorporated in products, in a form of formula which makes the products significantly different from those of competitors. These technologies are nourished, developed and protected continuously. On the other hand, organization has selected proper external technologies for products, such as packaging material to suit product features, product information to fulfill regulatory requirements etc.

Process technologies

Organization has clearly identified the core technologies that are incorporated in processes as unique methods, which makes the processes significantly different from those of competitors. It is important to establish organizational practices along with technology development in order to ensure better coordination of functions, improve quality and efficiency and continuous

improvement of the organization. These practices include quality management, management systems, product safety assurance and standard procedure.

Providing relevant training facilities for the staff in order to handle technology improvements via considering facts such as technical, administrative and managerial staff, defining roles and evaluation of work and finally training requirements being clearly identified at each level. Information required for business is clearly identifies as information related to machinery and plants, related to human resources and organization practice as well as management systems.

Technology Transfer

Technology transfer is the process if technology acquisition, by a particular interested party (transferee) from an available technology market (transferee). Khalil (2000) presents technology transfer divided in to five major categories as follows.

- i. International technology transfer
- ii. Regional technology transfer
- iii. Cross industry/ cross sector technology transfer
- iv. Inter-firm technology transfer
- v. Intra- firm technology transfer

Technology transfer takes many forms, but the international technology transfer is the mechanism which significantly helps a company to acquire latest technology and adapt enhance the competition and competitive advantage of the company.

On of the critical step in the choice of a technology is to establish a set of acceptable and usable pre-determined criteria, which can be used to evaluate the technology to be transferred.

Exploitation

The organization has the ability to properly identify relevant technologies and ensure identification of potential threats and opportunities from advances in key technologies.

Technology selection is based on clearly defined criteria which reviewed and revised as per the trends in market, expansions of operations and competition in business environment.

Acquisition

The organization is capable in negotiating effectively and obtaining most suitable technologies for its operations. Different transfer chains that can be followed to transfer technologies are identified clearly and the most suitable chain is selected for a particular transfer. It should be capable enough to establish the technologies by proper evaluation of all options available and has the capabilities to effectively and efficiently acquire new knowledge for improvements.

Indicators for Technology Assessment

A set of indicators has been developed to assess the level of technologies of the organization, in relation to the check sheet which is depicted above. The evaluation of each indicator will be done using as evaluation criterion, which is developed with the aim of assigning a specific rate to the respective indicator. Thus the assessment performed using the check sheet will be transformed to a quantitative evaluation using a three point scale. The score of 3 for each element represent the

best industry practice against which the other practices are measured. Evaluation criteria help to guide a technology assessment process to assign rates specifically without being subjective and evaluate the comparative positions of the indicators.

Table 1 – Indicators for Technology Assessment

| 1.0 Technology Environment | | | |
|-------------------------------------|--|--|-----------------------|
| 1.1 Leadership | | | |
| Indicators | | Evaluation criteria | Rating |
| LD i | Key position of the organization are held by technologists | 1. No technologists in key positions 2. Less than ¼ of key positions held by technologists 3. More than ¼ of key positions are held by technologists | Low Medium High |
| LD ii | Senior managers involve with understanding in technology development | Senior managers 1. do not involve in technology related issues and are not aware of industry specific technologies 2. are aware of industry specific principles of technology but do not involve effectively in relevant issues 3. involve effectively in technology related issues with a higher level of understanding in industry requirements | Low Medium High |
| LD iii | Leadership considers technologies as a major priority area | 1. Less than 1/3 of managerial staff considers technology as a major priority 2. Between 1/3-2/3 of managerial staff consider technology as a major priority 3. More than 2/3 of managerial staff consider technology as a major priority | Low Medium High |
| 1.2 Organizational Structure | | | |
| Indicators | | Evaluation criteria | Rating |
| OS i | Technology Management has been given an influential position in the organization | 1. No separate position for technology management 2. A senior position is vested with authority in technology management 3. Separate position is established for technology | Low Medium |

