TRIBHUWAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF ARCHITECTURE
PULCHOWK, LALITPUR

A THESIS
ON

‘ABATTOIR’
A HEALTHY MEAT PLANT IN THE CITY

SUBMITTED
IN:
PARTIAL FULFILLMENT OF THE
REQUIREMENT OF THE DEGREE OF
BACHELOR IN ARCHITECTURE

SUBMITTED BY:
SAMIP NEPAL
074-BAE-230

2023

COPYRIGHT

CERTIFICATE

This is to certify that this Thesis Report entitled “Abattoir- A healthy meat park in the city”, at Kathmandu submitted by Samip Nepal has been examined and it has been declared successful for the partial fulfillment of the academic requirement towards the completion of the degree of “Bachelor of Architecture”.

_____

PROF. DR. SUDHA SHRESTHA
(Thesis Supervisor)

DECLARATION

I DECLARE, that this dissertation has not been previously accepted in substance for any degree and is not being concurrently submitted in candidature for any degree. I state that this dissertation is the result of my own independent investigation/work, except where otherwise stated. I hereby give consent for my dissertation, if accepted to be available for photocopying and understand that any reference to or quotation from my thesis will receive an acknowledgement.

_____

SAMIP NEPAL
074-BAE-230

ACKNOWLEDGEMENT

I acknowledge the generous support from the Department of Architecture, IOE, Pulchowk Campus for all the resources and assistance they have provided.

I am indebted to my supervisor, **Prof. Dr. Sudha Shrestha**, for her continued guidance and an endless supply of knowledge and information. Her unassuming approach to my research is a source of inspiration. This approach is reflected by her interest in the project which has helped me a lot during the research and to have a clear understanding of the project. Her constructive advices and assistance for the research and design development are invaluable.

I gratefully recognize the invaluable suggestions, guidance and comments provided by Prof. Dr. Bharat Sharma, Ar. Pratiksha Shrestha, Ar. Anjana Vaidya, Prof. Surya Gyawali, Ar. Timila Bajracharya, Ar. Ritu Raj Rai, Asst. Prof. Ram Laxmi Tamrakar and all the teachers, external jury members and seniors which has helped me a lot on this research to correct my mistakes. I would like to express my sincere gratitude to our thesis coordinator Asst. Professor Dr. Inu Pradhan Salike for her insightful suggestion and guidance.

I am also indebted to all the juniors Asim Bhattarai, Dipak Karki, Anil Panthi, Saugat Baral, Anuzsri Oli, Saugat Khanal, Oshin Dura, Abhi Subedi, Bhumi Rai, Shreya Sharma, Prakirti Gyawali, Ritika Adhikari, Jwoelsha Bajracharya, Nayan Shrestha, Safal Adhikari who have helped me in this thesis. Also, I would like to mention my friends Diwas Bhattrai, Yugantar Paudel, Shankar Panthi and Abina Phoju for the incredible support.

Again, I would like to thank everyone who helped me with my thesis. Most importantly, I am grateful to my family, seniors, juniors and friends for their unconditional, unequivocal, and loving support.

Samip Nepal

074-BAE-230

ABSTRACT

Health is our wealth. We must be concerned about the food we eat and where do we get out food from. One such essential food industry is the meat industry. In Nepal, the meat we get from the local Abattoirs is dirty, unchecked and full of diseases. We, the stakeholders don't care about how the meat we are having is brought from the meat animals and how it is being brought into the market without a proper reviewed system. So, we must know about how the slaughter is being done inside our slaughterhouses, how the functioning of different areas takes place and how the produced wastes are being treated. People must be aware about the meat we are buying and what we are having as our food.

This study sheds light on the different slaughtering process, the spaces layout and function inside the slaughterhouse. Not only that how a proper humane slaughter can be done respecting all the animal welfare guidelines is being presented in this study. The methodology being implied during this report involves: i) literature review and data collection from secondary sources like journals, news articles, books, research papers and internet websites. ii) national case studies on abattoir and data and information regarding it.

The learnings have been implied with the design standards using the architectural concept to draft the meat park. This complex has all the required functional spaces in a proper flow involving meat process starting right from the farm, going into the slaughterhouse to the storage and then to the sales in the supermarket. The meat park is proposed to create a design that would focus mostly on the functional spaces along with pockets of green spaces to bind the people involved in various functions.

Keywords: Abattoir, slaughter, slaughter-house, animal welfare

Table of Contents

LIST OF FIGURES

1. INTRODUCTION

1.1 Background

"Not eating meat is a decision, eating meat is an instinct."

- Denis Leary

A slaughterhouse is an industrial facility where animals are processed for consumption as food products. Slaughterhouses act as the starting point of the meat industry, where stock come from farms/market to enter the food chain. In a major city, the settlements are too large for individuals to rear their own stock for personal consumption. So, to meet the consumption of large number of users, systematic and substantial meat plant is a must. (López, et al., 2022)

Licensed and inspected animal slaughter plants (also known as abattoirs) are the primary focus of the present demand. Live animals arrive at the abattoirs where they are unloaded, assembled, stunned, slaughtered, eviscerated and dressed and the meat harvested. All of these steps are inspected by employed and trained meat inspectors. Some abattoirs also process the meat from the carcasses after slaughter. (Encyclopedia of Food and Health, 2016)

2. PROJECT JUSTIFICATION

Annual consumption of meat in Nepal is approximately 552,000 metric tons as per 2020 (Sitaula,2021). Buffalo, goat, sheep, pig and poultry (chicken) are the major meat animals in Nepal. Although meat is an excellent source of protein and other nutrients in human diet, it can pose a significant health risk due to easy growth of pathogenic microorganisms and other zoonotic disease agents. Despite its widespread consumption in Nepal, meat is one of the most unsafe food items sold in the market. In an attempt to ensure the availability of safe meat to the public, government of Nepal formulated and enacted the Animal Slaughterhouse and Meat Inspection Act 1999 and regulation 2001. Among more than 100 food standards of Nepal, no standard is found about meat and meat products. (Bajgai,2012)

With a reduction of the country's poverty rate, Nepalese are eating more meat and eggs per capita than ever before, improving their nutrition levels and driving a rapid growth of the meat and poultry industry. Much of this new spending on food was a direct result of remittances being sent home to their families by Nepali workers abroad. Middle class families that ate meat only on weekends, now have it almost daily. Many Nepalese don't have to wait for Dashain or other festivals to have a meat dish in their diet. (Sitaula,2021)

The country is still not fully capacitated in terms of infrastructure and human resource development to implement food safety regulations. There are no adequate numbers of modern abattoirs in the country. Some slaughter houses made with the assistance of donor agencies are also not being operated satisfactorily. Lack of modern and hygienic abattoirs made people slaughter the animals in streets, open lands, pasturelands, riverside and courtyards. Meat animal traders collect the animals from farmers and keep them in certain designated places for sale. These animals are bought by the butchers who kill the animals to sell meat by themselves or by meat sellers nearby. Presently, there are not much slaughter houses to cater the needs of the users. Awareness in meat entrepreneurs and consumers about the importance of good slaughtering facilities in the health of consumers is very important to operate these facilities smoothly.

So due to this massive uphold in meat consumption, there is a dire need of a large-scale slaughterhouse in a city like Kathmandu which seeks to serve a large number of meat eating population.

3. PROBLEM STATEMENT

Safety of meat sold and consumed in Nepal is a major concern since long and debate about the legislation and its enforcement to assure safe meat to public has been continuing for more than a decade. There is numerous concerns in safety and freshness of the meat that are being consumed by the users. Some major issues are:

3.1. High prevalence of meat borne zoonoses

Studies by different scientists have evidenced that prevalence of meat borne zoonotic diseases in Nepal is very high as compared to those in developed countries. In a study 9.2% of the meat samples collected from capital city of Nepal (Kathmandu) were found to be positive for *Salmonella* species which is one of the major causes of food poisoning. Approximately 50% of the isolates were multi drug resistant. In another study, 11.4% of meat samples were found positive for salmonella in Kathmandu. Similarly, several meats borne parasitic zoonoses like trichinellosis, taeniasis, echinococcosis/hydatidosis etc. have been reported from different part of the country in different meat animals. Pigs in several urban area of the country has found infected with *Taenia.* (Food and Environment Nepal,2012)

3.2 Failure to enforce Animal Slaughterhouse & Meat Inspection Act

The act has the provision that the government can enforce the act in designated area from designated date upon notification in Nepal gazette. The most frustrating fact about the law is that it hasn't been successfully enforced till now. The government has tried to enforce the act in some of the municipalities of the country by constructing slaughter houses but

those slaughter houses were not utilized by the meat enterprisers. Turbulent political situation of the country for more than a decade and lack of adequate awareness among meat entrepreneurs, consumers and other stakeholders are suggested as the reasons behind the failure of enforcement of the law.

3.3 Poor Hygienic Practices during Slaughtering and Marketing of Meat

Poor hygienic practices during slaughtering and marketing of meat is one of the major contributing factors for unsafe meat in Nepal. Slaughtering animals in open and unhygienic places, use of dirty water during slaughtering process, and selling meat in open and non-refrigerated places are some of the unhygienic practices being used by the entrepreneurs. Due to which the meat gets contaminated with different microorganism which can be harmful for the health of the consumers. Keeping quality of the meat processed in these facilities is also poor.

3.4 Lack of Awareness among Stakeholders

Lack of information and knowledge about food safety among all stakeholders including producers, traders, consumers and even some government agencies have been regarded as one of the reasons preventing successful implementation of rules and regulation regarding food safety. Most of the small entrepreneurs are not aware about Good Hygienic Practices (GHP) which directly impede the safety of their products. Lack of awareness among different stakeholders has been stated as one of the major causes for the failure of enforcement of the slaughterhouse and meat inspection act. (Food and Environment Nepal,2012)

4. IMPORTANCE OF RESEARCH

The research will be helpful for future references for design of modern abattoir as it is relatively new architecture typology in context of urban fabric of Kathmandu. It will talk about the required amenities for the project and will impart the areas needed for the function and zoning inside the abattoir. It will also help to understand the function, importance, and demands of meat consumption and different products that a slaughterhouse can manufacture in massive city like Kathmandu. It would also help to understand the importance of healthy eating among the stakeholders.

5. OBJECTIVES

1. To challenge the traditional way of improper, unhygienic meat sells with modern abattoir meat products.
2. To promote sustainable architecture and support the creation of resilient infrastructure and foster consumers need.
3. To promote economic growth, raise employment opportunities for workers within the city.

4. To create a vibrant working environment for the workers with addition of different soft and hard landscapes.
5. To create bi-products like manure, chemicals, animal hair products and many more after meat processing to reduce waste production.

6. METHODOLOGY

Successful research follows specific methods of forming the backbone of the entire project. Therefore, you need to review the basic requirements. Following the research methods below to collect, analyze, and use the necessary facts, data, practice standards in the design process the final design will be made.

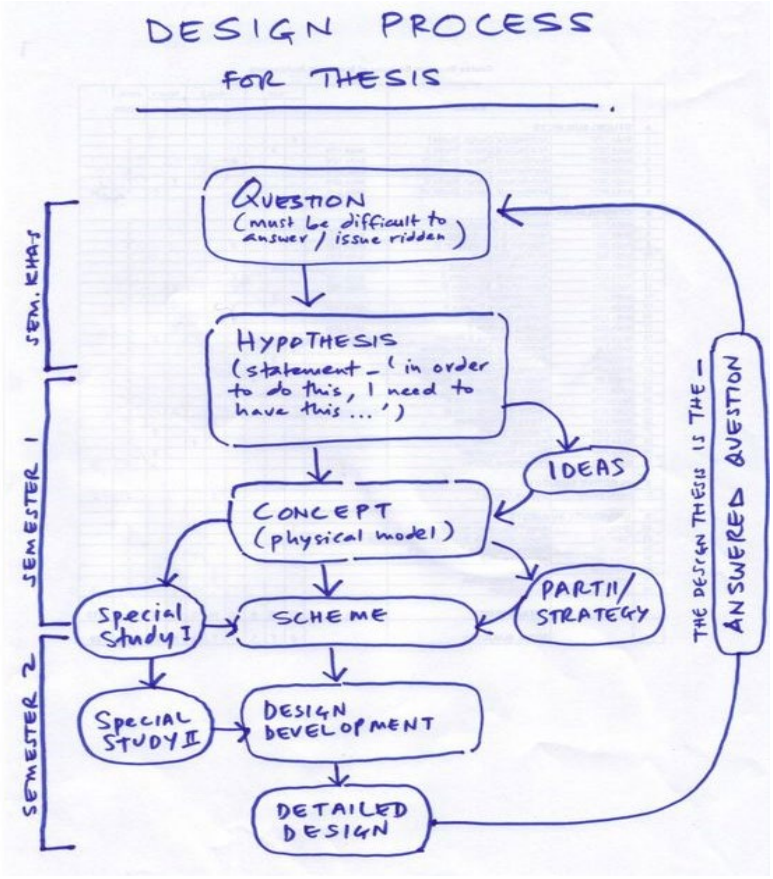


Figure 1: Flowchart of Proposed Methodology

6.1 Literature Review

This section will include guidelines to consider when designing any form of construction along with its function and zoning. Literature reviews review scientific articles, books, and other sources relevant to the field of study of the thesis.

6.2 Case Studies

Studies of various national and international case studies will be used to acquire first-hand data. The following case studies will be carried out in order to create the program and gather the essential information and numbers to construct the design. Studies of various national and international programs will be used to

acquire first-hand data and create the program and gather the essential information and numbers to construct the design.

7. EXPECTED OUTPUT

This thesis will try to provide an upliftment in healthy food habit of people of the city. The complex as a whole will try to cater for different food products, animal bi-products like organic fertilizers, green sustainable design and a refreshing workspace for the workers and also a lush green environment for any other users to come in and enjoy the space.
Similarly, it will contribute in:

- More workers' centric architecture.
- Contemporary approach to sustainable development.
- Provide an approach to achieve well design meat plant that is able to meet the demands for users need with a sense of recycling wastes from the plant such that it contributes to the community as a whole.
- Resilient design: Low Carbon emission, sustainable building, multi-use spaces.

