

Quality Systems Implementation in the Pharmaceutical Industry

Corinne Lee Siong Chan Wan Kai

Mauritius

Email: corinne_chan84@yahoo.co.uk

Fareeda Khodabocus *

Faculty of Engineering,

University of Mauritius

Email: f.khodabocus@uom.ac.mu,

fkhodabocus@yahoo.com

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Abstract

During the past decades, it has been observed that customers are becoming more and more quality conscious. One of the possible reasons might be that people want to acquire excellence. Pharmaceutical manufacturing industries are facing fierce competition amongst themselves, and to survive, one of the important issues to consider is the implementation of appropriate and effective quality systems. This will help to provide safer, more efficient and better quality pharmaceuticals.

This paper introduces some quality standard guidelines that usually apply to pharmaceutical manufacturing industries, namely, GMP, ICH Q10 and ISO 9001:2000.

Also, a case study of a fictitious Paracetamol manufacturing industry has been introduced in order to propose a model for it to achieve GMP certification and to make an estimation of its costs.

In USA, industries are seen to commit an offence if ever they do not possess a GMP certification or renewal of this certificate. Fines must be paid and the industry has to comply with GMP, else, it might be ordered to cease business.

In Mauritius, the Ministry of Health and Quality of Life is responsible of quality matters of pharmaceuticals. In contrary to other countries, there is presently no quality standards imposed on local pharmaceutical manufacturers.

Keywords: Quality/ GMP/ ICH Q10/ Pharmaceutical Industries.

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Background to Pharmaceutical products

Medicine is one of the Greeks' contributions to human civilization. In fact, medicines have their origin from the Greeks of the sixth century BC. Still nowadays, we use medicines to treat diseases. However, various changes have occurred in this field. Our generation has become more and more quality conscious and pharmaceuticals of better quality are asked for. This is mainly due to various fatal incidents which occurred in the past concerning pharmaceuticals manufacture. Fortunately, various world organizations have been set up in order to make sure that pharmaceutical products reaching patients comply with quality standards recommended. Also, governments from around the world have shown their concern about quality matters by allocating a substantial proportion of its total health budget to drugs. According to the World Health Organisation (WHO), this proportion tends to be greatest in developing countries, where it may exceed 40%.

Aims and objectives

The aim of this paper is to define the appropriate quality standards applicable for the in pharmaceutical manufacturing industries which when implemented will allow manufacturers to operate robust, modern quality systems.

The objectives of the study were to:

- Propose a model example of a quality system for a local pharmaceutical manufacturing industry.
- Determine the feasibility of implementation such a system for the Pharmaceutical Manufacturing Industry.
- Explore the benefits of implementing such a system in manufacturing Pharmaceuticals.

Quality of Pharmaceuticals in the local context.

As proved by some studies, developing countries are the most susceptible to substandard, counterfeit, unregistered and adulterated pharmaceuticals because of weak institutions for their quality control. Mauritius is a developing country with about a population of 1.2 millions of inhabitants. As such, the population of Mauritius can also be seen as a vulnerable one to such kinds of pharmaceutical products.

Authorities concerned in Quality Control implementation in Mauritius

In Mauritius, aspects such as quality, importation, and so on, related to pharmaceutical products are the concerned of the Ministry of Health and Quality of Life, more precisely, the Pharmaceutical Services Unit comprising of the Pharmacy board and various committees. The functions of the board and committees can be found in the Pharmacy Act 1983 of Mauritius. According to the present senior pharmacist, of the Pharmaceutical Services Unit, before a pharmaceutical manufacturing industry starts to operate, it must be granted the WHO GMP – ONLY Product Realization section certification (presently free of charge). This is done by the GMP inspectors of the Ministry of Health and Quality of Life, which comprised of 3 members, namely, the Director of Pharmaceutical Services Unit, the senior pharmacist, and finally the Registrar. In Mauritius, GMP certification for the pharmaceutical sector is still not an obligation as it is the case in USA and

various other countries. Also, the implementation of GMP would be quite expensive. Thus industries do not go for its certification. That is why in Mauritius there is presently only one institution that runs programs for the whole elements forming part of GMP for Pharmaceutical Products certification.

Facts concerning Pharmaceutical sector in Mauritius

Presently, the market of pharmaceutical products in Mauritius is estimated to be to the tune of around Rs 1.5 Billion. The country has about 25 pharmaceutical trading companies and two Pharmaceutical Manufacturing Industries in Mauritius, namely:

1. Mascareignes Pharmaceutical Manufacturing CO LTD,

This company produces generic pharmaceutical products both for local and overseas market. It is actually into the implementation phase of ISO 9001:2000, Quality Management System. However, it already complies with the WHO GMP guideline for the product realization section. Not yet GMP certified.

2. Ajanta Pharma (Mauritius) LTD.

Ajanta Pharma (Mauritius) LTD manufactures generic drugs for the African market since 1997, exporting mainly to French speaking African countries including Togo, Benin, Burkina Faso, Senegal, Cameroon, D.R. Congo, Madagascar and Comoro as well as supplies the local market. Ajanta Pharma is already ISO 9001:2000 certified. It has also been inspected, audited and approved its manufacturing facility for compliance with WHO GMP by Ministry of Health delegations from several countries and have registered its product for safety, quality and efficacy. (Mauritius Investment Opportunities, 2007.)