| | | | |
|--------------------------------|--|---|--------------------------------------|
| | | management | High |
| OS ii | Teams facilitate co-operation between experts involved in technological issues | <p>1. No formal teams appointed for technology related issues</p> <p>2. Separate teams operate on indigenous and modern technological aspects</p> <p>3. Multi skilled teams with experts in both indigenous and modern technologies are formed</p> | <p>Low</p> <p>Medium</p> <p>High</p> |
| 1.3. Culture | | | |
| Indicators | | Evaluation criteria | Rating |
| CL i | Learning is facilitated and managed in organization | <p>1. Organization has no proper mechanism to ensure that all categories if employees learn</p> <p>2. Only management and executive ranks are given learning opportunities</p> <p>3. All employees are given opportunities to acquire relevant knowledge by continuous learning</p> | <p>Low</p> <p>Medium</p> <p>High</p> |
| CL ii. | Organization adapt to changes in its environments | <p>1. Organization has not improved significant technologies within last 05 years</p> <p>2. Organization has improved only certain elements of technologies during last 05 years</p> <p>3. Organization has acquired significant improvement in all technologies during last 05 years</p> | <p>Low</p> <p>Medium</p> <p>High</p> |
| 2.0 Technology Strategy | | | |
| 2.1 Formulation | | | |
| Indicators | | Evaluation criteria | Rating |
| FM i | The organization has identified all technologies in its value chain | <p>1. Technologies are identified for less than 1/3 of activities of the value chain</p> <p>2. Technologies are identified for between 1/3 and 2/3 of activities of value chain</p> <p>3. Technologies are identified for more than 2/3 of activities of the value chain</p> | <p>Low</p> <p>Medium</p> <p>High</p> |
| FM ii | Potential path of change of key technologies have been determined | <p>1. Ni significant competitive advantages from changed I key technologies</p> <p>2. Up to ½ of all the products gained competitive advantage from changes in key technologies</p> | <p>Low</p> <p>Medium</p> |

| | | | |
|----------------------------|---|--|-----------------------|
| | | 3. All products gained competitive advantage due to changes in key technologies | High |
| FM iii | Technology assessments have been carried out to assess the position of the organization | 1. No proper sequence and practice in assessing technologies in the organization 2. Technologies are assessed in an informal manner as per the requirement of functional area 3. Technology assessments are carried out annually covering all functional areas | Low Medium High |
| 2.2 Direction | | | |
| Indicators | | Evaluation criteria | Rating |
| DR i | Customer needs are considered in deciding the technological development of the organization | 1. No improvement in customer base is evident due to development in technologies 2. Customer base is improved for few products only 3. Customer base is improved for all products due to technology developments | Low Medium High |
| DR ii | Trends in external environment are considered in determining the direction of technological strategy | 1. External environment has not been considered for technology development 2. Only a part of all technologies are established by proper analysis of external environment 3. All technologies are established by proper analysis of external environment | Low Medium High |
| DR iii | Linkage between technology strategy and business strategy has contributed for technological development | 1. Technologies have not changed due to change in business strategy 2. Technology strategy is totally depending on business strategy 2. Technology strategy and business strategy are independent | Low Medium High |
| 2.3 Core Competence | | | |
| Indicators | | Evaluation criteria | Rating |
| CC i | Organization has clearly identified and maintained its core competence | 1. Core competencies have not been identified 2. Core competencies are identified but remained stagnated for a longer period 3. Core competencies are identified and continually developed | Low Medium High |

| | | | |
|--------|---|--|--------------------------------------|
| CC ii | Core competencies are used throughout the products portfolio to fulfill customer requirements | <ol style="list-style-type: none"> 1. Core competencies are used in less than 1/3 of products 2. Core competencies are used in between 1/3-2/3 of products 3. Core competencies are used in more than 2/3 of products | <p>Low</p> <p>Medium</p> <p>High</p> |
| CC iii | Customers are made aware of core competencies of the organization | <ol style="list-style-type: none"> 1. Majority of customer are not aware of the core competence 2. A faction of customers are aware of core competence 3. All customer are aware of core competence | <p>Low</p> <p>Medium</p> <p>High</p> |

3.0 Innovation and Technology Development

3.1 Research & Development

| Indicators | | Evaluation criteria | Rating |
|------------|---|---|--------------------------------------|
| RD i | Cross functional teams in charge of assessing the development in technology | <ol style="list-style-type: none"> 1. No formal groups appointed for assessing technologies 2. Only R & D team assess development in technologies 3. Teams in R & D, production, marketing and sales involves | <p>Low</p> <p>Medium</p> <p>High</p> |
| RD ii | The organization has developed standardized technologies in the industry | <ol style="list-style-type: none"> 1. Organization has not influenced established technologies 2. Organization has developed existing technologies in the industry 3. Organization has made the existing technologies obsolete | <p>Low</p> <p>Medium</p> <p>High</p> |
| RD iii | Organization used formal tools and techniques in the product development | <ol style="list-style-type: none"> 1. No formal procedure for product development 2. A procedure exists bit tools and techniques not identified 3. Formal tools and techniques utilized in established procedure | <p>Low</p> <p>Medium</p> <p>High</p> |