8. TENTATIVE SITE LOCATION

The site for the abattoir will be close from the market of Kalimati, Balkhu and Kalanki. This meat plant will help to supply the users with ranges of products so it will be located and connected well from the markets and all those supermarkets of Kalanki, Kalimati and Patan. It should be a bit fringe from the core residential areas but should be located in such a way that it is well connected by the transport and will have good services to run the place.
Likewise, the site must offer proper landscapes to the workers just to relax from the harsh working environment. The intended site for the project is in the vicinity of Lalitpur city at the fringe of Dhobighat.

9. LITERATURE REVIEW

9.1 Meat

Meat is the flesh or other edible parts of domesticated animals which is used for food. Meat is not only the muscles we it but also the fats, tendons and ligaments as a whole. It is the most complete protein intake for human body which includes amino acids. Fat of meat differs from species to species and it also affects cut, quality and influences the flavor, juiciness and tenderness of meat. While the livers, kidneys and heart are the excellent vitamins and minerals source to the body. Overall, meat gives energy and protein to the humans along with different nutrients. (T. Editors of Encyclopaedia, 2022)

Figure 2: Meat

Pig is the world's largest provider of meat which weigh between 90 and 135 kg and provide about 70 to 74% of the weight in meat. It contributes 36% of global consumption. Chicken is second most consumed meat in the world. The third most widely consumed meat is beef which is extracted from cattle which normally weigh from 450 to 540 kg and yield almost 55 to 60% of its weight in meat. It represents 25% of global consumption. Meat from lambs and sheep is produced on a much smaller scale. They weight between 45 to 70 kg and yield about 48 to 50 % of their weight in meat. Lamb is the fourth most consumed meat followed by goat meat, turkey, duck meat, buffalo meat, goose and rabbit meat. (MeaTech, 2022)

Figure 3: Global meat consumption in numbers

In global scale, the dominant livestock for meat are poultry, cattle (which includes beef and buffalo), pig, sheep and goat. Similarly, wild game meat like horse, duck, rabbit, etc. also account for significant global consumption. The meat consumption varies as per countries, culture, religion and many other factors. (Ritchie & Roser, 2017)

Global production of all major meat types has been increasing in absolute numbers. But the percentage share of meat types have changed drastically over the last 50 years. In 1961, poultry meat only contributed for 12 percent of global meat production but it tripled to 35 percent by 2013. While beef and buffalo meat production has nearly halved now contributing around 22 percent. Pig is the largest contributor accounting for 35-40 percent of global meat consumption. (Ritchie & Roser, 2017)

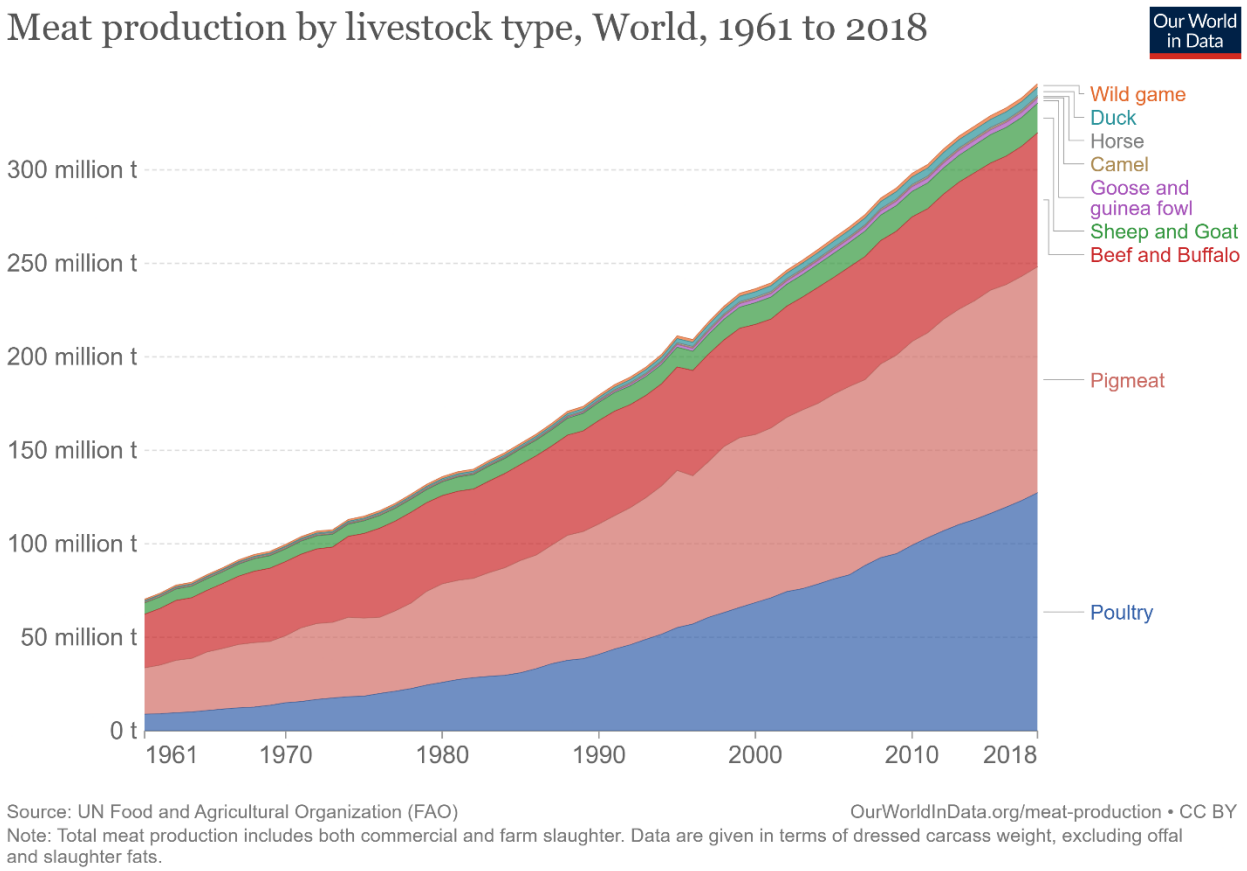


Figure 4: Meat production by livestock type, World, 1961 to 2018

As a global average, per capita consumption of pig meat is the highest of meat commodities; in 2013 the average person consumed around 16 kilograms of pig meat; followed by 15 kilograms of poultry; 9 kilograms of beef/buffalo meat; 2 kilograms of mutton & goat; and only a fraction of other meat types. (Ritchie & Roser, 2017)

Consumption trends vary significantly across the world. In China, pig meat accounts for around two-thirds of per capita meat consumption. In Argentina, beef and buffalo meat dominates, accounting for more than half of consumption. New Zealanders have a much stronger preference for mutton & goat meat relative to the global average. While in Nepal poultry dominates the meat preference. (Ritchie & Roser, 2017)

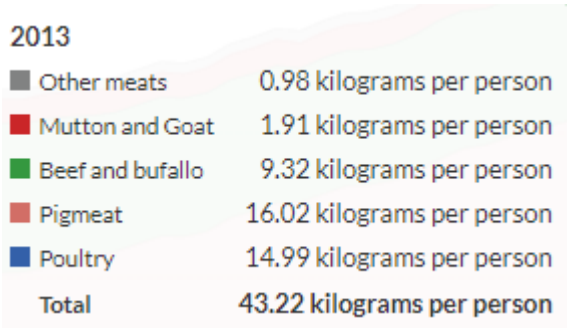


Figure 5: Average consumption of meat per person

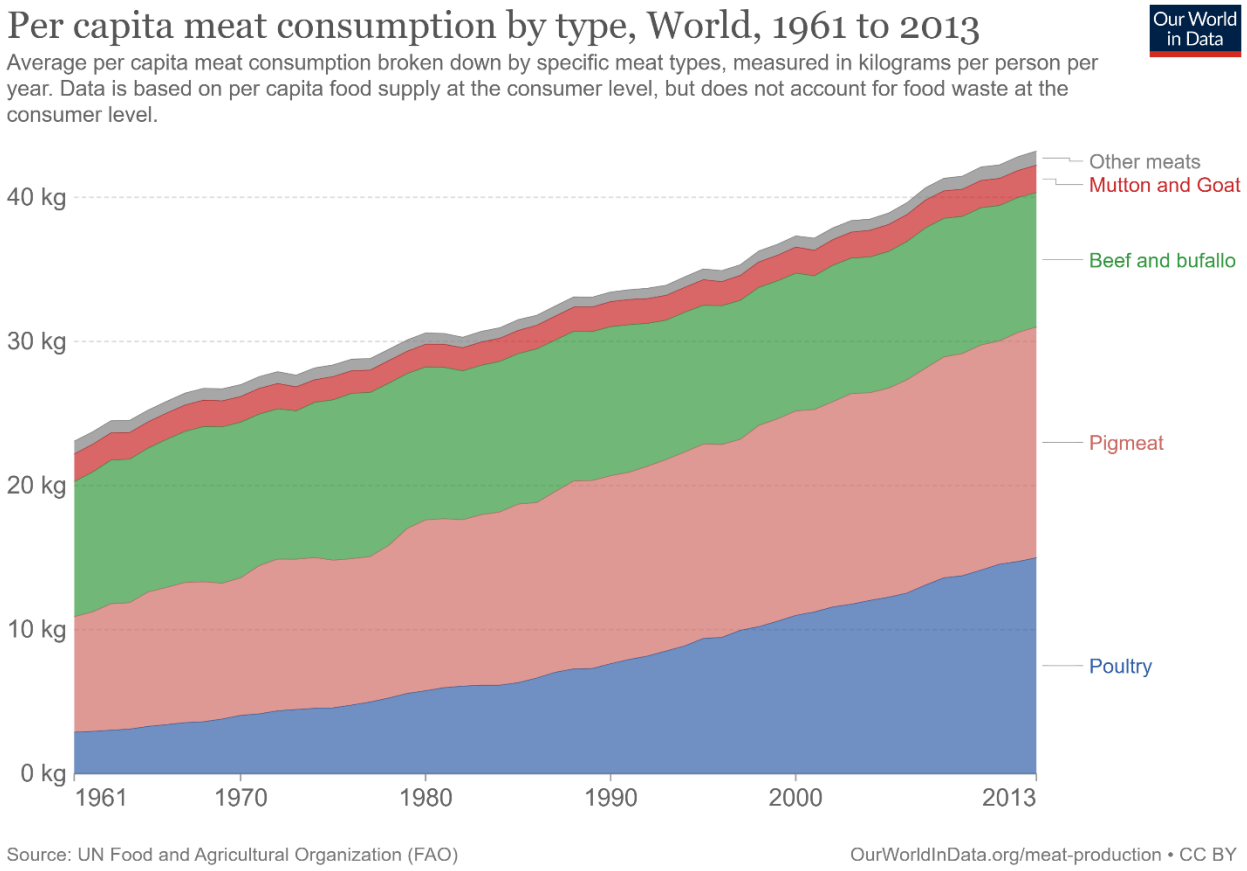


Figure 6: Per capita meat consumption by type, World, 1961 to 2013

9.1.2 Types of meat

In general meat is categorized into 3 different categories:

9.1.2.1 White meat

White meat is light colored meat. Meat color comes from the pigment called myoglobin. White meat has low myoglobin content. Some examples are poultry (breast), pork, white fish, veal, rabbit, etc. Also, the color of meat also depends on exercised muscles as they need more oxygen and is darker. (Wong, 2021)

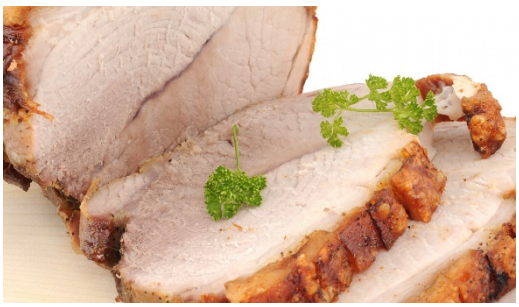


Figure 7: White meat

9.1.2.2 Red meat

Red meat has a higher myoglobin content and is red when raw and dark when cooked. Beef, lamb, mutton, bison, etc. are some examples of red meat. Red meat not only is a good source of protein but also provides iron, creatine, minerals such as zinc, phosphorus and B-vitamins. Red

Figure 8: Red meat

meat has a higher percentage of fats compared to white meat. (Wong, 2021)

9.1.2.3 Game meat

Game meat is the meat hunted for food. It is the wild meat of endangered species not typically raised on farms. Deer, elk, moose, reindeer, wild boar, snake, alligator, rabbit, squirrel, beaver, and birds (pheasant, grouse, quail, wild turkey, wild geese and ducks) are some examples of game meat. It is tougher and much darker in color. (Wong, 2021)

Figure 9: Game meat

9.1.3 Meat and Meat Products from meat industry

Meat can be consumed in different forms. The raw meat from different meat animals can be cooked as per user likings while meat industry also processes the meat into different products. Processed meat is any meat which has been modified in order to either improve its taste or to extend its life. Methods of meat processing include salting, curing, fermentation, smoking, and the addition of chemical preservatives. It generally composed of beef, pork and poultry and it is processed into bacon, ham, sausages, salami, jerky, hot dogs, lunch meat, canned meat, chicken nuggets and meat based sauces. Meat processing includes cutting, grinding or mixing and cooking or salting which prolongs the life of fresh meat. (Wikipedia, 2022)

Figure 10: Processed meat products

9.1.4 Composition of Meat

Meat we eat is made of fibers which is bounded by connective tissues and linked to other groups of muscles and to bone structure. Meat contains 60 to 70% moisture, 10 to 20% protein, 2 to 22% fat and 1% ash depending on type and species. The ash contains minerals and vitamins like zinc, iron, Vitamin A and B-complex. Percentage of carbohydrates is very less in meat. (The BC Cook Articulation Committee, 2013)

No	Chemical Composition	Percentage (%)
1.	Water content	68-80
2.	Protein content	16-22
3.	Fat content	1,5-13,0
4.	Non protein nitrogen	1,5
5.	Carbohydrate	0,5-1,5
6.	Inorganic constituents	1,0
7.	Vitamins	trace

Figure 11: Chemical Composition of Meat

9.1.5 Meat and Health

Meat is a part of a balanced diet which helps to enhance health and provides us with many different nutrients. Protein found in meat and poultry is complete as it contains all amino acids necessary for health. (North American Meat Institute, 2012)

Meat contains iron, which helps to prevent anemia as the body absorbs the iron present in meat than non-heme iron found in vegetables. Similarly, meat also contains iron and zinc as other nutrients. High quality protein in meat prevents muscle loss, weight loss and maintains muscles in the body. (North American Meat Institute, 2012)

Meat also contains calcium, vitamin D, vitamin B-12, protein and omega-3 fatty acids which provides strength to the bones. Meat is the only natural source of Vitamin B12 which helps in brain development in children and helps the nervous system function properly. Meat protein also helps in cardiovascular function and can also help to control blood sugar. (North American Meat Institute, 2012)

Zinc in meat helps in optimal immune function and promotes would healing. Similarly, it also has selenium which helps in cell damage, promotes proper thyroid function and cancer prevention. (North American Meat Institute, 2012)

S.N.	Benefits
1.	Protein diet
2.	Iron rich
3.	Bioavailable minerals
4.	Muscle strength
5.	Bone Strength
6.	Brain Function
7.	Heart Health
8.	Blood Sugar Control
9.	Selenium Rich
10.	Weight Management

Figure 12: Benefits of Meat Consumption

9.1.6 Diseases related to meat

Meat not only helps in enhancing health but also can causes diseases. Overconsumption and unclean meat can cause many different diseases. High cholesterol and excessive red meat can cause heart diseases and stroke. Similarly, it can cause diabetes, obesity as meat protein takes a lot to digest. Packaged food and processed food can cause cancer in long run.