Setting up of a Quality Control Laboratory for Pharmaceutical Products.

The Quality aspects of pharmaceutical products have become a must for our country nowadays due to worldwide market competition. Furthermore, the Mauritian population has become a more quality conscious one due to better knowledge related to quality issues. Hence, the Ministry of Health and Quality of Life has recently initiated the project of setting up the first quality control laboratory of the island for the testing of new and suspicious pharmaceutical products. Presently, the latter is sent to South Africa for testing. This project will help in improving the pharmaceutical sector, also, it will reduce costs and time taken for the testing of pharmaceuticals as tests will be carried out locally.

Some of the objectives of the Quality Control Laboratory are to:

- (a) Ensure that drugs procured are of the required quality;
- (b) Serve as a technical backup to the licensing of new drugs and generics;
- (c) Foster confidence in generic drugs amongst prescribers and enable the eventual implementation of generic substitution in private pharmacies;
- (d) Prevent and combat the scourge of counterfeit drugs;
- (e) Assist in the setting up and development of pharmaceutical manufacturing industries in Mauritius; and
- (f) Assist in the setting up of Contract Research Outsourcing companies in the field of pharmaceutical products in Mauritius. (Government of Mauritius Cabinet Decision, 2006).

Background of quality systems in Pharmaceutical industries

Pharmaceutical Industries are complex ones and great attention to the processes involved in the manufacture of a medicinal product should be primordial as, any slight error may be fatal to the ones consuming it. Examples of tragedies that had been engraved in the pharmaceuticals manufacturing history are:

- In USA, Sulphanilamide Elixer (a pharmaceutical product) sold as a powder was changed to an oral liquid by making use of Diethylene Glycol, which is an aircraft antifreeze . This caused 107 deaths in 1937 due to renal failures. The victims were mainly children. The manufacturer paid a fine of only \$26 000 and this incident led to the Food, Drug and Cosmetic Act 1938.
- In Haiti, 1996, Paracetamol pediatric syrup was contaminated by the glycerol used. The latter contained 26 % diethylene glycol, causing the death of 59 children due to acute kidney failure.

Quality system in the Pharmaceutical Industry consists of implementing the best Quality Management System within the industry. In so doing, one would need to implement ISO 9001:2008 and the Good Manufacturing Practices (GMP) for Pharmaceuticals in order to have the assurance that pharmaceutical products are consistently produced and controlled to the quality standards appropriate for their intended use and as required by marketing authorization. However, the International Conference for Harmonisation has recently introduced a guideline known as ICH Q10 which has as its foundation both ISO 9001:2000 standards and GMP.

ISO 9001:2000 - Scope for a Pharmaceutical Manufacturing Industry

The standard can also be used for the Drug industry and its purpose in this case will be to demonstrate its ability to provide a pharmaceutical product that meets customer and regulatory requirements and achieves customer satisfaction. This purpose is accomplished by evaluating and continually improving the system, rather than the product. The requirements of the standard are intended to be applicable to all types and sizes of pharmaceutical organizations.

Quality Assurance of Pharmaceutical Products

Quality Assurance is an important requirement governing the testing of chemicals to obtain appropriate information on their properties and ensuring safety with respect to human health and the environment. Within an organization, quality assurance serves as a management tool. In contractual situations, quality assurance also serves to generate confidence in the supplier.

The manufacturer must assume responsibility for the quality of the pharmaceutical products to ensure that they are fit for their intended use, comply with the requirements of the marketing authorization and do not place patients at risk due to inadequate safety, quality or efficacy. The attainment of this quality objective is the responsibility of senior management and requires the participation and commitment of staff in many different departments and at all levels within the

company, the company's suppliers, and the distributors. To achieve the quality objective reliably there must be a comprehensively designed and correctly implemented system of quality assurance incorporating GMP and quality control. It should be fully documented and its effectiveness monitored. All parts of the quality assurance system should be adequately staffed with competent personnel, and should have suitable and sufficient premises, equipment, and facilities.

The concepts of quality assurance, GMP and quality control are interrelated aspects of quality management.

Good Manufacturing Practices (GMP) for Pharmaceutical Products.

Good Manufacturing Practice is that part of quality assurance which ensures that products are consistently produced and controlled to the quality standards appropriate for their intended use and as required by the marketing authorization.

GMP is concerned with both production and quality control. It is aimed primarily at diminishing the risks inherent in any pharmaceutical production. Such risks are essentially of two types:

- a) cross-contamination (in particular of unexpected contaminants) and
- b) Mix-ups (confusion) caused by, for example, false labels being put on containers.

Six-system Inspection Model for a Pharmaceutical Manufacturing Industry.

Figure 1 shows the relationship among the six pharmaceutical manufacturing systems: the quality system and the five manufacturing systems. The quality system provides the foundation for the manufacturing systems that are linked and function within it.