3.2 Innovation

| Indicators | | Evaluation criteria | Rating |
|------------|-----------------------|---|--------|
| IN i | Organization focus on | 1. Internal technologies not developed during last 05 | Low |

| | | | |
|--------|---|--|-----------------------|
| | innovation strategy | years 2. Internal technologies developed using expertise of the organization only 3. Internal technologies developed using expertise of the organization and inputs from similar industries | Medium High |
| IN ii | Organization works continuously with external linkages to enhance innovations | 1. Not developed any technology by working with external technologies 2. Developed new technologies working with any one or two of following groups: customers, suppliers, R&D institutes and universities 3. Developed new technologies by working with all above parties | Low Medium High |
| IN iii | Product innovation planning is linked to overall business strategy | 1. Product innovation is not planned and systematic 2. Product innovation is planned but no drive from top management 3. Product innovation is planned, systematic and driven by top management | Low Medium High |

4.0 Technology Components

4.1 Product Technologies

| Indicators | | Evaluation criteria | Rating |
|------------|--|---|-----------------------|
| PD i | Organization has established significant product formula to make proprietary products | 1. Less than 1/3 of sales are given by proprietary products 2. Between 1/3-2/3 of sales are given by proprietary products 3. More than 2/3 of sales are given by proprietary products | Low Medium High |
| PD ii | Product design process incorporates knowledge on basic technologies to improve competitiveness of products | 1. Knowledge in basic technologies is low 2. Knowledge in basic technologies is moderate 3. Knowledge in basic technologies is high | Low Medium High |
| PD iii | Organization uses external product technologies to enhance | 1. External technologies are never considered 2. External technologies are considered occasionally 3. External technologies are considered whenever | Low Medium |

| | | | |
|---------------------------------|--|---|--------------------------------------|
| | competitiveness of products | necessary | High |
| 4.2 Process Technologies | | | |
| Indicators | | Evaluation criteria | Rating |
| PC i | Organization has established unique processing methods | <ol style="list-style-type: none"> 1. Only common processing methods are used 2. Common methods are scientifically developed for limited products 3. Scientifically developed methods are used for all products | <p>Low</p> <p>Medium</p> <p>High</p> |
| PC ii | Organizational practices have been established in relation to improvements in process technologies | <ol style="list-style-type: none"> 1. Not established with improvements in technologies 2. New practices are occasionally established with improvements in technologies 3. Established whenever necessary with improvements in technologies | <p>Low</p> <p>Medium</p> <p>High</p> |
| PC iii | Organization has developed and utilized human skills effectively for improvement in process technologies | <ol style="list-style-type: none"> 1. Staff is not trained and developed for improvements in technologies 2. staff is not developed occasionally with improvements in technologies 3. All the staff s properly selected, trained and developed | <p>Low</p> <p>Medium</p> <p>High</p> |
| PC iv | Technologies for information processing have been established | <ol style="list-style-type: none"> 1. less than 1/3 of information processing is done electronically 2. Between 1/3-2/3 of information processing is done electronically 3. More than 2/3 of information processing is done electronically | <p>Low</p> <p>Medium</p> <p>High</p> |
| PC v | Organization has selected appropriate external technologies for processing | <ol style="list-style-type: none"> 1. Less than 1/3 processes use state of the art technologies 2. Between than 1/3-2/3 of processes use state of the art technologies 3. More than 2/3 processes use state of the art technologies | <p>Low</p> <p>Medium</p> <p>High</p> |
| 5.0 Technology Transfer | | | |

| 5.1 Exploitation | | | |
|-------------------------|---|--|-------------------------------|
| Indicators | | Evaluation criteria | Rating |
| EX i | Organization has the ability to properly identify appropriate technologies | 1. More than ½ of identified technologies proved inappropriate later 2. Between ¼-1/2 of identified technologies proved inappropriate 3. Less than 1/4 of identified technologies proved inappropriate | Low Medium High |
| EX ii | Technology selection is based on clearly defined criteria | 1. No clear criteria followed in selection 2. Organization is partially capable and work with external parties 3. Organization id fully capable and work independently | Low Medium High |
| 5.2 Acquisition | | | |
| Indicators | | Evaluation criteria | Rating |
| AQ i | The organization is capable in negotiating effectively and obtaining most suitable technologies | 1. Organization is not capable and depend entirely on external parties 2. Organization is partially capable and work with external parties 3. Organization is fully capable and work independently | Low Medium High |
| AQ ii | Different transfer chains are identified and used according to the capabilities of organization | 1. Relying on a single transfer chain for the past 05 years 2. Used at least 02 transfer chains during last 05 years 3. Manipulated between different transfer chains during last 05 years | Low Medium High |
| AQ iii | Organization is capable of acquiring and establishing the technologies | 1. Entirely depend in external parties in establishing/implementing new technologies 2. internal team is working equally with external parties in establishing/implementing technologies 3. Internal team handles entire establishing/implementing process | Low Medium High |