Not only that unclean and uncooked meat can cause bacterial meat borne infections like *Escherichia coli* foodborne infection, Enteroinvasive *E coli* (EIEC) causes a Shigella-like dysentery and other food poisonings. So, proper care must be given before buying and cooking meat. (Ranabhat, 2021)

9.1.7 Meat Culture in Nepal

Nepal is very rich in meat culture. Previously only Newas used to eat buff while it was looked down by higher caste people. While Brahmins only used to consume goat meat and disregard chicken. And, lower caste consumed pig but Brahmins used to consume wild boar as a delicacy. The killing of cows was outlawed nationwide by the Hindu Shah king in 1805 so, beef is banned in Nepal. Similarly, Thakalis abstain from eating yak but it was commonly consumed by neighboring communities. (Khanal, 2020)

Today, thing have evolved and with the changing society, new generations have challenged the conventional notion of what to eat and what not to according to the caste. And, every caste eat meat as per their likings irrespective of the past cultures. (Khanal, 2020)

9.1.8 Animal Slaughterhouse and Meat Inspection Act, 2055(1999)

Some of the major highlights of the Slaughterhouse and Meat Inspection Act are as follows:

- "Animal" means castrated or castrated goat, sheep, Himalayan goat (Chyangra), pig, wild pig, he buffaloes or rabbit the females of buffalo, goat sheep, Himalayan goat, pig, or rabbit which are fit for meat other than a cow, an ox a bull, and this word also includes poultry, ducks, pigeon or other species of beasts and birds kept for meat purpose.
- Nobody shall establish a slaughterhouse or become a meat seller without obtaining license under this Act.
- A person or an organization interested to establish a slaughterhouse or selling of meat shall have to apply for a license in the prescribed format to the prescribed officer.
- In order to examine animal and meat, the Government of Nepal may appoint or designate a person who is at least a graduate in veterinary science as a Meat Inspector.
- Any animal to be slaughtered shall be produced for ante-mortem examination at the slaughterhouse where such place is established and where slaughterhouse has not yet been established at the site as specified

by the Meat Supervisor. The procedure for examination of animal shall be as prescribed.

- The Meat Inspector shall have to affix clearly visible stamp or mark as prescribed at the time of giving permission for the sale of meat after the post mortem examination of meat of the animal.
- No sale of meat shall be made by deceiving the species of animal or by adulterating meat of one species of animal with other species of animal. (Animal Slaughterhouse and Meat Inspection Act, 2055)

Although, the law has been formulated it hasn't been implemented and unchecked meat industry is causing serious damage to the general public.

9.2 Slaughterhouse

Slaughterhouse or abattoirs as it is called is a facility where meat for general public is prepared.

9.2.1 Introduction of Slaughterhouse

Abattoir or simply called Slaughterhouse is a licensed authority for production of meat, meat products and slaughter by-products in a large scale. It is a place where animals reared on farms are brought and humanely slaughtered for consumption. Modern abattoir is a slaughterhouse where animals are slaughtered under humane and hygienic conditions for production of healthy and safe meat for consumption. People feel bad about the open animal slaughter. So to obviate the stigmas related to the animal slaughter a healthy humane system catering to handle whole process in hygienic and methodological way is a must. This is the very reason why rethinking a healthy meat plant which integrates carcass cutting, production of custom-designed lean cuts, proper packaging and dispatch to consumers is in dire need.

9.2.2 Types of Slaughterhouses

Slaughterhouses can be characterized into many types as per facilities and as per the killings occurring per day.

9.2.2.1 Types of Slaughterhouses (as per facilities)

1. Traditional Type

In traditional slaughterhouse, the slaughter of animals generally takes place inhumanely within the household or certain open space. In this facility, all the cutting and cleaning process takes place in manual manner and is not much hygienically clean as the chemical composition of meat and bacteria present there is rarely tested.

Figure 13: Traditional Type

2. Semi-modern Type

In this type there is a presence of facilities for slaughter and bleeding of stunned animals. This process generally takes place on the clean floor inside the meat plant but the dressing, washing, halving and quartering takes place on the rails in hoist position where skilled workers extract the meat from the animals. This facility is clean and more systematic than the traditional type but it doesn't care for the waste produced.

Figure 14: Semi-modern Type

3. Modern Type

Modern abattoir is the most systematic of them all. It is where the scientific and hygienic slaughtering of animals with proper waste management as per pollution control norms and compliance of environmental laws occurs. Not only that it ensures the supply of safe and hygienic meat to the consumers with minimum manual handling and also cares for the environment by treatment of wastes produced.

Figure 15: Modern Type

9.2.2.2 Types of Slaughterhouses (as per slaughter per day)

According to the classification by the Municipal Corporation of Delhi,1990, the abattoirs can be sub divided into 3 different types as per the killings that takes place inside the abattoirs.

A. Small Abattoirs

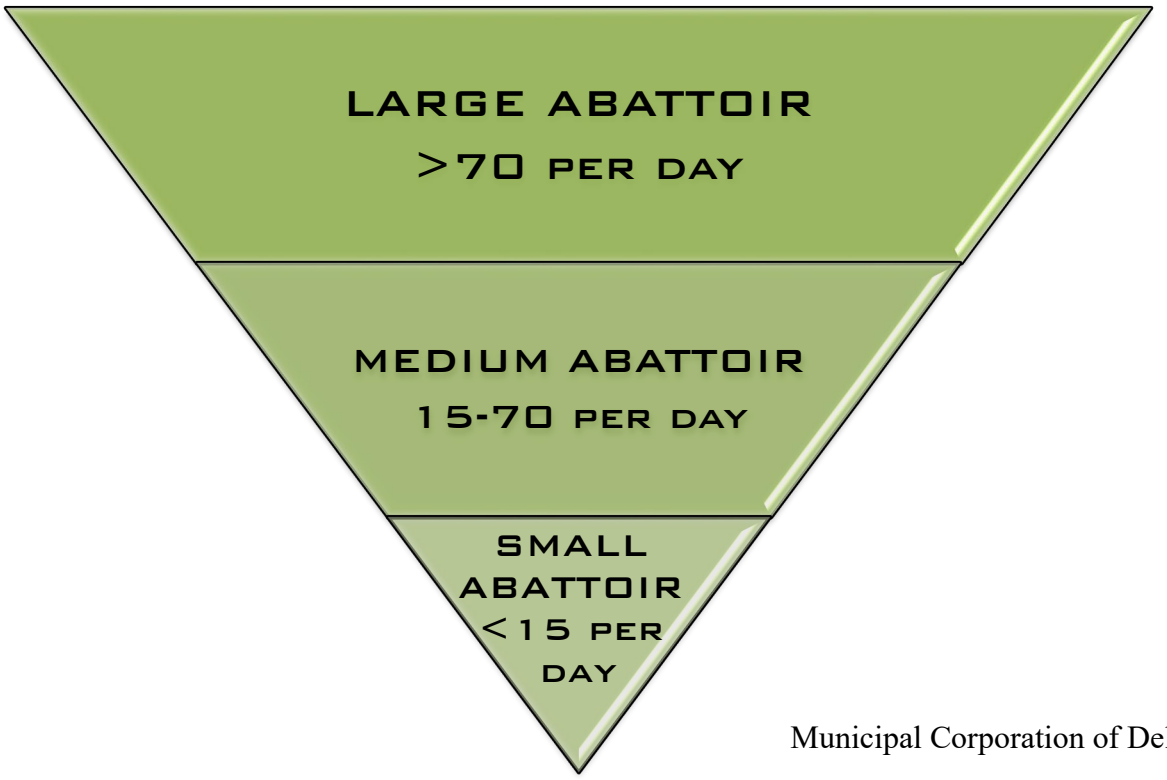
It is a facility where less than 15 carnage occurs per day.

B. Medium Abattoirs

In this facility about 15 to 70 carnage occurs per day.

C. Large Abattoirs

Large abattoir is a facility where more than 70 slaughter occurs and its production is in a very large scale.



Municipal Corporation of Delhi,1990

Figure 16: Types of Slaughterhouses (as per slaughter per day)

9.2.3 History of Abattoirs

9.2.3.1 On Global Context

Abattoir has persisted to exist since the start of settlements as people used to kill animals and turned them into meat. Previously, the slaughter used to occur in diverse locations such as backyards of houses. But the officials prohibited this as it was difficult to inspect every meat selling places in US by the end of 18th century. Due to these only licensed areas could sell meat and it was easier for public inspection (Fitzgerald, 2010).

The present form of Abattoir is a product of the modern industrial era with the start of nineteenth century. At first there were private slaughterhouses and due to the demands more centralized form of it was in need. Modern Abattoir story starts from Paris in 1867 where George Eugene Haussman erected the Central Slaughterhouse of La Vilette, the largest in France. It was Called Les abattoirs de la Vilette which was connected with railway for transportation of animals. It became high mark in the architecture of the abattoirs which influenced other offspring in Europe and other places in the world. (Giedion, 1948)

While in America, due to rapid expansion of Chicago there was a huge problem of slaughterhouses. So, the Union Stock Yards was created during Christmas 1865 which was the largest cattle market in the world covering 120 acres of pens (Giedion, 1948). It became home to many workers and soon slum like condition emerged with crowded and in poor condition related with slaughter process. Later

this era was replaced by the European "Public Abattoir "model nearly after 100 years. In 1960s the new era of industrial meat houses took over US as the slaughterhouses were integrated with rest of the industrial praxis and the working system became more mechanized. (Fitzgerald, 2010)

At first the slaughter used to occur far away from the consumers but later the animals were reared on the countryside and were brought to city for slaughtering and consumption like today. (Giedion, 1948)

In the beginning, the slaughter took place in a separate place while freezing and packaging took place on a different place. But around mid-19th century, it started to take place under the same roof. And with the introduction of refrigerator car in 1870s the meat used to be transported all over US. (Fitzgerald, 2010)

In the later part of the 20th century, most of the U.S. slaughterhouses was influenced by the work of Dr. Temple Grandin where she suggested to reduce the stress of animals being led to slaughter by designing pens and corrals, a single file for slaughter also a long sweeping curves for animal concentration to just front of it with reduced noise at the end point. All these were done to encourage animals forward in the chute.

Still the process is the same but there has been improvement in techniques with the advancement of modernity. Similarly, different technologies are helping in meat, its chemical composition as per suitability of human health and also rechecking of meat and its products to be bacteria free and healthy and safe for consumption.

9.2.3.2 On Nepalese Context

Nepal is an agricultural country. As per a study it suggests that around 68% of household has ownership of cattle or other animals in one way or the other (Acharya, Acharya, & Wilson, 2018). So, livestock contributes around 11.5% of total GDP in Nepal. (Poudel, Dahal, Upadhyaya, Chaudhari, & Dhakal, 2020)

Livestock species	Percentage of households owning	Mean number of animals in unit	Percentage of males in species
Cattle	68.0	2.82	56
Buffalo	49.0	1.90	22
Yak and yak-cattle crosses	0.2	7.84	33
Goat	70.0	4.67	31
Sheep	3.0	6.32	34
Pig	13.0	1.84	–
Horse	0.3	1.84	–
Donkey/mule	< 0.1	4.35	–
Rabbit	0.2	3.88	–
Indigenous domestic fowl	52.0	8.60	13
"Commercial" domestic fowl/[a]	3.0	103.71	–
Duck	3.0	3.95	–
Pigeon	5.0	8.73	–

Note. /a = broilers outnumber layers in the ratio 2.5:1.
Source: Adapted from CBS (2014), MOAD (2013), Sherchand (2001).

Figure 17: Table showing animal husbandry in Nepal

(Acharya, Acharya, & Wilson, 2018)

The animals that are available for human consumption is then converted into meat. In Nepal as the study suggests the slaughter of animals used to and till date still takes place in open areas like backyards, village courtyards under the open sky where the animal is beheaded by Khukuri then the animal hide is skinned off, cleaned with well water and the carcass is chopped into pieces and then sold to customers. There is no examination of meat and its composition. Due to this very reason the presence of *Echinococcus, Faciola spp. and Taenia saginata* is found in meat which causes various diseases. (Bajracharya, 2009)
Slowly there can be seen a change in people about their eating habits. Now such open slaughter has been reduced and there is a culture of cold-stores in cities and towns. In urban towns the animals are slaughtered in cold-stores instead of open grounds but still cleanliness and disease-free meat remains a big concern.
There are only 8 registered modern slaughterhouses but only 3 are in operation (Livestock Market Promotion Directive Inventory, 2073/074). The condition of the slaughterhouses is quite a concern regarding the meat it serves to the common public. So, the need for Modern Meat Plant in a city like Kathmandu and all over Nepal is must keeping in mind the health of the people and public demand it should cater to.