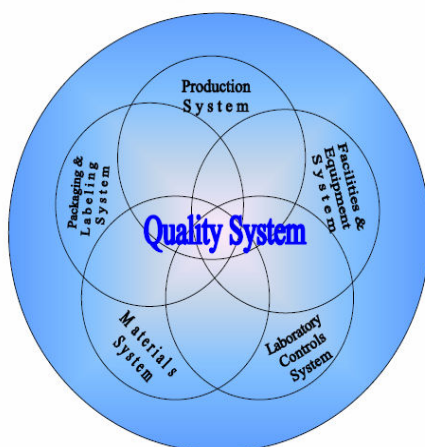


Figure 1 Six System Inspection Approach

[Source FDA, Pharmaceutical GMP regulations, 2004]

Some examples of Good Manufacturing Practices (GMP) Requirements:

Under GMP:

- all manufacturing processes are clearly defined, systematically reviewed in the light of experience, and shown to be capable of consistently manufacturing pharmaceutical products of the required quality that comply with their specifications;
- instructions and procedures are written in clear and unambiguous language, specifically applicable to the facilities provided;
- records are made (manually and/or by recording instruments) during manufacture to show that all the steps required by the defined procedures and instructions have in fact been taken and that the quantity and quality of the product are as expected; any significant deviations are fully recorded and investigated;
- the proper storage and distribution of the products minimizes any risk to their quality;
- A system is available to recall any batch of product from sale or supply; complaints about marketed products are examined, the causes of quality defects investigated, and appropriate measures taken in respect of the defective products to prevent re-occurrence.

Integrating GMPs into an ISO 9001:2000 Quality System Program

On the surface, Good Manufacturing Practices and other standards may appear redundant and overwhelming. Although ISO 9001 standards remain the foundation for good quality systems and provide documented methods for demonstrating value to customers, ISO quality standards are currently voluntary and there is no ramification or penalty for noncompliance to the standard, other than potential breach of contract with a customer or loss of business. In contrary, various governmental agencies e.g., US FDA and Canada's HPFB can and do enforce compliance to GMPs, thus differentiating them from ISO standards, and elevating their relative importance. Similar trends are currently underway with other governments in Europe and Asia. *Figure 2* shows some examples of areas where additional GMP criteria should be considered for materials being targeted for pharmaceutical applications.

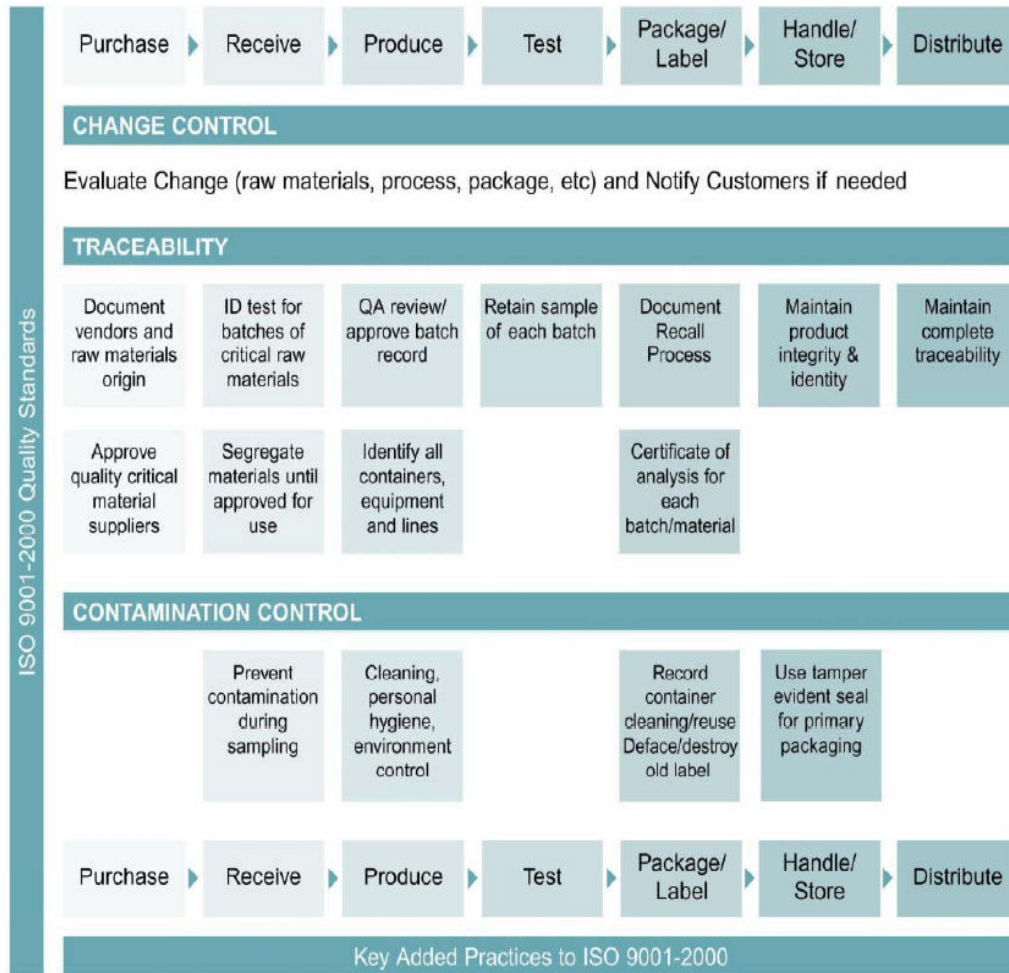


Figure 2 Integrating GMPs into an ISO 9001:2000 Quality System Program

(Source: <http://www.dowcorning.com/content/publishedlit.pdf>)

PHARMACEUTICAL QUALITY SYSTEM- ICH Q10

ICH Q10 gives the description of one comprehensive approach to an effective pharmaceutical quality system having as basis the ISO concepts, including relevant Good Manufacturing Practices (GMP) regulations and completes ICH Q8-Pharmaceutical Development, and ICH Q9- Quality Risk Management. ICH Q10, the model for a pharmaceutical quality system, can be implemented throughout the different periods of a product lifecycle. Much of the content of ICH Q10 relevant to manufacturing areas is currently mentioned expressly by regional GMP requirements. ICH Q10 is not designed to create any new expectations beyond current regulatory requirements. Consequently, the content of ICH Q10 that is additional to current GMP requirements is optional.