Chapter 4 - The Case of LNP Ltd

LNP Ltd is engaged in designing, manufacturing and marketing of a range of herbal products which includes herbal pharmaceuticals, health care products, cosmetics, essential oils and oleoresins. It supplies products to both local and foreign markets and has achieved significant success in building an image of a producer of quality products. The core competency of the LNP Ltd is the ability to develop innovative products using scientific and technical knowledge base. It has got the service of consultants who are well qualified in chemical processing and chemical engineering science. The integration of scientific knowledge with traditional knowledge has created an opportunity to design production process in a more creative and logical approach.

LNP Ltd commenced operation as a producer of spice essential oils which is an ingredient for cosmetics, food, pharmaceuticals etc. the market for these products is basically large-scale manufacturers of above items in Europe and the USA. They diversified in to Ayurvedic pharmaceuticals manufacturing in the year 1984. Later they have moved in to over the counter health care products such as instant peyawa, herbal tooth paste, and herbal hair oil and pain relief ointment. The company was able to further expand the business in to herbal cosmetics with the use of research and development capabilities.

Analysis of Technologies of LNP Ltd

Technological Environment

Leadership

The manufacturing related divisions are comprised with technologists which is approximately 40% of the management team. More focused and systematic approach is required to formalize the technological skills enhancement among the existing technologists in the management.

Prominent indicators for the consideration of technology as a priority are

- All new employees from every field irrespective of their nature of job are given a basic knowledge of the technologies in use.
- LNP has obtained the service of experts from various fields including Ayurveda, chemistry, Pharmacology, chemical engineering etc. to enhance the knowledge base.

Structure

A minus point in the technology management process is the lack of clear position that has overall authority to carry out technology management activities. Since a number of senior management who are not experienced in technology management though they are familiar with technology, involving technology related issues, there are instances where certain decisions have wasted resources. This has also resulted in lack of co-operation between the ranks involved in technology issues.

Culture

LNP Ltd is a knowledge based organization. Therefore it's vital to improve the knowledge of all levels of staff. It is important to facilitate learning. Currently there is no systematic program for career building. Few key individuals have acquired knowledge and have disseminated the knowledge through various ranks but in long run no significant knowledge buildup is evident in the majority of staff. Measures such as product coding and access control to information have been established in order to protect the continuously created new knowledge.

Assessment and Evaluation of Technology Environment

According to the above analysis of Technology Environment in LNP, each element is evaluated using 03 point scale, assigning levels to relevant indicators.

Table 2 Evaluation of Technology Environment

| Aspect | Element | Rating |
|------------------------|---------|--------|
| Leadership | LD i. | 3 |
| | LD ii. | 2 |
| | LD iii. | 3 |
| Organization structure | OS i. | 1 |
| | OS ii. | 3 |
| Culture | CL i. | 1 |
| | CL ii. | 2 |

Average 2.1

According to the evaluation, Technology Environment of LNP stands between Medium and High with an average of 2.1. Though the priority given by the leadership for the use of technology is "high", there is a need to enhance the involvement of leaders in technology related matters. In the technological culture of the organization, learning and managing knowledge has been given a lower standard. The other aspects that is under technological culture, managing/adapting to changes in external technological environment and technology demands, requires more attention to improve from current position of 'medium' level.

Technology Strategy of LNP Ltd

Formulation of Strategy

Recently LNP has identified and categorized the technologies in its value chain. Accordingly following technologies have been listed.