9.3 Meat Demand in Nepal

Nepal's poverty rate is reducing day by day and people are caring about their nutritional level. This is the very reason that Nepalese people are eating more eggs and meat per capita than ever before. Previously meat was a luxury food item for festivals and weekends but it has enhanced Nepalese kitchens almost daily. (Kumar, 2021)

Nepalis consumed 552,000 tons of meat in 2020 up from 357,000 tons the year before. So, the consumption is ever increasing. The average per capita consumption of meat in Nepal has reached 18 kg per year from just 6 kg per year in 1970s. UN has set 14 kg annual per capita meat consumption as the minimum requirement for a balanced diet. (Kumar, 2021)

Almost 700,000 kg of chicken meat is consumed daily throughout Nepal where Kathmandu valley eats half of it alone making poultry meat 46% of total meat consumption in Nepal. Nepal is now eating 552,000 tons of meat, 91,000 tons of fish and 1.62 billion eggs annually. The country produces meat worth Rs 275 billion, milk worth Rs 122 billion, fish worth Rs 37 million and eggs worth Rs 17 billion per year. (Prasain, 2021)

Not only in meat, Nepalis are now consuming 55 eggs per year per capita compared to UN threshold of 48 eggs per year. Due to this very reason poultry farms are increasing exponentially in numbers. There are almost 340 hatcheries providing employment to more than 500,000 people. Poultry meat is popular as it cost 3 times less than goat meat making it most consumed meat.
Not only that there has been increase in production of goat meat as it has increased to 71,000 tons per year. (Kumar, 2021)

The meat consumption scenario of Nepal shows that the poultry meat covers 46% of total annual meat consumption with buffalo making up 33%, goat meat 17% and pork at 4% of total consumption. Due to this massive consumption the malnutrition among children in Nepal has decreased from 56% in 1996 to 36% in 2016 further to 31% as per Central Bureau of Statistics. The protein rich diet has increased average nutrition levels. (Kumar, 2021)

Nepal is being self-sufficient in meat production which is improving the country's economy. And the huge demand of meat, fish and eggs per consumption shows that there is a huge base for a modern slaughterhouse to flourish in Nepal.

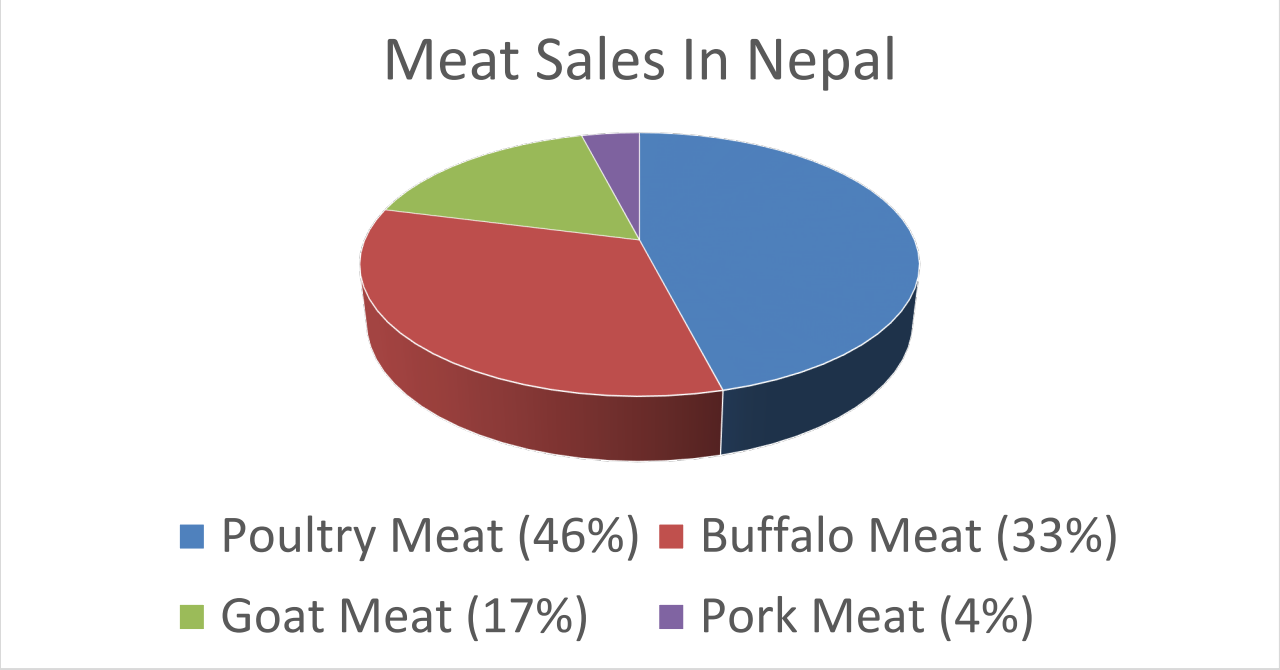


Figure 18: Meat Sales in Nepal

9.4 Major issues in Meat in Nepal

Meat consumption is widespread in Nepal but it is one of the most unsafe and unhygienic food items sold in market without proper check and review. And no such meat and meat products standards have been found in Nepal. Government of Nepal has formulated the Animal Slaughterhouse and Meat Inspection Act 1999 and regulation 2001 but it hasn't been implemented properly. (Bajagai, 2012)

Scientific study shows prevalence of meat borne zoonotic diseases in Nepal. In a study 11.4% of meat showed presence of *Salmonella* species which causes food poisoning. Similarly, many meats borne parasitic zoonoses like *Trichinellosis, Taeniasis, Echinococcosis/Hydatidosis* etc. were found in meats from different parts of the country. (Bajagai, 2012)

The Meat Inspection Act prevent adulteration and contamination of meat during and after slaughtering and secondly to ensure slaughter of healthy animals without diseases. This law has compulsory provision for ante mortem inspection of animals and its carcass by qualified meat inspector and marks it with stamp for healthy meat. But the enforcement of law has failed miserably due to lack of awareness of

stakeholders about Good Hygienic Practices (GHP) and also due to turbulent political situations. (Bajagai, 2012)
The country lacks infrastructure and human resource to implement food safety. There are no adequate modern abattoirs in the country and even the existing ones are not being operated satisfactorily. The butchers buy animals and kill and sell meat by themselves without being aware about the importance of good slaughtering facilities and health of the customers. Still the dirty water is being used for slaughter, selling meat in open and non-refrigerated places and contamination of meat by different micro-organisms are some of the unhygienic practices. Due to this the quality of meat is not satisfactory for wholesome consumption. (Bajagai, 2012)

Figure 19: Traditional Meat Store in Nepal

9.5 Need of Slaughterhouses in the World

The world population is expected to reach nine billion by 2050, and thus an increase in protein demand and production is likely to occur (Tomlinson, 2011). So the demand for meat is ever increasing. This is the reason the meat production system is likely to become industrialized to optimize efficiency, decrease cost, improve food safety and provide constant homogenous meat products. The local or regional abattoir are 'Zero Kilometer' supply where it caters to the local people in food chain and where calves are born, finished, slaughtered, processed and consumed nearby. Local Cattle can graze more and distance is less whereas the industrial one have more optimized process and safety but the distances and the conditions for cattle are cold. (López, et al., 2022)

"Over 65 billion land animals are killed for food each year a number that is only rising." (López, et al., 2022)

9.6 Need of Slaughterhouse in Nepal

So to solve all the related issues a proper facility with meat inspection, quality check and assurance and hygienic meat products is a must in city like Kathmandu. Slaughterhouses provide an opportunity for inspection and evaluation of fitness for

human consumption as it allows checking the live animals on arrival (ante mortem inspection) as well as the carcasses and other parts such as organs of slaughtered animals (postmortem inspection).

The traditional method produced a lot of blood and animal wastes and created a foul smell along with pollution. The existing meat plants are lacking basic facilities like water, electricity, ventilation, drainage, ceramic flooring, overhead rails and waste disposal. Similarly, the meat produced are flowing in market without a proper check.

Figure 20: Traditional Method of Cruel Slaughter

It is therefore necessary to establish modern slaughter-houses to bring improvement in meat handling process, recovery and utilization of by-products and waste treatment for pollution control to provide wholesome and safe meat to consumers with contribution to environment. Not only that it must be equipped with the basic facilities along with humane and hygienic slaughter of meat animals.

9.7 Abattoir Process

The abattoir process involves to processing of meat animals from farm to fork and all the steps involved within. The general processing steps are as follows:

Figure 21: Flow diagram of essential abattoir processing steps.

- Transportation of Animals

When meat animals reach market weight, they are then transported from farm to abattoir by trucks. The animals are then held in lairage for few hours, then processed in the abattoir as in the flow chart. While poultry, birds are processed in a poultry processing plant, where they are scalded, eviscerated, washed and chilled. (Guo, et al., 2015)

- Inspection

Ante-mortem inspection is done to check the health-related condition of the animal and only the healthy animals are allowed to be slaughtered for human consumption. (Guo, et al., 2015)

- Stunning

Now, the animals are stunned either by electrical shock or carbon dioxide after which they are hoisted by one leg for bleeding. The purpose of bleeding is to kill the animals with minimal damage and to remove blood. The jugular vein is severed and blood is drained from the animal. (Guo, et al., 2015)

- Skinning

After slaughter, the hide of ruminants (cattle, sheep and goats) is removed mechanically through a skinning process. A scalding process is used to remove the hair and feathers of pigs and poultry followed by mechanical de-hairing and de-feathering process. Pigs are scalded in warm water (57.7 to 61^0 C) for about 3 to 8 minutes to loosen the hair, whereas chickens are scalded in warm water (51 to 64^0 C) for a short time (30 to 120s) to remove the feathers. (Guo, et al., 2015)

- Singeing and Polishing

Following de-hairing, the surface of the livestock carcass is exposed to a very high temperature (800 to 1000^0 C) by singeing. It is a burning-off process to remove most of the surface contamination (dirt and fecal material) as well as to reduce the bacterial counts on the carcass surface. Then it is polished by a device to remove to superficial burnt skin. (Guo, et al., 2015)

- Evisceration

Now the head of the animal is removed for evisceration. This process is used to open up the belly and remove the viscera. Since both the interior and exterior surface of the carcass can be contaminated by the intestinal contents, so evisceration is important. The instruments used should be sanitized in hot water hotter than 82^0 C for a few seconds or can be sanitized by chemical disinfectants such as trisodium-phosphate, polyphosphates, hydrogen peroxide, organic acid, chlorine, and isopropyl alcohol. These are done to prevent *T. gondii* tissue cysts to be transferred from one organ to another. (Guo, et al., 2015)

- Splitting

After evisceration, the carcass is split into half through a mechanical saw which is cleaned after every split. Now, carcass dressing is done where Kidney are removed

and then a final washing is done to remove further dirt and blood on the carcass. (Guo, et al., 2015)

- Chilling

The carcass is then stored at low temperature to remove the heat from the carcass and ensure the quality of meat. There are three types of chilling system that are used in commercial abattoirs: conventional chilling, spray chilling and blast chilling. Conventional chilling cools the carcass to approx. 1^0C for 24 hrs. Spray chilling uses cold water (1 to 5^0 C) for a period of 10 hrs to meet the target temperature. Blast chilling is the most effective and fast as it involves exposing the carcass to circulating cold (-20 to -40^0 C) air. (Guo, et al., 2015)

- Deboning and Meat Fabrication

The meat after chilling is subjected to post-mortem inspection and then to further after 24-96 hr of chilling, deboning or cutting where slaughter facilities perform fabrication which involves breaking the carcass into large cuts (primals), smaller cuts (subprimals), potion cuts, and retail cuts. (Guo, et al., 2015) The primals can be stored up to 6 weeks in vacuum packs under anaerobic conditions. (Nastasijević, Lakićević, & Petrović, 2017)

- Packaging and Transport

The carcasses should be such chilled so that the temperature throughout the meat is <7^0C. This is done to retard bacterial growth. For trade and export the products are either chilled or frozen form at cold temperatures. During the meat distribution(transportation) route to the final user- wholesale cold storage or retail, the cold chain must be maintained. Industrial trucks must maintain targeted temperature through the power of compressors, ventilation and insulation as well as energy with good refrigerated system to maintain the required temperature of meat/offal at all times. (Nastasijević, Lakićević, & Petrović, 2017)

The special focus should be put on temperature consolidation/deconsolidation during meat handling (e.g. daily transfer of meat cuts from the chilling chamber to the retail cabinet where internal temperature of meat cuts should be at all times < 7°C). The management approach that dominates in the meat market is related to the principle “First in – First Out”. This is to prevent shrinkage, rotting, trim loss, odor and color change in meat. (Nastasijević, Lakićević, & Petrović, 2017)
However, if stored as per the enhancement of shell life, the meat can be stored for long periods. The vacuum-packed chilled storage (two weeks for beef and lamb, at 4^0C and up to 30 weeks for beef at -0.5^0C and 7 weeks for lamb at -1.5^0C) and also upto 1 yr at -18^0C. (Nastasijević, Lakićević, & Petrović, 2017)

There are several available options for control and management of the cold chain, such as chilled and frozen storage combinations, super chilling, ionizing radiation, bio preservation, high hydrostatic pressure (HHP), active packaging, wireless sensors, supported with the software-based cold chain database (CCD) for packaging and transporting the products to the users. (Nastasijević, Lakićević, & Petrović, 2017)