ICH Q10 shows industry and regulatory authorities’ interest of providing an effective pharmaceutical quality system to enhance the quality and availability of pharmaceutical products around the world in the interest of public health.

Implementing ICH Q10 throughout the product lifecycle should ease innovation and continual improvement and strengthen the link between pharmaceutical development and manufacturing activities.

The product lifecycle usually includes the following technical activities for new and existing products:

- Pharmaceutical Development
- Technology Transfer
- Manufacturing
- Product discontinuation

The ICH Q10 Objectives are to

- Achieve Product Realization ;
- Establish and Maintain a State of Control;
- Facilitate Continual Improvement

Guidance and regulations

Important institutions, which regulate or guide actors in the European pharmaceutical industry in designing their quality systems:

- (1) **Good Manufacturing Practices – GMP;**
- (2) **World health organization- WHO;**
- (3) **EU legislation on manufacture**

There are three directives that guide pharmaceutical manufacturers.

- (i) *Directive 2001/83/EC* of the European Parliament;
- (ii) European Commission Directives *91/356/EEC* and
- (iii) Directives *91/412/EEC* (*medical products for veterinary use*)

Hazard and Risk Analysis in Pharmaceutical Products.

Traditionally, the Hazard Analysis and Critical Control Point (HACCP) methodology has been considered to be a food safety management system. It aims to prevent known hazards and to reduce the risks that they will occur at specific points in the food chain. The same principles are also increasingly being applied in other industries, such as the pharmaceutical industry, car industry, aviation and the chemical industry.

Hazards affecting quality are controlled to a certain extent through the validation of critical operations and processes in the manufacture of finished pharmaceutical products in accordance with Good Manufacturing Practices (GMP). However, GMP does not cover the safety of the personnel engaged in manufacture, while both aspects are covered by HACCP. Procedures, including GMP, address operational conditions and provide the basis for HACCP. HACCP is a systematic method for the identification, assessment and control of safety hazards. Such hazards are defined as biological, chemical, or physical agents or operations that are reasonably likely to cause illness or injury if not controlled. In the manufacture of pharmaceuticals, these may include the manufacture of certain antibiotics,

hormones, cytotoxic substances or other highly active pharmaceuticals, together with operations such as fluid-bed drying and granulation, which are examples of hazard unit operations. The use of inflammable solvents (solutions) and certain laboratory operations may also constitute hazards.

METHODOLOGY

Research strategy

Intensive research had been carried out on quality aspects related to the pharmaceutical manufacturing industries from the net, books, responsible authorities and pharmaceutical manufacturing industry. The research was mostly oriented towards Good Manufacturing Practices applicable to such an industry.

Data collection for this study

Data has been collected from sources like GMPs websites, books, pharmaceutical company, journals, Ministry of Health and Quality of Life, some concerned authorities, and certification bodies such as Mauritas and MSB.

The first study was a survey carried out to understand to what extent our population is concerned with the quality standards of locally marketed medicinal products and to have the perceptions of Pharmacists and of the general public on quality of medicinal products.

Secondly a Case Study was analysed to understand the requirement for implementing a Quality Systems in the manufacture of a Pharmaceutical product. The case example chosen for this study was for the manufacture of Paracetamol. A survey was also carried out on the manufacture of Paracetamol.