- i. Technologies in raw material sourcing (cultivation, maintain purity and authenticity, standardization)

- ii. Technology for storage of raw material (protecting from adverse conditions, traceability, stick maintenance)
- iii. Technology for material processing (new, scientific methods, modified equipment/machinery, acquired/ designed equipment/machinery)
- iv. Manufacturing technologies (process technology, product technology)
- v. Technologies in distribution of goods (distribution plan, infrastructure, communication)
- vi. Quality assurance technologies (physical, chemical, biological)
- vii. Technology for research & development (scientific methods, equipment/machinery)
- viii. Technologies for financial management and accounting
- ix. Technologies for human resource development
- x. Quality management, environment management and product safety assurance technologies

In any organization, understanding the position of its technology is vital in selecting new technologies, new products and new market segments in order to gain competitive advantage. Usually this is resulted in a systematic audit of the existing technologies deployed in the value chain. Therefore the cost incurred to company for the improvements in relation to the opportunity cost, cost benefit ratio and cost for failed technologies are not properly understood through the relevant levels of the organization. This has also left the company not clearly identified the extent of technological improvements in comparison to the increase of profitability in the recent past.

Direction of Technology

Direction of technology in the selected company is determined largely by few major factors including needs of customers, trends in external environment and changes in business strategy. These in combination have created turning point in the strategic direction of the company.

LNP has not deployed a systematic program in order to identify the customer needs in the local market. It cause a gap between the capabilities of the organization and fulfilment of customer needs. Whereas in the foreign market, need if the customer are continuously monitored and identified and upgraded the existing technology accordingly. Therefore it's important to apply the same for the local market segment as well.

It was observed that trends in technological changes in the external environment are considered and LNP has adjusted accordingly. Technology strategy of the organization is integrated with the business strategy throughout the different stages of development.

Core competence

The core competency of LNP is the ability to develop innovative products using scientific and technical knowledge base together with strong research and development capability. The company continuously attempts to upgrade its core competency by acquiring new knowledge, recruiting personnel with exposure to new subjects, upgrading the machinery and equipment and

conducting technical training programs. Although company has managed to gain competitiveness in its foreign market the same is lacking in local market due to the fact that they have not established proper methods to educate the customers. Therefore, a significant difference is not prominent doe some products which hinders the attraction of new customers.

Assessment and Evaluation of Technology Strategy

Based on the above analysis of Technology Strategy of LNP, each element is evaluated using the 03 point scale, assigning levels to relevant indicators.

Table 3 – Evaluation of Technology Strategy

| Aspect | Element | Rating |
|-----------------|---------|--------|
| Formulation | FM i. | 3 |
| | FM ii. | 2 |
| | FM iii. | 1 |
| Direction | DR i. | 2 |
| | DR ii. | 2 |
| | DR iii. | 3 |
| Core Competence | CC i. | 3 |
| | CC ii. | 3 |
| | CC iii. | 1 |

Average – 2.2

Technology Strategy of LNP has achieved an average rate of 2.2, displaying an overall status between ‘medium’ and ‘high’. In formulation of technology strategy the organization has a ‘high’ status in identifying all technologies in the value chain, which affects the existing and desired position within the industry. But its ability to determine potential path of changed of key technologies is only in the ‘medium’ status, while assessing the available technologies periodically is further low in status.

The direction of technology strategy indicated a ‘medium’ status in considering needs of customers for deciding technological developments. The other element which significantly contributed to direction of technology strategy, influence if changes in business strategy to technology strategy, stands at ‘high’ status. Similar to deciding paths of changes of key technologies, the organization attention to trends in technological development in external environment in deciding the direction f technology strategy is position at ‘medium’.

The core competence of LNP has contributed to technology strategy of the organization, with a 'high' position in identifying and utilizing core competency to improve competitiveness. Other two elements, deploying core competency in value chain and aligning all activities of organization with core competency, have positioned as 'high' and 'low' respectively, thus indicating the requirement for more emphasis on strengthening the latter.

Innovation and Technology Development

Research Development

At LNP, research and development process aims to develop product and process technologies of the organization. R & D division carries out this task by,

- i. Developing new products and processes
- ii. Improving and modifying existing products
- iii. Re-engineering products

R & D Setup

There is a panel of Ayurvedic experts including academics, researchers and practitioners providing consultancy to LNP. This panel liaises with governing body of the Ayurveda, various research institutes and universities. This group strengthens the scientific and technological base of the organization.

Technological development – technological development of external sectors has indirectly forced the organization to enhance its productivity, efficiency and quality. Improved extraction methods, preservation and presentation to the market has been developed through new technologies.

The technology push has enabled LNP to compete with competitors and set benchmarks for certain components of process and product technologies. Product safety and efficacy are two important aspects.

Product safety is determined by the chemical, biological and physical features of products such as avoiding contaminations as well as developing technologies to detect harmful components in the product and remove it.