Fig. 1

Flow chart of slaughterhouse

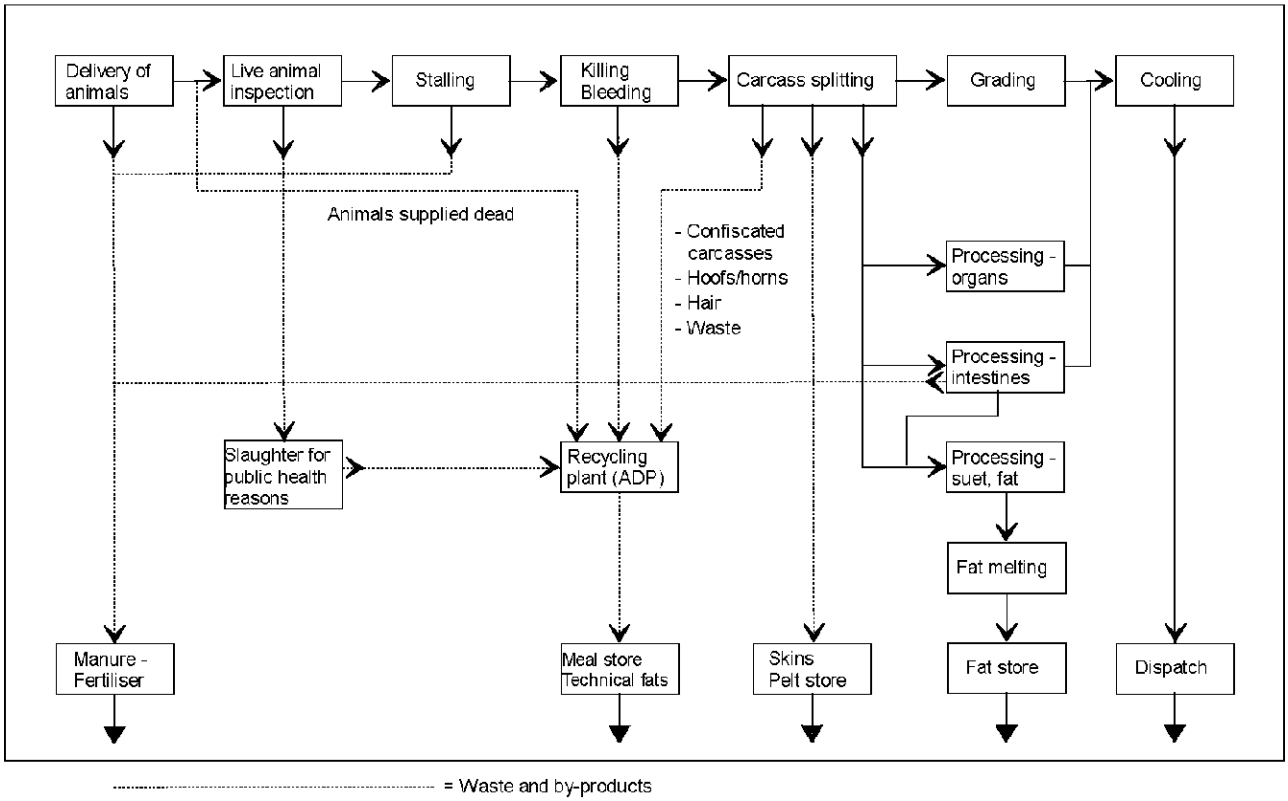


Figure 22: Flow Chart of Slaughterhouse

9.8 Meat Products and By-products Processing

9.8.1 Meat Products Processing

Fig. 3

Flow chart of a meat product factory

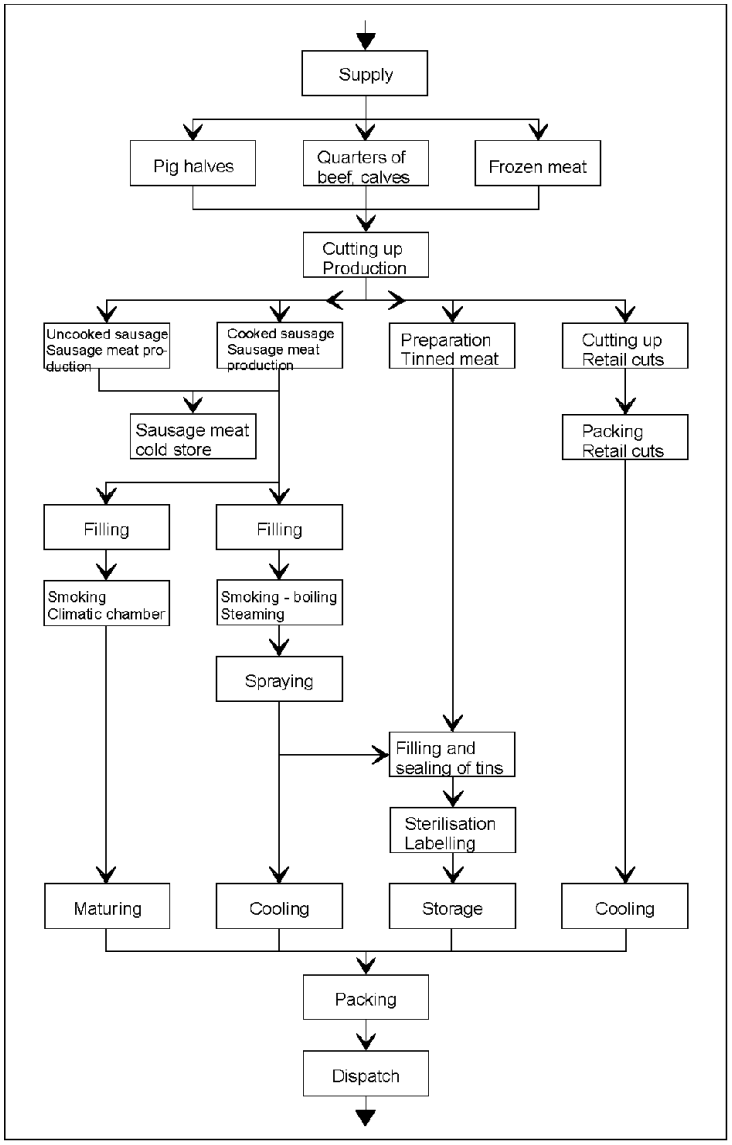


Figure 23: Flow chart of a meat product factory

The meat processing is all about cutting the meat, inspecting it to ensure it is safe for consumption, packaging it and processing it into different products like sausage, lunch meat and delivering it to the stores. It involves taking the meat in its raw form and turning it into another product that is marketable, safe for consumption, and attractive to consumers. Some processing steps are:

- Vacuum Packaging
  Bacteria requires oxygen to grow. So, the meat is vacuum-packaged which extends its life too approximately 100 days. It also minimizes the oxidation of unsaturated fatty acids and slows the development of rancid meat.

- Canning
  It involves sealing meat in a can and heating it to destroy all the microbes. Canned products can be stored under a room temperature.

- Drying
  It removes moisture from meat products so that microbes can't grow so the meat is dried from 50 to 80^0C for hours. Dry sausages, freeze-dried meats and jerky meat products are the examples of dried meats.

- Fermentation
  It involves adding of harmless bacteria to meat. These bacteria produce acid as they grow, lowers pH of the meat and inhibits growth of other pathogenic microorganisms. This process develops color, flavor and texture.

- Irradiation
  It is a pasteurization method accomplished by exposing meat to doses of radiation. Radurization as it is called is effective as heat pasteurization in killing microbes. Here, the meat is exposed to high-energy ionizing radiation produced by electron accelerators or exposure to gamma-radiation-emitting substances such as cobalt-60or cesium-137. This meat still requires refrigeration and packaging.

- Curing and Smoking
  It is the oldest meat preservation method. They enhance meat life, color and flavor. While curing involves addition of salt, nitrite, phosphates, antioxidants, flavorings and other preservatives. It improves meat color, juiciness of meat and also the water-holding ability.
  Smoking after curing decreases moisture on meat surface, prevents microbial growth and spoilage. Smoking can be hot smoking, warm smoking and cold smoking. Cold smoking is often used to produce raw or fermented sausages, and meat is smoked between 12 and 25^0C for a time ranging from several hours to 16 days. Warm smoking is carried out at 23 to 45^0C for 4 to 48 h. Hot smoking can be divided into different stages: treatment at 40 to 50^0C for 30 min without smoke in the first stage, followed by several stages of smoking that bring the internal temperature of meats to 68 to 72^0C. Antimicrobial and aromatic compounds, such as organic acids, phenols, and carbonyls, are often added during smoking; this lowers the pH of the meat products.

- Mixing
  In this process, meat ingredients are combined together that may be homogeneous or heterogeneous. Here a stuffing mixer is used where mix of

raw meat particles of different sizes are stuffed and produces meat products like dry sausages, meat granules or meatballs and so on.

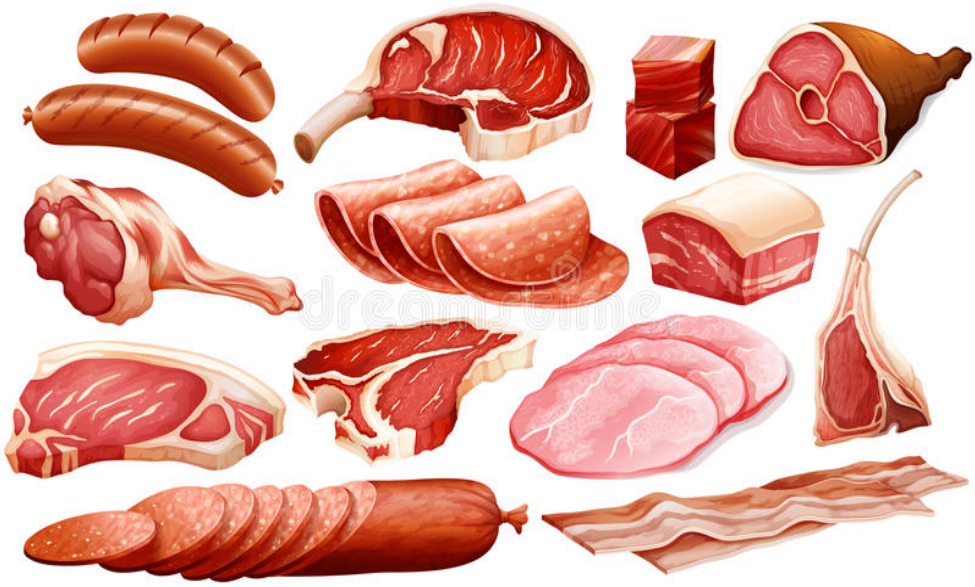


Figure 24: Various Meat Products

9.8.2 By-products Processing

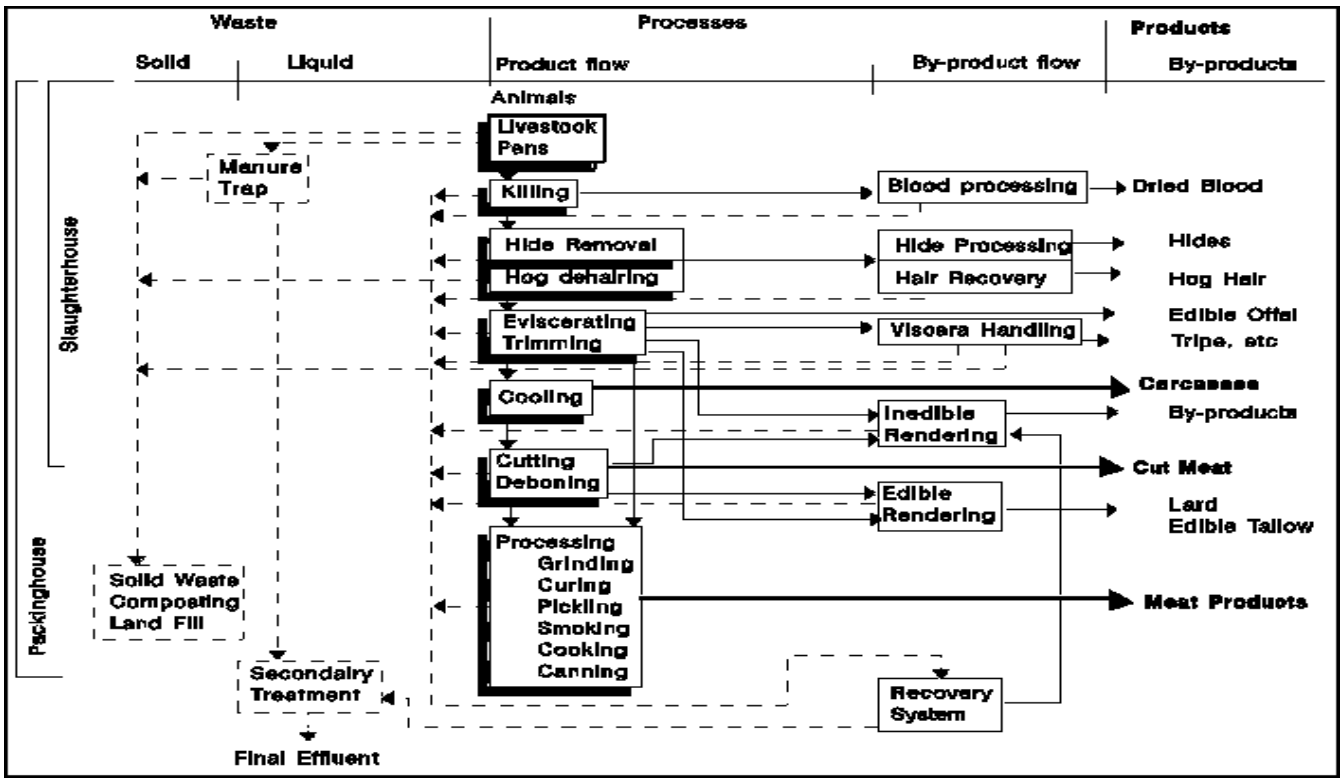


Figure 25: By-products Processing

Abattoir not only contributes in meat products; it can contribute a lot by by-products as they have a commercial value. These by-products not only contribute financially but also helps in environmental perspective.