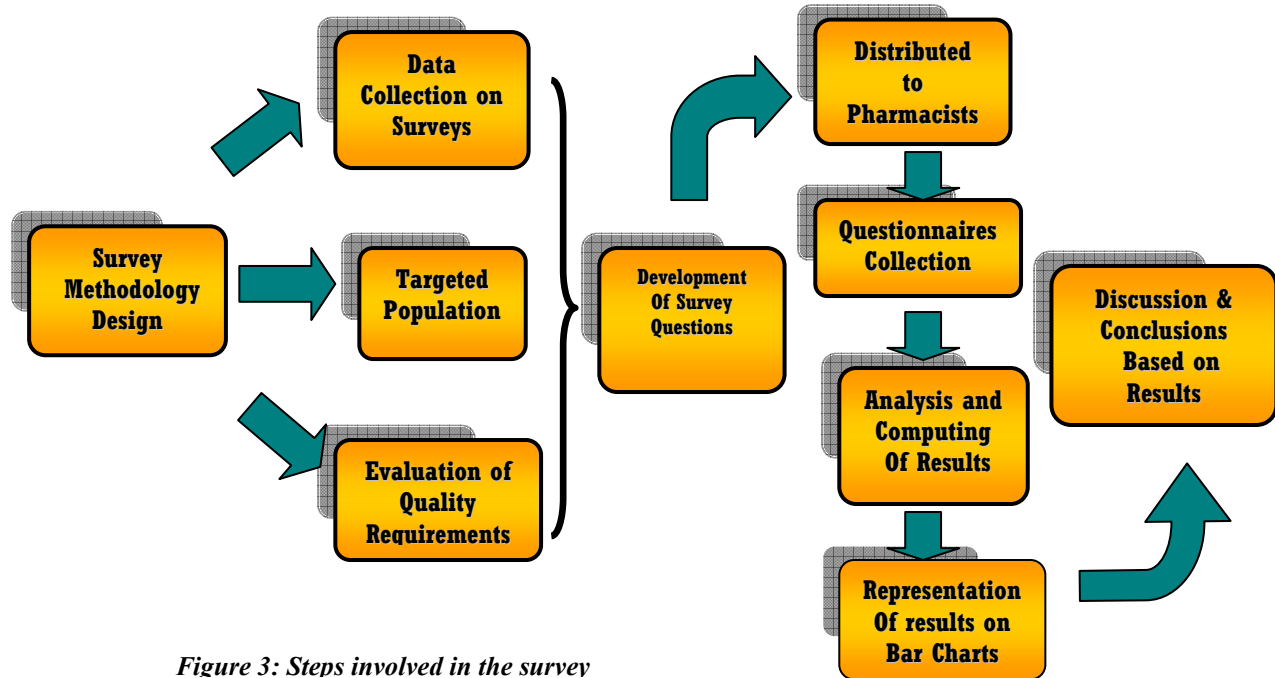


Figure 3: Steps involved in the survey

Primary data was collected by sample surveys from about twenty pharmacies and eighty interviews from the general public. Visits to private pharmacies, few hospital pharmacies and to consumers from different part of the island were carried out. In some cases, face to face interviews with the pharmacists were possible while they were filling the survey.

Visits of consumers were carried out to different geographically situated offices of some relatives and permission for leaving some questionnaires to the personnel was done. Filled questionnaires were also recovered from participants.

Classification of Target Population

Since different point of views were required for the survey concerning the quality of pharmaceuticals, data were gathered from two categories of people, that is,

- Retailers and
- Customers.

Pharmacists were also classified as the retailers of pharmaceutical products, thus they are directly involved in the marketing of pharmaceutical products. Therefore, their opinion on the quality standards requirement for medicinal products would be quite different from that of a patient. Also, pharmacists have a better knowledge of the subject since they are directly associated to it.

Consumers of medicinal products are patients looking for some treatment. Their opinion on the quality requirements of those products were collected and compared to that of a pharmacist.

Strategy of survey sampling

Surveys on people from different part of the island was first carried out so as to have a wider range of opinion for better survey results, as it is believed that people from rural and urban areas might have some different point of views on quality of medicinal products due to lack of knowledge, poverty, and so on.

Sampling has been done for about three weeks over quite a large number of people so as to have a more accurate result.

Objectives of collecting data from survey questionnaires

- Results and findings would be used to build a model for implementation of GMP for pharmaceutical manufacturing industries.
- Also for the survey on Paracetamol, findings would help in better meeting customer satisfaction for Paracetamol products for the fictitious case study.

RESULTS AND DISCUSSIONS

Comparison of GMP and ISO

It can be found that there are various differences between GMP and ISO standards. The table below shows these differences:

Table 1: Comparison of GMP and ISO

	ISO	GMP
Objectives	Customer Satisfaction	Customer Protection
Binding Nature	Voluntary	Legally Binding
Supervision	Neutral Institution	Health Authority
Degree of Detail	General	Detailed
Type of Business	All Businesses	Pharma Specific
Main Emphasis	System Related	Product Related
Standards	Own Standards	Legally set Standards

(Source: FDA and GMP compliance in QA Units, 2000)

Therefore, to have an excellent quality system, it would be better for a pharmaceutical industry to implement both GMP and ISO standards as each of them has their own functions. Or, one can simply implement ICH Q10 in his industry since the latter has as basis both GMP and ISO standards. After implementation, regular internal auditing by trained employees of the industry and external auditing by competent inspectors of regulatory bodies should be carried out in order for continually improving and controlling the quality systems implemented.

Analysis of Survey Results

Pharmacists

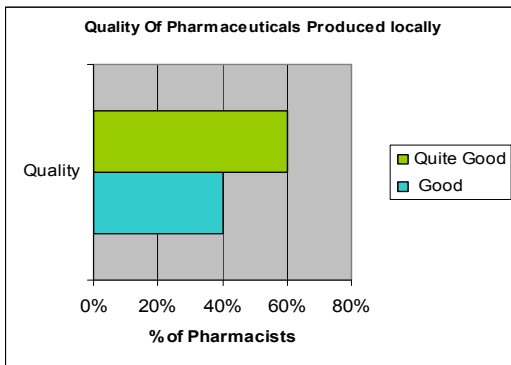


Figure 4 *Quality of pharmaceuticals produced locally*

- Quality of medicines produced locally is seen as quite good.
- Improvement could be made. Government should encourage existing pharmaceutical manufacturing industries to implement GMP and GLP which are more Pharma specific

Consumers

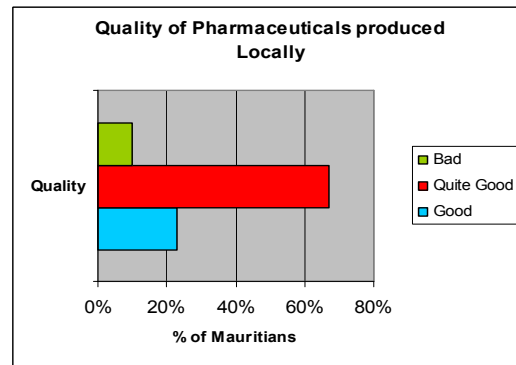


Figure 5 *Quality of pharmaceuticals produced locally*

- Quality of medicines produced locally is seen as quite good because:
- They think that raw materials come from abroad- not a good reasoning as they might not be pure and of good quality, hence they should firstly undergo quality tests.