Efficacy is determined by quality of raw material used in the production process such as the effect of plant materials becoming mature. Technologies to identify all these and detect deficiencies are established by LNP Ltd.

Implementation Mechanism

LNP has a formal system for implementation of product design process, integrated with the Quality Management System. This system comprises of four main steps. Design and development planning, design development of input, design/ development of output and design development changes.

Innovations

Innovation Strategy

To overcome the competition among the industry players, managing research and development along with innovation have become vital for the industry. Innovation is a key factor in deciding the strategic advantages of the industry. Novelty and complexity prevents two external factors such as reduced threat from substitute products and reduced threat from new entrants.

Innovation has created monopoly as well as rivalry among competitors. It also reduces cost by lowering raw material requirement, simplify features and supplying of materials. Extraction with a high soluble solvent reduces the bulk raw of raw material needed and improve uniformity of extraction.

Product innovation as well as process innovation are two important strategies which is focused by LNP Ltd. Product portfolio has been grown since the initial product of the company by incorporating scientific knowledge. Product innovation has applied for all areas including herbal health care products, herbal cosmetics, wellness products, herbal tea/other beverages.

Process innovation applied for manufacturing process changed from traditional and simpler technologies to modern complex use of technology and process improvements. Engaging of steam operated boiling vessels, stylization methods, forming machines and formalities for quality assurance from the tradition preparation methods of open fire boiling and use of clay/wooden holding vessels is an example of process innovation of LNP ltd.

Assessment of Innovation and Technology Development

Table 4 – Evaluation of Innovation and Technology Development

| Aspect | Element | Rating |
|------------------------|---------|--------|
| Research & Development | RD i | 3 |
| | RD ii. | 2 |
| | RD iii. | 3 |
| Innovation | IN i. | 3 |
| | IN ii. | 2 |
| | IN iii. | 2 |
| Average | | 2.5 |

Innovation and Technology Development has got an average rate of 2.5, the highest rate out of all 05 components of technology. Thus this area can be considered as having ‘medium’ status but more towards a ‘high’ position in LNP. Research and development shows more strength compared to innovation of the organization.

In the R & D process, consideration for development in relevant technologies and development in competitor's technologies are at a 'high' rate while the organization's capability to establish industry standards and introduce standardized technology rated as 'medium'. In contrast, application of formal tools and techniques successfully for improvement benefits is rating 'high' indicating the availability of more formalized mechanism to enhance the previous two elements. Focusing on LNP innovation strategy, its stage of development and significant developments in relevant technologies, is rated 'high' while collaborations with major customers for improving innovations indicate a 'medium' level stage, indicating the organizations lack of concern on innovations strategy in the overall business strategy.

Technology Components

Product Technologies

Product technologies can be broadly categorized as formulation of product, product design and packaging of products.

Formulation of product

Product formulation includes the formula, form of each raw material used for a particular formula and specific details of activities of ingredients on product. The company has developed formula for both generic and new products, using existing Ayurveda formula which appears as in pharmacopeias. Formula for new products has been developed by combination of material, which appear in generic formula, according to therapeutic features.

Product Design

Design of a product comprises of chemical, physical and biological parameters and stages in manufacturing process. Analysis of products at the different stages of value addition process is determined when the product is designed. For each product, chemical, physical and biological testing parameters have been developed to ensure conformity to design specifications during all major steps of transformation process.

Packaging and usage information for products

External technologies of products include material used for packing and information accompanying the pack. Following factors have considered when selecting the packing materials for herbal products.

- i. The ability to protect the product from adverse atmospheric conditions
- ii. Prevent reaction between product and packing material
- iii. Preserve the product till the intended period

Process Technologies

In all value addition processes, LNP has developed specific methods to enhance effectiveness of each step of processes. These methods are developed in combination of traditional processing methods and scientific methods. LNP seriously has considered practices, linkages and related arrangements to utilize machinery and human skills by the year 2000.

During recent past the company has adopted several mechanisms that help the value chain to accomplish requirement of international market. This includes adopting quality management system – ISO 9001, and Environment Management System – ISO 14001.

Operational skills - In the material processing and manufacturing processes, all factory workers belong to the operational skill category. When R & D / QA processes are considered, operational, administrative and managerial categories are integrated to a larger extent.

Administrative and Managerial staff – Method of acquisition and development of above categories is quite different from the method of operational staff. Managers are generally recruited from outside with relevant work experience from reputed organizations. Training programs are conducted for managers to enhance knowledge on latest development in relevant fields.