By-products from livestock slaughter include (Ockerman and Hansen, 2000):

- edible offal for human consumption;
- edible fats for shortening, margarine, sweets and chewing gum;
- bone utilized in soup for human consumption, mixed with potter's clay, or the manufacture of buttons, knife handles and bone meal;
- blood for human consumption and for animal feed, pharmaceuticals and food additives;
- glycerin for numerous industrial uses, such as nitroglycerin, ointment bases, solvents, food preservatives and plasticizers;
- intestines for sausage casings, the strings of musical instruments and surgical ligatures;
- gelatin for confectionery items, ice cream and jellied food products;
- rennin for cheese making; numerous pharmaceutical products;
- livestock feed (usually high in protein, fat and minerals); pet food and feed for fish farming;
- hides and skins for use as fur, leather or leather goods;
- inedible fats for use in industrial products such as tires, lubricants, insecticides and germicides;
- hair for brushes, felt, rugs, upholstery, plaster binding and insulation; and glue

Blood can also contribute in blood sausages and other products for human consumption, for animal feed, fertilizers, glue, pharmaceuticals and food additives (emulsifiers, stabilizers, clarifiers, nutritional additives, egg albumin substitute). Other edible by-products include cheeks, head trimmings, lungs, spinal cord, breast fat and stomachs and cattle paunches. These are commonly sent to other facilities for the manufacture of animal feed, including pet food. (Pollution Prevention Services InfoHouse, 2018)

Figure 26: Various By-products from Pig

9.8.3 Rendering

Rendering is a heating process for meat industry waste products where fats are separated from water and protein residues for production of edible lards and dried protein residues. In this process the dead animals and its products are recycled into human food to biodiesel. Heads, hooves, bones, blood, offal (internal organs) and anything else that cannot be used ends up in rendering plant. (Morgan, 2022)

Meat by-products, chicken fat, cattle fat, lard, fish oil, fish meal, bone meal, and tallow are examples of rendering used for human use. Ales contain esters, which also arise from rendering. Many foods, flavorings, and pharmaceutical preparations contain tallow. Crayons, soap, and wax products are examples of non-edible tallow products. (Morgan, 2022)

Toothpaste, nasal sprays, shampoos, lotions, and ointments are a few examples of additional finished goods. Other products that come into close touch with people include toys, rubber goods, plastics, and solvents. Anything that contains glycerin, linoleic acid, oleic acid, steric acid, tallow, meat, or bone meal is a product from a rendering facility. (Morgan, 2022)

Edible rendering process requires heating the products and 2 steps of separation. At first the solids are separated from liquid and fat and in second fat and water are separated. While in inedible one, the materials are grounded, fat is removed which is called dry-rendered tankage which helps to produce bone meal. (Morgan, 2022) Rendering in general helps to recycle waste into useful products and contribute to the environment and also economically. (Morgan, 2022)

Inedible by-products, such as fat, bones, hoofs, condemned offal and dead carcasses are rendered into tallow (derived from both cattle and sheep fat) or lard (derived from pig fat), and meat and bone meal. Tallow and lard have numerous applications and meat and bone meal are used predominantly as animal feed supplements. Rendering can take place either on site or at independent rendering plants. (Pollution Prevention Services InfoHouse, 2018)

Animal hide is one of the most valuable by-products from meat processing. Hides are converted into a variety of consumer goods, in particular shoes, bags and clothing. However other parts of the original hide can be recovered for use in the manufacture of cosmetic ingredients and medical prosthetics. At abattoirs, hides may be chilled or salted and sent directly to the tannery. Alternatively, fleshing may take place at abattoirs to recover the meat trimmings and fat from the hides before they are sent to the tannery for useful by-products. (Pollution Prevention Services InfoHouse, 2018)

9.8.4 Spaces flow in Abattoir

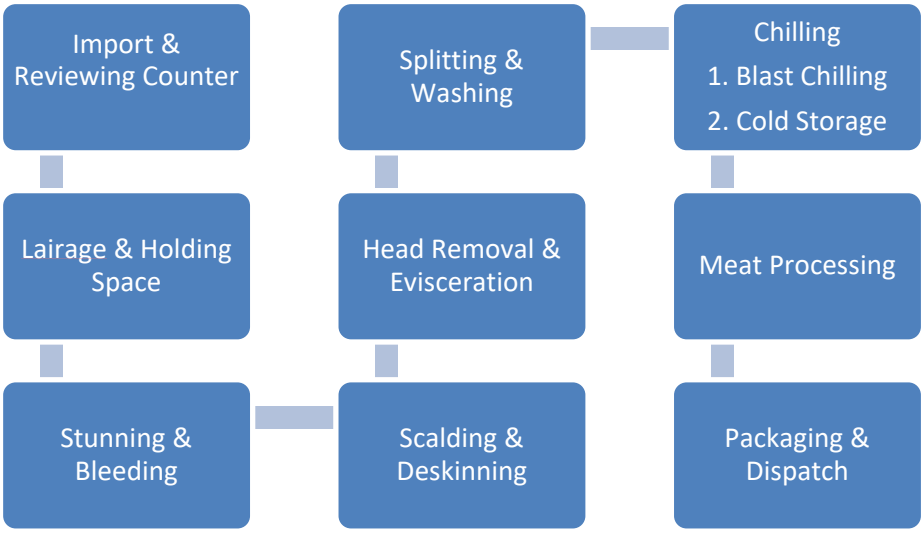


Figure 27: Spaces Flow inside Abattoir

9.9 Instruments Used

9.9.1 Inside Slaughterhouse

Modern slaughterhouse has automated processing equipment. They help in efficient and healthy extraction of meat. Some of them are as listed below: (Hightop Poultry Equipment, 2021)

A) Living Poultry Killing and bleeding unit

9.9.2.1.1 Poultry killing and bleeding automatic overhead conveyor rail

9.9.2.1.2 Closed-type poultry scalding machine

9.9.2.1.3 Automatic claw-removing machine

9.9.2.1.4 Horizontal type plucking machine

9.9.2.1.5 Poultry carcass receiving trough

9.9.2.1.6 Automatic un-loading device for claws

9.9.2.1.7 Automatic cleaning machine for hooks

9.9.2.1.8 Standard-type trolley

9.9.2.1.9 Frequency conversion electric controlling cabinet

B) Evisceration unit

1. ***Poultry evisceration automatic overhead conveyor rail***

2. *Viscera sliding trough*
3. *Spraying-type carcass cleaning machine*
4. *Standard-type trolley*
5. *Normal electric controlling cabinet*

C) Poultry carcass pre-cooling, de-boning and packing unit

1. *Poultry carcass spiral-type pre-cooling machine*
2. *Poultry carcass receiving trough*
3. *Poultry carcass de-boning and packing automatic overhead conveyor rail*
4. *Poultry carcass de-boning belt conveyor*
5. *Carcass de-boning table*
6. *Half carcass cutting machine*
7. *Packaging table*
8. *Dual-chamber type vacuum packaging machine*
9. *Normal electric weighing scale*
10. *Plate-type electric weighing scale*

D) Auxiliary equipment and installation material unit

1. *Knife sterilizing and hand washing device*
2. *High pressure gun*
3. *Poultry slaughtering plant installation material*

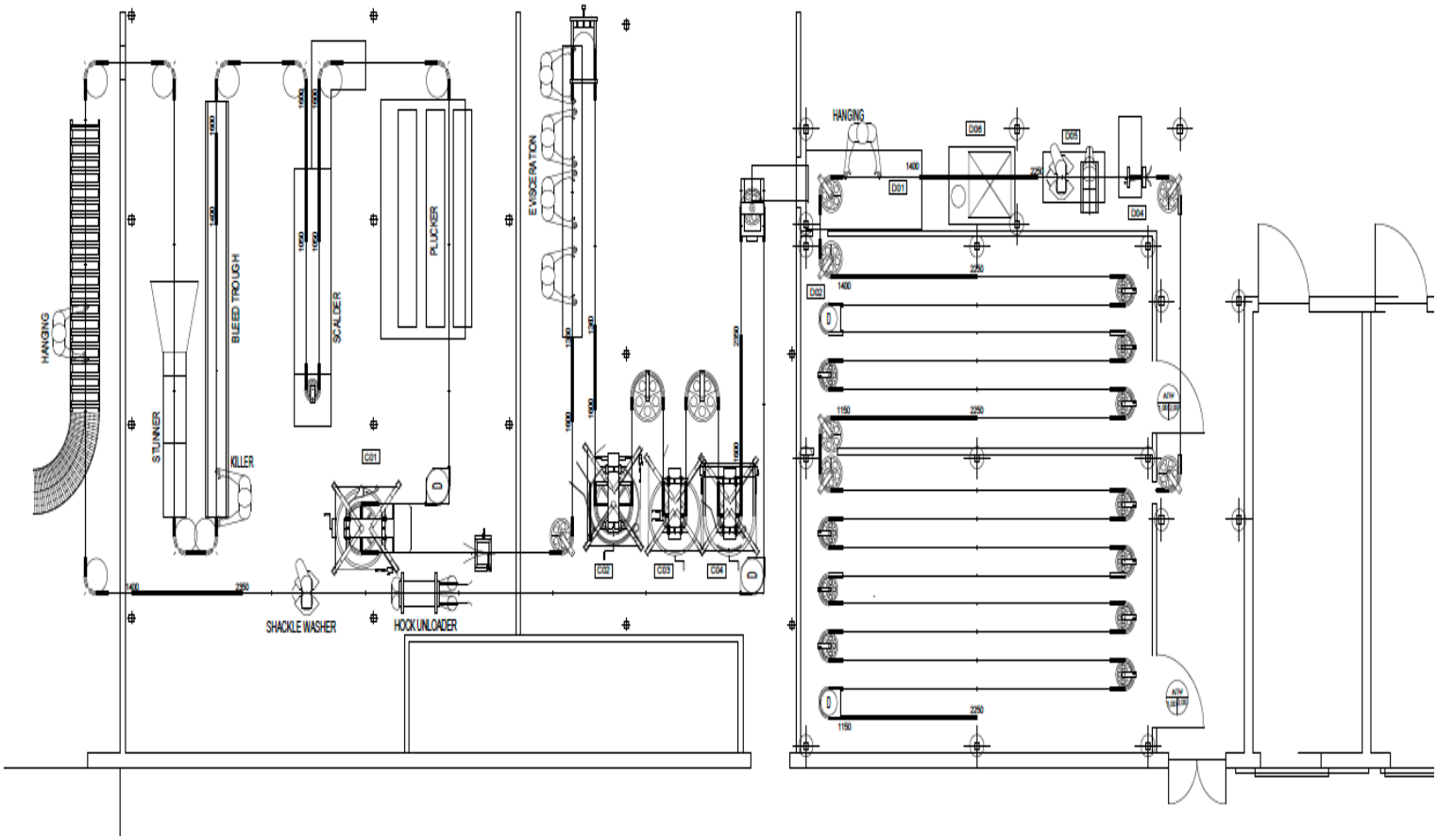


Figure 28: Equipment and Flow inside an Abattoir

Figure 29: Technological Flow Sheet for Poultry Slaughtering and Processing

Figure 30: Hanging Conveyor

Figure 31: Stunning Machine

Figure 32: Bleeding Table

Figure 33: Scalding Machine

Figure 34: Claw Removal Machine

Figure 35: De-feathering Machine

Figure 36: Head Removal Equipment

Figure 37: Bird Washing Machine

Figure 38: Leg Cutter

Figure 39: Chillers

Figure 40: Bird Wash & Drying Machine

Figure 41: Electrical Board

9.9.2 Inside Meat Processing Plant

A) Meat Tenderizer

It is a powered tool used to tenderize slabs of meat in the preparation for cooking.

Figure 42: Meat Tenderizer

B) Sausage Calibration Unit

A sausage is a type of meat product usually made from ground meat—often pork, beef, or poultry—along with salt, spices and other flavorings. The meat is grounded and flavored and given shape as per the casings. This instrument can also be used to prepare salamis.

Figure 43: Sausage Calibration Unit

C) Raw sausage maturing chamber

Once the sausages are prepared, they are taken to maturing chamber and cooked under certain temperature and pressure for a certain amount of time.

Figure 44: Raw Sausage Maturing Chamber

9.10 Meat and Architecture

There has always been a negative sense about slaughterhouses. As described by Paula Young Lee as “culturally suppressed as embarrassing necessities, massive in scale but without symbolic monumentality”. The slaughterhouse is especially reviled, for its sole purpose is to kill, producing serial death as well as saleable meat so, it must be completely removed from all ambitions to architecture and

ornamentation to avoid high costs. This was the general consensus about slaughterhouses and its design. (Wiles, 2014)

But with modernism, slaughterhouses are designed on desired site layout and is subjected to clean design as it is the sign of hygiene. The "three requirements in a slaughter-house" are "Air – Light – Space". Slaughterhouses were meant to look anonymous, so rarely is much thought given to their exterior design. Yet those lines of suspended carcasses played a fundamental role in the birth of modern architecture. And it is designed as a landmark of what we are eating. So, neat and clean contemporary style is a must as "Meat is modernism". (Wiles, 2014)

9.10.1 Urban Market Space

Urban market spaces are a proper space in city fabric where different infrastructures are present such that city people can cope with their necessities harmoniously in their daily lives. Major components of the space are buyers, sellers, products, back end, front end, infrastructures and support services. The main advantage of market space is that it is convenient for the consumers as they do not have to travel from one market place to another in search of the products they require. The space flow and spaces generated is what comforts the users in it as they meet up with other customers and creates a sense of social bonding inside the space. Similarly, improved public services will help in better quality of life. (Bhasin, 2020)

9.10.2 Meat Mart

Meat mart is one such retail market space in urban fabric which offers a quality range of fresh meats and processed meat products at very competitive prices with dedicated experts offering a great service. It is an ease of access to consumers as customers can choose the products as their liking in one place. Similarly, it is greatly arranged marketspace as it has all sorts of hygienic practices and regularly sanitized environment. It doesn't show the sight of live slaughter as opposed to wet markets present in today's condition. (myAyan, 2022)