Pharmacists

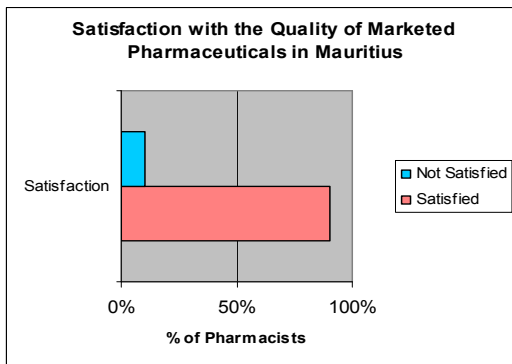


Figure 6 *Satisfaction with quality of marketed pharmaceuticals*

- 80% satisfied with marketed Pharma products because:
- Part of them come from high quality standard companies from overseas
- However, they feared that some of the generic products (which are much cheaper) marketed in Mauritius come from less quality strict countries and that they believe that these products are of inferior quality, hence do not treat efficiently.

Consumers

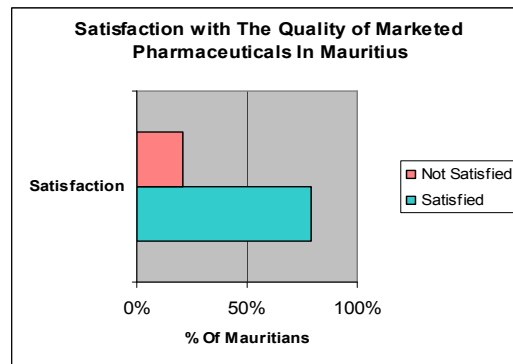


Figure 7 *Satisfaction with quality of marketed pharmaceuticals*

- 70 % of the public are satisfied with the marketed products and they gave the same reason as the pharmacists.
- However, 30% are not satisfied because they found that a majority of the marketed pharmaceuticals come from less quality recognized countries and are not enough efficient. Also, they do not trust those products and usually avoid buying them.

Pharmacists

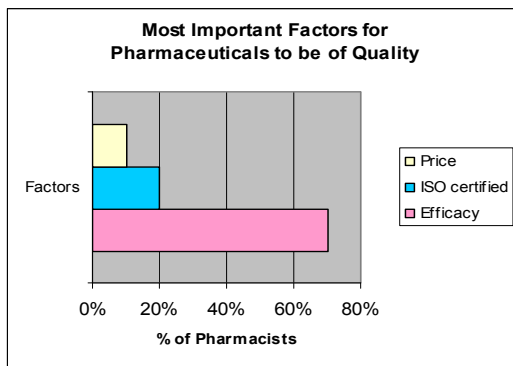


Figure 8 Factors for pharmaceuticals to be of quality

- Efficacy has been firstly chosen because pharmaceuticals are taken for treatment and the pharmacists believe that to cure a patient rapidly, they shall be very efficient.
- Due to many fraud cases in pharmaceuticals manufacturing and counterfeiting of medicines, ISO certification is viewed as another important parameter.
- For products to achieve quality requirements, several tests are carried out before they are being marketed, thus the manufacturing costs of these pharmaceutical products have the tendency to increase, resulting in high selling price.

Consumers

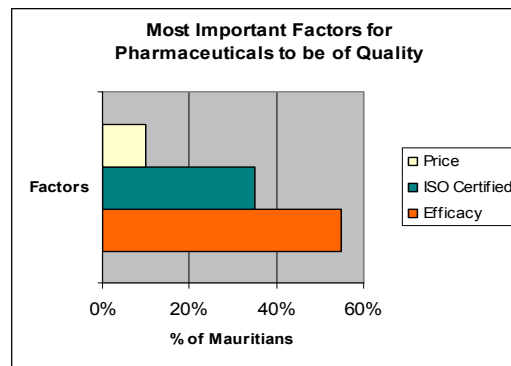


Figure 9 Factors for pharmaceuticals to be of quality

From above, it can be found that efficacy, followed by ISO certification and prices are the most important factors for the public. They say that they believe that products treating rapidly and efficiently must be of excellent quality. Furthermore, ISO certification as they trust the ISO standards and can therefore be quality assured of these products.

Quality Systems for the manufacture of a Pharmaceutical product

Introduction

The name Waypharma was given to this fictitious Paracetamol manufacturing industry. It is seen as a major player in the Mauritian generic Paracetamol market since 2006. The company's vision is to be the leading company in the sales, development and manufacturing of Paracetamol products and other quality generic pharmaceuticals in the regional markets. The industry's group employs about 165 workers and is headquartered in Mauritius and has manufacturing facilities both in Mauritius and Rodrigues.