Information processing

An area where LNP is showing a significant lagging behind is the management of information. This is mainly due to not an established system of centralized hub for information retrieval. Lack of knowledge on handing of information and ignorance for information creates confusion among processes. Unavailability of systematic information of the specifications, operation manuals, parts details and their attachments and other details of machinery in use, is a big issue. This becomes a problem when there are specific laboratory equipment's such can't be operated using general understating but specific instructions are essential.

Machinery and Equipment

The organization used sophisticated machinery in the process to ensure a constant manufacturing of sufficient quantities of products. The areas where machinery is used within the material transformation process can be identifies as follows.

- i. Material preparations
- ii. Material Transformation
- iii. Material handling
- iv. Storage and loading
- v. quality assurance
- vi. Research and Development
- vii. Energy Generation

Out of all the machinery used in material transformation, 90% required direct involvement of an operator to decide all actions where the rest are high tech laboratory equipment which are

integrated to information processing units which performs independent from man- machine interface.

Assessment of Technology Components

Table 5 – Evaluation of Technology Components

| Aspect | Element | Rating |
|----------------------|---------|--------|
| Product Technologies | PD i | 2 |
| | PD ii. | 3 |
| | PD iii. | 3 |
| Process Technologies | PC i. | 3 |
| | PC ii. | 2 |
| | PC iii. | 3 |
| | PC iv. | 2 |
| | PC v. | 1 |
| Average | | 2.4 |

When considered the Technology Components, LNP shows a significant strength in product technologies of which all elements are rated above ‘medium’ level. In the assessment, technology components of LNP has been rated with an average of 2.4, the second highest of all areas considered for the assessment. Thus, it is between ‘medium’ and ‘high’ status with elements of product technologies contributing more to the overall rating.

Considering the process technologies, unique processing methods of LNP have achieved the ‘high’ status while three of other four elements are rated below that. Establishment of organizational practices, establishment of information processing technologies and acquisition of external technologies for processes require more attention , having rated ‘medium’ and ‘low’ in the assessment. Development of Human Skill has rated higher portion with status as ‘high’.

Technology Transfer

Exploitation

LNP identifies its need for new technologies and development of new technologies in the market, through few methods including,

- Knowledge of both in-house and outside personal who are expert in different fields and who have been continuously vigilant on process requirement and modifications.

- Publications of suppliers of technology from various countries where technologies are designed by collecting and subscribing.
- Benchmarking other organizations, both in the same field of operation and other fields.
- Via exhibitions, trade fairs, conferences and other knowledge sharing platforms

Acquisition

Transferring selected technology involved two major steps including, negotiating to ensure transfer and transfer using a suitable method. LNP attempts to negotiate with suppliers of technology, to ensure the acquisition of best possible alternative from the selected technologies.

Technology transfer had been carried out since the early days of the company, in different level of operations. When manufacturing and related areas are considered, technology transfer methods can be categorized as intra-firm transfers, inter-firm transfers and international technology transfers.

Establishing the transfer technologies to produce the expected result to enhance competitive advantage is attempted by LNP with following measures.

- Higher foreign consultants to gain knowledge in specific areas.
- Encourage senior members of management to study developments in technology and gain knowledge
- Supporting improvement of human skills by allowing professional qualifications.
- Follow testing/validation process for established technologies

Assessment of Technology Transfer

According to the above analysis of technology transfer of LNP, each element is evaluated using the 03 point scale, assigning levels to relevant indicators.

Table 6– Technology Transfer

| Aspect | Element | Rating |
|--------------|---------|--------|
| Exploitation | EX i | 3 |
| | EX ii. | 2 |
| Acquisition | AQ i. | 2 |
| | AQ ii. | 3 |
| | AQ iii. | 2 |

Average 2.4

Technology transfer, the final area of technology used for the assessment us rated with an average of 2.4 in the position of ‘medium’ and ‘high’. Under the exploitation of technology, organization’s capability in identifying appropriate technologies as well as related opportunities and threats is rated ‘high’ while lack of proper criteria in selection of technologies is indicated by the ‘medium’ ranking for that particular element.

The ability of LNP for negotiating and obtaining most appropriate technologies remains at a lower position than its capabilities in identifying the technologies. The organization’s attention to utilizing different transfer chains for effective acquisition process is in ‘high’ position. Though the timing of acquisition of selected technologies shows a ‘medium’ rating.