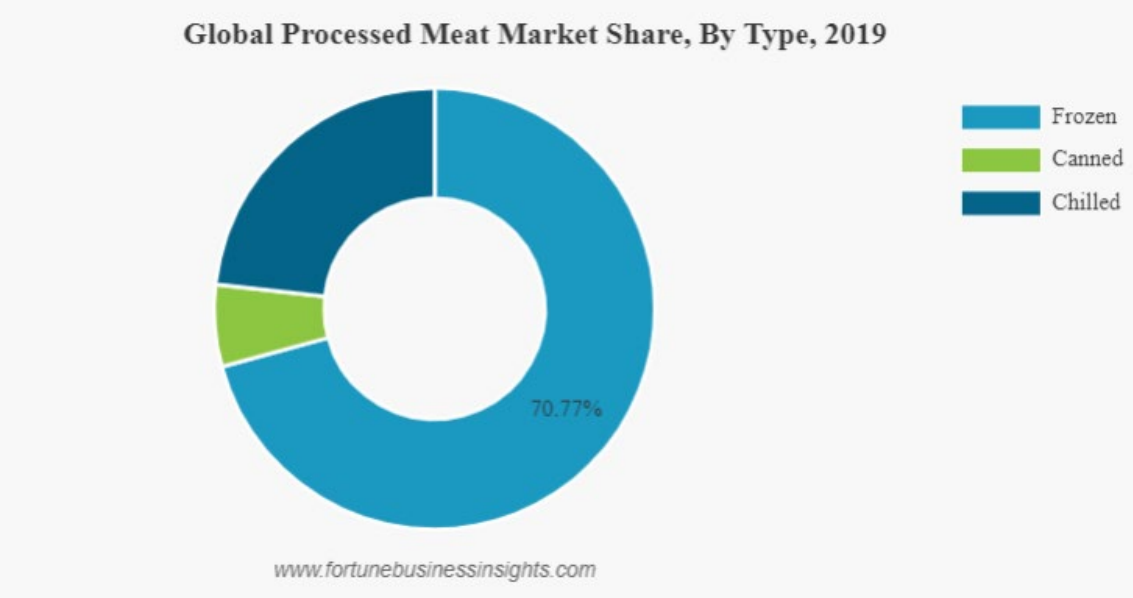


Figure 45: Global Processed Meat Market Share, by type 2019

With the enhancement of modernization, there have been many factors which have driven the rise of modern meat marts. Some of them are:

- Consumer Inclination towards Flavored Meat Products: Various marinades, seasonings and spices are applied to packaged meat products. Due to this the demand for flavored and nutritious meat products and evolving taste preferences is ever increasing.
- Rising Consumers Awareness for Processed Meat Products: There is a rise in awareness among people about healthy, safe, free from antibiotics and chemical residue foods which has pushed them to shift towards processed meat.
- Frozen Meat Hold Largest Share Owing to the Ease of Transportation: Frozen meat offers an advantage over fresh meat such as longer shelf life and less chances of microbial contamination. There is increasing consumption of salami, sausages and nuggets among the consumers.
- Increased Consumption of Packaged Chicken: The global demand is ever increasing for packaged chicken and its processed products.
  (Fortune Business Insights, 2020)

9.10.3 Waste Recycle in Meat Park

Utilization of disposal of solid and liquid waste generated in abattoir and such by-products is a challenge in Nepal due to:

- Lack of modern Abattoir i.e., small scale facilities have less volume of byproducts
- Lack of collection and transport system
- Preference to hot meat
- Collection of Bones
- Dead and fallen animal/birds not used
- Lack of processing facilities
- Lack of human resources
- Lack of research and development
- Diseases
- Synthetic substitutes from biotechnology
- Agitation by Ethical Groups
- Identification of markets (Irshad & Sharma, 2015)

So to manage those wastes is a must as giving something back to the environment by creating a “Zero Waste Concept Meat Park”. The methods for treatment and disposal of slaughter house and meat mart waste include: (Ahmad & Ansari, 2012)

1. Screening: It is the practice of taking waste materials and separating them out into multiple grades, depending on the size of the objects.
2. Incineration: It is also known as controlled–flame combustion or calcination and is a technology that destroys organic constituents in waste materials.

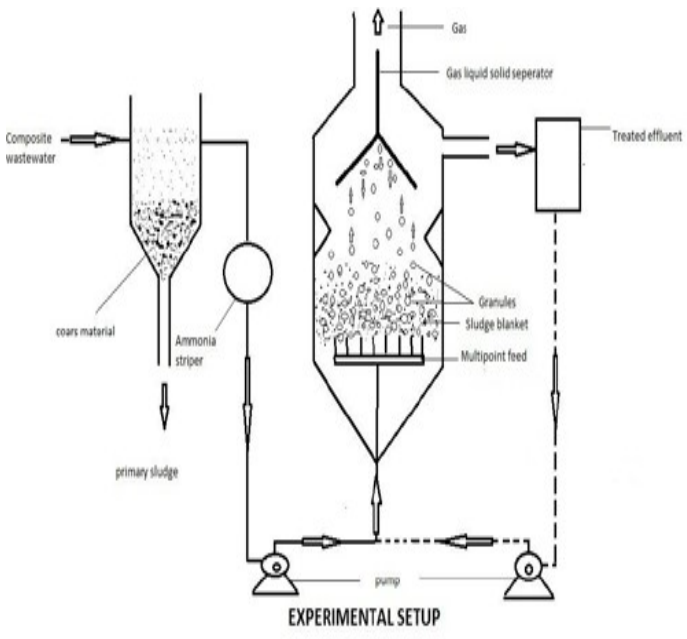


Figure 46: Experimental Setup of UASB reactor

3. Land filling: A landfill is an engineered pit, in which layers of solid waste are filled, compacted and covered for final disposal. It is lined at the bottom to prevent groundwater pollution.
4. Skimming: In the skimming tank the oil, fat, grease etc. rise and remain on the surface till its removal while the sewage flows out continuously under the partition.
5. Primary settling: It is the removal of settled organic solids and floating organic material (called scum) to reduce the suspended solids, load for downstream treatment processes (Metcalf and Eddy/AECOM, 2014)
6. Blood Separation: The slaughterhouse uses an anaerobic digestion pump to transfer animal blood. Once the animals have been slaughtered, the blood drains off in the bleeding zone. A large stainless-steel basin is there to collect all the blood flowing from the incision.
7. Protein recovery: Protein recovery from waste streams can provide an alternative resource that could be utilized as animal feed. Membrane separation, adsorption, and microbe-assisted protein recovery can be used for it.
8. Biological treatment such as composting and biomethanation: Biomethanation is a process by which organic material is microbiologically converted under anaerobic conditions to biogas. (Ahmad & Ansari, 2012)

The effluent from the abattoirs is moderate to high strength complex wastewater with about 45% soluble and 55% coarse organic materials. So, it shouldn't be mixed directly into municipal sewage without pre-treatment. It can be treated with the production of biogas which reduces greenhouse effect and pollution due to it. (Ahmad & Ansari, 2012)

> *"The success of process, especially the effective removal of BOD (Biochemical oxygen demand) has potential for use of biogas plant for treatment of slaughterhouse effluent." (Ahmad & Ansari, 2012)*

The use of UASB (Up flow anaerobic sludge blanket) for the treatment of slaughter house wastewater was used for study which showed that the reactor gave good performance without reduction in quality and quantity of biogas irrespective of temperatures. But higher temperatures gave higher gas production rates on

account of increased digestion rates. The recycle ration of 1.5 was found in enhanced biogas formation due to utilization of residual BOD. The UASB reactor is efficient in producing bio-gas which can be used for various purposes like cooking, heat production and many more. It helps in sustainable used of the waste effluent gases. (Ahmad & Ansari, 2012)

Methane production is not much affected even on low temperature but is dependent on COD (Chemical Oxygen Demand) on USAB. So, from the study the use of a recycling system is more beneficial in terms of a reactor space and efficiency than a system without recycling. All these help us to think about the use of a biogas plant in slaughterhouse to recycle the gases and use it for energy. (Ahmad & Ansari, 2012)
The economical aspect of biomethanation of slaughterhouse waste helps in:

- Utilization of primary sludge as: Fertilizers, Manure, Animal feed, etc.
- Utilization of Biogas in electricity production: "For example, treating of 3000 liters (about 792.52 gal) of waste water will give an average 147.67 m^3 of biogas) day, which could be utilized to produce 294 kWhr/m^3-day of electricity." (Ahmad & Ansari, 2012)

The UASB process can be used for the treatment of wastewater which helps to efficiently remove suspended as well as soluble organic waste from wastewater and the reactor can work excellently on low temperatures with enough biogas production. All these provide a counter to the greenhouse gas production from abattoirs and provide efficient methods to treat those wastewaters. (Ahmad & Ansari, 2012)

9.10.4 Workers' settlement in Working Area

The purpose of providing shelters for workers is to minimize or eliminate transportation costs borne by industrial workers. If the location of workers is close, then it creates a walk-to-work condition for workers which in turn creates more efficiency in the work flow.

Sustainable development is seen as a multi-dimensional process of environmental protection with economic, social, and cultural development. All these aspects are interrelated and are considered as four-dimensional approaches in sustainable development (Habitat, 2012). So, these factors should be cared about while providing suitable living environment to the workers.

10. Design Considerations & Anthropometric Data

10.1 Animal Slaughter House and Meat Inspection Technical Directive 2064

As per this act, various considerations have been given for the design of Slaughterhouses:

पशु वधशाला र मासु जाँच प्राविधिक निर्देशिका, २०६४

पशु वधशाला र मासु जाँच नियमावली, २०५७ को नियम २१ ले दिएको अधिकार प्रयोग गरी पशु सेवा विभागले यो निर्देशिका बनाएको छ ।

१. **संक्षिप्त नाम, विस्तार र प्रारम्भ :** (१) यस निर्देशिकाको नाम "पशु वधशाला र मासु जाँच प्राविधिक निर्देशिका, २०६४" रहेकोछ ।

(२) यो निर्देशिका ऐन लागू भएको क्षेत्रमा लागू हुनेछ ।

(३) यो निर्देशिका तुरुन्त प्रारम्भ हुनेछ ।

२. **परिभाषा :** विषय वा प्रसङ्गले अर्को अर्थ नलागेमा यस निर्देशिकामा,-

(क) "ऐन" भन्नाले पशु वधशाला र मासु जाँच ऐन, २०५५ सम्झनु पर्छ ।

(ख) "नियमावली" भन्नाले पशु वधशाला र मासु जाँच नियमावली,२०५७ सम्झनु पर्छ ।

(ग) "पशु वधस्थल" भन्नाले नियमावलीको नियम ६ को उपनियम (१) अनुसार व्यवस्था गरिएको पशु वध गर्ने स्थान सम्झनु पर्छ ।

(घ) "कोल्डचेन" भन्नाले मासु संरक्षणको लागि प्रयोग गरिने चिस्याउने उपकरण र यसको नियमित प्रयोग सम्झनु पर्छ ।

(ङ) "भेटेरिनरी निरीक्षक" भन्नाले पशु स्वास्थ्य तथा पशु सेवा ऐन, २०५५ को दफा २ को खण्ड (ठ) बमोजिमको व्यक्ति सम्झनु पर्छ ।

३. **पशु वधस्थल स्थापनाको लागि स्थान छनौट :** (१) पशु वधस्थल निर्माण गर्न स्थान छनौट गर्दा नियमावलीको नियम ६ को उपनियम (१) मा उल्लिखित मापदण्डका अतिरिक्त देहाय बमोजिमका अन्य मापदण्ड भएको स्थान छनौट गर्नु पर्नेछ :-

(क) मासु पसलबाट अलग्गै रहेको,

(ख) फोहोर मैला फाल्ने सार्वजनिक क्षेत्रको नजिक नभएको र

(ग) जङ्गल तथा मानिसको बसोबास वा घना बस्तीसँग नजोडिएको ।

(२) पशु वधस्थलको निर्माण गर्दा देहायका मापदण्ड पूरा गरेको हुनु पर्नेछ :-

(क) वध गर्नुभन्दा अगाडि पशुलाई कम्तीमा चौबीस घण्टासम्म विश्राम गराउन छाना समेतको टहरा (ल्यारेज) भएको,

(ख) खण्ड (क) बमोजिमको टहरामा जमीनबाट ५० से.मी उचाईमा पिउने पानीको व्यवस्था भएको,

(ग) वध गर्नु अगाडि पशुहरुलाई सफा गर्ने र तौल लिने व्यवस्था भएको,

(घ) वध गर्नु अगाडि पशुहरुको स्वास्थ्य परीक्षण गर्ने र रोगको आशङ्का भएका पशुलाई राख्ने छुट्टा छुट्टै स्थान भएको,

(ङ) भुईंको सतह पानी नजम्ने किसिमबाट बनाईएको,

(च) छाला काढ्ने, भुत्ल्याउने, मासु सफा गरी काट्ने र निरीक्षण गरी वितरण गर्ने अलग अलग ठाउँको व्यवस्था भएको,

(छ) देहायका पशुलाई वध गर्न कम्तीमा देहाय अनुसारको क्षेत्रफल उपलब्ध भएको :-

(१) पाडा, बाख्रा, भेडा, बड्गुर, सुँगुर : ९ वर्ग मीटर प्रति पशु

(२) राँगो, भैंसी : २० वर्ग मीटर प्रति पशु

(३) पन्छी जाति : १ वर्ग मीटर प्रति पन्छी

(ज) सूर्यको ताप सोझै नपर्ने तर प्रकाश र स्वच्छ हावा वहन सक्ने गरी बनाईएको ।

(३) वधस्थलको स्वरुप अनुसूची-१ मा उल्लेख भए बमोजिम हुनु पर्नेछ ।

४. **पशु वधशाला स्थापना** : (१) पशु वधशाला निर्माण गर्न स्थान छनौट गर्दा नियमावलीको नियम ४ को उपनियम (१) मा उल्लिखित मापदण्डका अतिरिक्त देहायका थप सुविधा भएको स्थान छनौट गर्नु पर्नेछ :-

(क) फोहोर मैला फाल्ने सार्वजनिक क्षेत्र तथा उद्योग, स्कूल, मठ मन्दिर र खाद्य उद्योगको नजिक नभएको,

(ख) फोहोर मैला तह लगाउन र ढल निकासको व्यवस्था गर्न सकिने,

(ग) स्वच्छ पानी पर्याप्त मात्रामा उपलब्ध हुन सक्ने,

(घ) जङ्गल तथा मानिसको बसोबास वा घना बस्तीसँग नजोडिएको,

(ङ) सडक, विद्युत र सञ्चार सेवा पुगेको,

(२) पशु वधशाला निर्माण गर्दा नियमावलीको नियम ४ को उपनियम (१) मा उल्लिखित मापदण्डका अतिरिक्त देहायका थप सुविधा भएको हुनु पर्नेछ:-