Objectives of Company

The core objectives of the company are to provide reliable Paracetamol tablets to customers within reasonable time frame and to ensure that all products are of good quality and affordable price.

Strategy for Quality Systems Implementation.

In 2005, before starting Paracetamol tablets manufacturing, the company carried out surveys concerning Paracetamol products, touching a wide range of Mauritian.

The survey was made in order to meet customers' demand on the quality of the Paracetamol manufactured. Also, particular attention was made to the design of the packaging, forms and dosage of the Paracetamol products as to be able to provide products of quality; surveys must be done in order to obtain customers' expectations before starting business.

Findings from Analysis of Case Study Company

A market survey was carried out for the manufacture of Paracetamol in the island. Results obtained indicated that 90% of consumers prefer insoluble Paracetamol products and syrup type is the least preferred. Results further indicated that consumers found it most practical and easier to handle Paracetamol tablets instead of a bottle of syrup or having to carry a cup in order to use the soluble ones. Also, blister packaging is the most demanding one. This is because this type of packaging is more protective than the strip package and that it is most practical and handy than a plastic box. Furthermore, the preferred shape is the round one as customers find that it is easier for swallowing. Concerning the dosage preferred by participants, it was observed that the 500mg is the one. They probably chose the 500mg one because it can be easily controlled, that is, if one member of the family used to take 500mg Paracetamol tablet and that another one takes 1000mg, it is easier for the one having to take 1000mg to take two tablets instead of one. Finally, it was observed that out of 50 persons, only 3 knew what has to be done in case of a Paracetamol overdose.

Finally after analyzing results of the market survey, management reviewed its processes and decided that the industry would manufacture round shape Paracetamol tablets of 500mg and that the type of packing to be used would be the blister one. Also, the company decided to create necessary awareness in case of Paracetamol overdose. The label information provided was improved by providing more information for the dosage limit. Also, a hotline number would be introduced on every blister packing in case of emergency.

Some facts concerning the present quality system of the fictitious industry:

- It has its own quality systems based on the company's quality manual
- It does not have any certification or accreditation for its current quality system.
- Raw materials and finished products undergo tests based on British and International Pharmacopeias.
- A few of its employees are qualified workers and they are the ones who train new employees.
- The industry has now a system for documentation. Relevant records concerning processes and products are kept on hard copies and are also computerized.

Conclusion

Overall, from the study of the quality systems of pharmaceutical manufacturing industries, the conclusion that can be made is that quality of products from this type of industry is a very important issue. This is because lives of billions and billions of human beings are concerned. A slight error such as a wrong labeling of medicines can cause the death of hundreds of people. As such, implementing a

good quality system shall be the priority of anyone wanting to set up this type of industry. Also, concerned organizations and government authorities shall make sure that quality aspects are followed by these industries. Moreover, governments shall be more severe on corruption and fraud issues occurring in this sector in order to discourage evil minded persons from putting the lives of innocents in danger.

Pharmaceutical counterfeiting is more and more a public health problem, especially in developing countries where the most counterfeit drugs are antibiotics, antimalarials and other life-saving drugs. As such, Mauritius, a developing country can be seen as vulnerable to counterfeit products. A majority of Mauritian still cannot afford having a good quality of life due to insufficient revenue and lack of education. So, you can imagine that buying good quality standard, efficient and safe medicines for treating a disease is practically impossible since quality pharmaceutical products coming from high quality standard countries are quite expensive. Thus, this part of the Mauritian population may be exposed to counterfeit products which are most of the time cheaper than recommended ones.

From the survey made, pharmacists stated that, in Mauritius, there is presently not enough emphasis from regulatory authorities upon the quality standards of imported medicines. Also, there are no specific authorities that regulate the quality of pharmaceutical products, like the Food and Drug Administration in USA. Furthermore, importation of pharmaceuticals in our country is firstly a business matter for importers instead of being a quality one. This means that products are being bought according to their prices in detriment of products' quality assurance.

Finally, to conclude, pharmaceutical manufacturing companies would be encouraged to incorporate Good Manufacturing Practices (GMP) into their processes although it is quite an expensive implementation, their quality systems would become a more robust and modern one. Thus, with time, their profit would flourish and everyone, manufacturers and consumers would benefit from such systems.

Recommendations for a Model for Implementing a GMP System.

Although the fictitious Paracetamol manufacturing industry is not adhered to any recognized quality certification or accreditation, it has got its own basic quality systems concerning products manufacturing, documentation, records and so on. However there are some gaps in their quality system and implementing GMP will definitely help the company to have a more robust and modern quality system.

A few examples of quality gaps of the industry analyzed against GMP requirements:

- The company does not have a well organized system for product recalls from sale or supply.
- The company does not have a system to deal with complaints about marketed products. The latter should be examined and causes of quality defects investigated, and appropriate measures taken in respect of the defective products to prevent recurrence.
- It does not have an outstanding record and documentation systems covering manufacture and distribution, which enable the complete history of a batch to be traced.
- Key elements of a qualification and validation programme should be clearly defined and documented in a validation master plan.

- Report should be made after regular self inspections and quality audits.
- The company should provide continuing training to its personnel and specific training should be carried out for workers dealing with hazardous materials.
- Weighing areas should be made in a dust controlled unit.