Chapter 5 - Conclusion and Recommendations

Assessment of Technologies LNP Ltd

According to the average rating of the main 05 technological aspects, all areas are between Medium and High with an overall standing of 2.3 for the organization’s technology position. Table 5 contains the average rating s of the 05 technological aspects that were discussed in this study.

Table 7 – Overall rating of Technologies of LNP Ltd

| Aspect | Average rating |
|---------------------------------------|----------------|
| Technology Environment | 2.1 |
| Technology Strategy | 2.2 |
| Innovation and Technology Development | 2.5 |
| Technology Components | 2.4 |
| Technology Transfer | 2.4 |

| | |
|-------------|-----|
| LNP Average | 2.3 |
|-------------|-----|

Conclusion

Analysis of the technologies of LNP using the case study, assessment of identified technologies using indicators and developing guidelines for local manufacturers of herbal products are the main objectives of this study. Accordingly technologies established at LNP were discussed under five categories. A set of indicators were developed to evaluate the identified technological aspects, which rates individual technologies between low and high levels. Technologies of LNP were assessed using these indicators and the same can be applied to other manufacturers of herbal products as guidelines to evaluate their current technological position.

As a whole the position of technological environment of LNP has more contribution from the aspects that are directly influenced by the leadership of organization, the priority given by

leaders to technologies, formation of teams in different disciplines and emphasis of knowledge management.

Technology strategy of LNP should have more contribution from formulation stage and integration of core competencies to technology strategy.

Innovation and technology development aspect has more strengthen in R&D area, while LNP shows a comparative weakness in innovations, to strengthen innovations and technology development.

A significant feature in technology component is that product technologies have more strength than process technologies at LNP. This indicated lack of attention on process development during the recent past.

LNP should develop its technology acquisition capabilities further by paying more attention to enhance negotiating capabilities and make the technology transfer more effective.

Main problem identified during the initial stage of development of this study are challenges to herbal industry from external environment, higher degree of innovation and R&D of competing multinationals, need to maintain quality, consistency, safety and efficacy of products and need for assessment of technologies in a continuous basis. The check sheet and indicators developed in the study provides a set of guidelines and benchmarks for the herbal products industry in general by considering and analyzing the above mentioned problems in detail. The check sheet and indicators can be readily utilized for assessing the technological position of any individual organization in the herbal products industry, in a similar manner.

Recommendations and Directions to Further Study

According to overall rating of technologies of LNP, all the areas of technology evaluated are positioned between 'medium' and 'high' status. In general, all five areas of technology should be further improved, while more emphasis on the low rated areas.

Technology environment of LNP can be promptly improved by enhancing knowledge and involvement of senior managers in technological issues, assigning technology management under a senior managerial position and establishing a mechanism to adopt to changes in external environment.

Technology strategy can be further streamlined mainly by implementing a technology assessment program at functional level considering trends in external environment in determine the direction of technology strategy and aligning all activities of the organization with core competencies.

In Sri Lanka, herbal product industry consists of nearly 300 manufactures ranging from small scale to large scale organizations. Most registered manufactures possess basic technologies and manufacture only a few products and cater to a small regional market. Therefore, technology assessment can't be performed in a uniform manner for all manufacturers. It is recommended to

carry out changes in the set of indicators either by eliminating the steps that are insignificant for a particular organization or carry out modification to certain elements and adapting to the existing conditions in the organization.

The technology Assessment Chart (TAC) used in this study has been developed by obtaining inputs from similar studies and considering the technological aspects that are significant in LNP's context. Suitability of the TAC in assessing technologies can be further tested by doing further research in the herbal products manufacturing industry. Validity of the TAC can be tested by carrying out a survey for a sample of organizations within the industry. A questionnaire survey can be applied to test the view point of industry representatives on each element of technology identified in this study.

Another area for further study on technology assessment in herbal products industry would be carrying out case studies for few other organizations, representing the different levels in the industry. Such studies would help to identify the modifications that are needed to further refinement of the check sheet and the set of indicators presented in this study.

Proper management of finance is of utmost importance for any organization to be successful in technological development. Therefore an organization should concentrate on maintaining a balance between technology management and finance management. Hence this is an area that can be incorporated in the TAC to further improve the model and evaluate using appropriate indicators.

This model has used a 03 point scale in assessing the aspects of technologies through relevant indicators. A disadvantage in using such scale would be the final ratings becoming closer to the middle value that is 2. Comparatively a 4 scale would present a clear picture of the weak and strong areas in an organization's technology aspects. This is another possible improvement that can be done to the assessment model.

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