Therefore, based on the findings and results obtained, a model for the implementation of a quality pharmaceutical system adapted from WHO GMP standard guidelines is recommended for this industry to cater for these gaps. Following is a schematic pathway has been designed for this industry to achieve GMP certification.

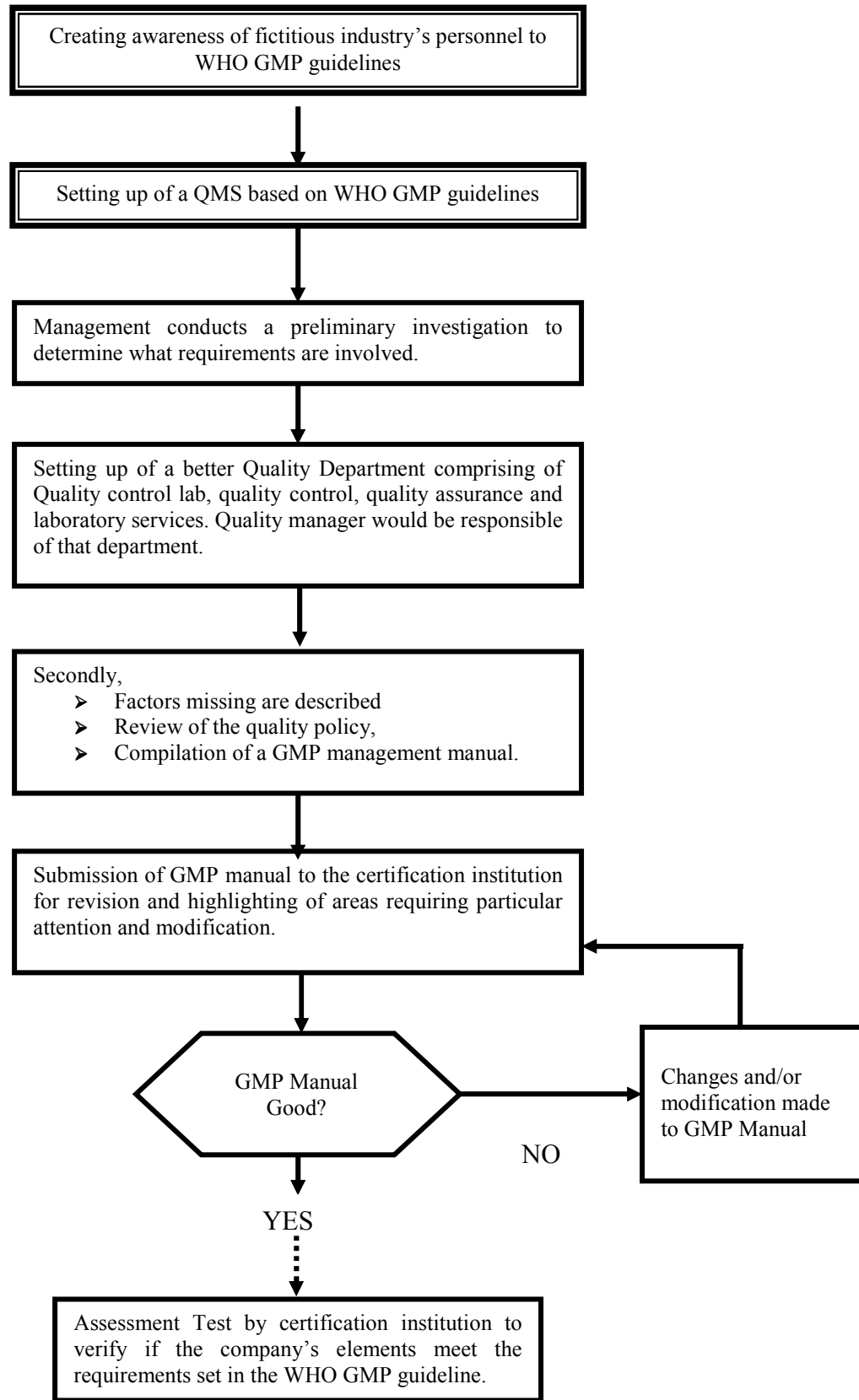


Figure 10: Stages towards GMP certification of fictitious industry

The GMP elements referred to are:

- Sanitation and hygiene,
- Qualification and validation,
- Complaints,
- Product recalls,
- Contract production and analysis,
- Self-inspection and quality audits,
- Personnel,
- Training,
- Personal hygiene,
- Premises and Equipment,
- Materials,
- Documentation,
- Good practices in production and Good practices in quality control issues.

(WHO Quality assurance of pharmaceuticals GMP practices, 2003)

Estimated Costing of GMP Implementation

GMP implementation costing would not be a constant one for any pharmaceutical industries. This is because the implementation depends on various factors such as, types of pharmaceutical products being manufactured, extent of activities, number of personnel, sizes of industries amongst others. However, an estimated cost of converting a standard production line to GMP status would be between **6 - 30 million USD** depending on company's size. *(Achemasia, 2006)*

Also, the costs consist of application fee, assessments, triennial registration certificate and other expenses related to certification for achieving GMP certification would be approximately between **250- 350 thousand Mauritian rupees** for a period of 3years, after which, renewal of certification and continuous assessment should be again accounted for. Those figures have been estimated based on the schedule of fees for MS ISO 9001:2000 (March 2002) of the Mauritius Standards Bureau.

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