(क) पशु वधशाला परिसरमा सवारी साधान भित्रने र निस्कने सुविधाका साथै पशु ओराल्न १.२ मीटर अग्लो सिँढीको सुविधा र सोही ठाँउमा पशु बुझ्ने,

(ख) वध गर्नु अगाडि पशुहरुको तौल लिने र सफा गर्ने ठाउँ,

(ग) वध गर्नुभन्दा चौबीस घण्टा अघिदेखि पशुलाई आराम गराउन वधशाला परिसरभित्रै विश्राम गराउने छाना तथा देहाय अनुसारको विश्राम स्थल (ल्यारेज) :-

(१) पिउने पानीका लागि जमीन देखि ५० से.मी उचाईमा भाँडाहरु भएको,

(२) भेडा, बाख्रा, बड्गुर जस्ता पशुहरुका लागि प्रति पशु शुन्य दशमलव सात तीन (०.७३) वर्गमिटर क्षेत्रफल र सून्य दशमलव नौ (०.९) मिटर उचाई तथा राँगा भैंसी जस्ता पशुका लागि प्रति पशु तीन दशमलव सात सात (३.७७) वर्गमिटर क्षेत्रफल र तीन (३) मिटर उचाई भएको विश्रामस्थलको व्यवस्था भएको,

(३) स्वास्थ्य परीक्षण गर्ने र रोगको आशंका भएका पशु राख्ने छुट्टा छुट्टै स्थान भएको,

(घ) कुनै कारणबाट अपरझट वध गर्नु पर्ने पशुहरुलाई तत्काल वध गर्ने छुट्टै आपतकालीन कक्ष,

(ङ) खण्ड (घ) बमोजिमको कक्ष रोगको आशङ्का भएका पशु राख्ने, शङ्कास्पद मासु झुण्ड्याउने र चिस्याउने कक्षसँगै जोडिएको,

(च) पशुलाई बेहोस गराउने, मार हान्ने र रगत निथार्ने कार्यका लागि स्थान,

(छ) वध गरिएको पशुको रगत निथार्न भूईंदेखि राँगा, भैंसीका लागि चार दशमलव पाँच मीटर र भेडा, बाख्रा तथा बड्गुरका लागि दुईदेखि तीन मीटर उचाईमा घिर्नीहरु राखिएको र यी घिर्नीहरु हल्का भिरालो प्रकारले वधशालाको मूल कक्षतर्फ सजिलै सर्ने,

(ज) छाला काढिने पशुको छाला काड्ने र छाला नकाडिने पशु जस्तै सँगुर, बड्गुर र पन्छीलाई तातोपानीमा डुबाई जगर, भुत्ला वा प्वाँख निकाल्ने स्थान,

(झ) छाला काढी सकेपछि अथवा जगर, भुत्ला वा प्वाँख भुत्ल्याई सकेपछि सफा गर्ने स्थान र मासु निरीक्षकले मासुमा छाप लगाउनु अघि सफा गर्ने छुट्टा छुट्टै स्थान,

(ञ) मासु निरीक्षण गर्ने छुट्टै स्थान,

(ट) मासु काट्ने र बिक्री गर्ने छुट्टा छुट्टै स्थान,

(ठ) उपभोग गर्न नहुने शङ्कास्पद मासु, छाला, रौं, खान योग्य बोसो र खान अयोग्य बोसोहरु प्रत्येकलाई अलग अलग राख्ने,

(ड) भित्र्याँस, आन्द्राभुँडी, टाउको, खुट्टा, रक्ती बिक्री गर्ने हो भने मासुसँग लसपस नहुने गरी अलग्गै राख्ने,

(ण) शङ्कास्पद मासुमा सङ्क्रमणको परीक्षण गर्न प्रयोगशालाको व्यवस्था,

(त) वधशालामा काम गर्ने कर्मचारीले कपडा परिवर्तन गर्ने कोठा,

(ण) वधशालामा काम गर्ने मासु निरीक्षकको प्रयोजनको निमित्त देहायका व्यवस्था सहितको कार्यालय :-

(१) आवश्यक टेबुल कुर्सी,

(२) कपडा फेर्ने कोठा,

(३) स्नानघर तथा शौचालय र

(४) चक्कु, गम्बुट, एप्रोन, ग्लोभ, मास्क, चस्मा, छाप र मसी जस्ता आवश्यक सामाग्रीहरु राख्ने लकर वा दराज

(त) वधशालामा काम गर्नेहरुका लागि मासु सम्बन्धी काम हुने स्थानभन्दा कम्तिमा एक सय फिट वरपर छुट्टै स्थानघर र शौचालय,

(थ) मासुलाई कम्तीमा चौबीस घण्टासम्मका लागि माईनस् पाँचदेखि चार डिग्री सेल्सियस्बीचको तापक्रम नियमन हुने कक्ष र चौबीस घण्टापछि डीप फ्रिज गर्न माईनस् अठार डिग्री सेल्सियस् तापक्रम नियमन हुने कक्ष,

(द) चिस्यानमा मासु झुण्ड्याउँदा राम्ररी हावा फैलिन जमीनको सतहबाट देहायको उचाईभन्दा माथि झुण्ड्याउने :-

(१) भैंसी राँगालाई ०.९ मीटर,

(२) बड्गुरलाई ०.७ मीटर र

(३) भेडा बाख्रालाई ०.५ मीटर ।

(ध) मासु झुण्ड्याउँदा बीच बीचमा ०.३ देखि ०.४ मीटर फरक,

(न) रेड अफलका लागि चिस्यानको अलग्गै कोठा,

(प) कर्मचारीका लागि वधशाला परिसरभित्रै चमेना गृह,

(फ) वधशाला परिसरभित्रै पशुहरु ढुवानी गर्न प्रयोग गरिने सवारी साधनहरु राख्ने छुट्टै ग्यारेज र लोड, अलोड गर्ने प्लेटफर्म,

(ब) सवारीसाधन निःसंक्रमण र सफा गर्न पानीको फोहरायुक्त सुविधा,

(न) वधशालाको प्रशासनिक कार्यको लागि अलग्गै कार्यालय कक्ष ।

(३) पशु वधशालाभित्र देहाय बमोजिमका सुविधाहरु उपलब्ध भएको हुनु पर्नेछ :-

(क) फोहोर सङ्कलन गरी तह लगाउन उपकरणको पर्याप्त व्यवस्था,

(ख) नष्ट गरिने मासु वधशालाबाट बाहिर निकासी गर्दा खान योग्य मासुसँग लसपस हुन नपाउने व्यवस्था,

(ग) उपकरणहरु सफा गर्ने र निःसङ्क्रमण गर्ने आवश्यक व्यवस्था,

(घ) कुखुरा ढुवानी गरिने क्रेट र साधनलाई सरसफाई एवं निःसङ्क्रमण गर्ने व्यवस्था,

(ङ) वधशाला प्रवेशद्वारमा निःसङ्क्रमणका लागि आवश्यक व्यवस्था,

(च) वधशालाको प्रवेशमार्ग सफा क्षेत्रबाट फोहोर क्षेत्रतर्फ उन्मुख,

(छ) पानी प्रयोग हुने सबै क्षेत्रमा ढल निकासको व्यवस्था,

(ज) चिसो पार्नु नपर्ने कोठाहरुमा आवश्यक मात्रामा प्राकृतिक प्रकाश र स्वच्छ हावाका लागि झ्यालहरुको व्यवस्था,

(झ) मासु निरीक्षण कक्षमा पाँच सय चालीस लक्स, काम गर्ने कक्षमा दुई सय बीस लक्स् र अन्य क्षेत्रमा एक सय दश लक्स् प्रकाशको व्यवस्था,

(ञ) आपतकालीन बत्तीको अलग्गै व्यवस्था,

(ट) कोठाभित्र भएको हावा बाहिर फ्याक्ने पङ्खाको व्यवस्था,

(ठ) खाने पानी पर्याप्त नभएको ठाँउमा मासु सफा गर्ने र वधशाला सफा गर्ने पानी छुट्टा छुट्टै पाईपबाट वितरण गर्ने व्यवस्था,

(ड) पशु बध गर्ने हलमा सफा स्वच्छ तातो पानीको निर्यामत आपूर्तिको व्यवस्था,

(ढ) हात धुनको लागि तातो चिसो पानी, साबुन, ब्रसको व्यवस्था,

(ण) वधशाला भित्रको भुईको सतह सफा क्षेत्रबाट फोहोर क्षेत्र तर्फ हल्का भिरालो भई ढलमा जोडिएको र जोडिने मुखमा छान्ने जाली जडान गरिएको र

(त) वधशाला भित्रका भित्ता भूई देखि १.६ मीटर उचाई सम्म सिमेन्टले बनाएको चिल्लो र ईपोक्सीरेसिन रङ्ग लगाई त्यसभन्दा माथि छतसम्म कुनै हल्का रङ्ग पोतेको ।

(४) वधशालाको स्वरुप अनुसूची २ मा उल्लेख भए बमोजिम हुनु पर्नेछ ।

५. **मासु पसल** : (१) मासु पसल बनाउँदा नियमावलीको नियम ८ को खण्ड (झ) मा उल्लिखित मापदण्डका अतिरिक्त देहाय बमोजिमका थप सुविधा भएको हुनु पर्नेछ :–

(क) पर्याप्त क्षेत्रफल भएको पसल कोठा र भित्तामा हल्का रङ्ग पोतिएको र फोहोर नजम्ने,

(ख) पसलमा निस्कने फोहोर व्यवस्थित तरिकाले तह लगाउन सकिने,

(ग) स्वच्छ र सफा पानीको पर्याप्त व्यवस्था भएको,

(घ) मासु बिक्रेताले लुगा फेर्ने छुट्टै स्थान भएको,

(ङ) बिक्री कक्षमा कोल्डचेनको व्यवस्थाका लागि कम्तिमा फ्रिजको व्यवस्था भएको,

(च) मासु पसलमा उपभोक्ताले अलग्गै स्थानबाट हेर्न सक्ने व्यवस्था भएको,

(छ) प्रयोग गरेको पानी सजिलै बाहिर जानसक्ने गरी निकासको व्यवस्था भएको र

(ज) बिक्री गर्न राखिने मासु झुण्ड्याउन हुकको व्यवस्था भएको ।

(२) मासु पसलको स्वरुप अनुसूची-३ मा उल्लेख भए बमोजिम हुनु पर्नेछ ।

६. **मासु निरीक्षक र निजको काम कर्तव्य :** (१) गैरसरकारी क्षेत्रमा स्थापित वधशालामा सो वधशालाको सञ्चालकले र स्थानीय निकायद्वारा सञ्चालित वधशाला वा वधस्थलहरुमा सम्बन्धित स्थानीय निकायले देहायको आधार पूरा गरेका व्यक्तिलाई मासु निरीक्षकको रुपमा काम गर्न लगाउन सक्नेछ :–

(क) ऐनको दफा ६ को उपदफा (१) अनुसार योग्यता पुगी नेपाल सरकारले तोकेको र नियममवलीको नियम १७ उपनियम (१) बमोजिम अनुमति प्राप्त गरेको,

(ख) मान्यता प्राप्त चिकित्सक वा स्वास्थ्य संस्थाबाट वर्षको एक पटक स्वास्थ्य परीक्षण गराई प्रमाणपत्र लिएको,

(२) मासु निरीक्षकले ऐन तथा नियमावली बमाजिमको काम कर्तव्य र अधिकारका अतिरिक्त देहाय अनुसारका थप कार्य समेत गर्नु पर्नेछ :–

(क) दैनिक कार्यको विवरण वधशाला व्यवस्थापन र मासु सुपरीवेक्षकलाई निर्यामत रुपमा बुझाउने,

(ख) बध गर्न योग्य वा अयोग्य छुट्टयाईएको पशुको स्वास्थ्य परीक्षणको अभिलेख अनुसूची-४ को फारम १ अनुसारको ढाँचामा राख्ने,

(ग) पशुका किसिम अनुसार दैनिक बध गरिएको सङ्ख्या, मासु जाँचको अभिलेख अनुसूची-४ को फारम २ अनुसारको ढाँचामा राख्ने,

(घ) निरीक्षणको क्रममा मासुमा अनुसूची-५ मा उल्लिखित कुनै रोग लागेको पाईएमा मानिसले खान अयोग्य ठहर गर्ने,

(ङ) कुनै रोग लागेको शङ्का भएको पशुलाई बध गर्न रोक लगाउने र मासुमा शङ्का भए परीक्षणका लागि तुरुन्त प्रयोगशालामा पठाउने र परीक्षण भई नआएसम्म बिक्री गर्न रोक लगाउने,

(च) चक्कु तथा अन्य औजार प्रयोग गरेपछि निःसङ्क्रमण गरेर मात्र पुनः प्रयोग गर्ने,

(छ) प्रयोगशालामा परीक्षण गर्न पठाएका शङ्कास्पद मासुको नमूना र प्रयोगशालाबाट प्राप्त नतिजाको लगत अनुसूची-६ बमोजिम राख्ने ।

७. **बध गर्नु पूर्व पशु जाँच गर्ने कार्यविधि** : वधशाला वा वधस्थलमा पशु बध गर्नु पूर्व त्यस्ता पशु जाँच गर्दा नियमावलीको नियम ९ को उपनियम (१) मा उल्लिखित कार्यविधिका अतिरिक्त देहायका थप कार्यको समेत पालन गर्नु पर्नेछ :–

(क) पशुको परीक्षण गर्दा ल्यारेज वा सोका लागि छुट्टयाईएको निश्चित स्थानमा मात्र गर्नु पर्छ ।

(ख) पशु परीक्षण गर्दा पशुलाई कुनै प्रकारको तनाव नहुने गरी व्यवहार गर्नु पर्छ ।

(ग) परीक्षण गरिएका पशुलाई देहाय अनुसार चार वर्गमा छुट्टयाएर अलग चिन्ह लगाई राख्नु पर्छ :–

(१) बध कालागि योग्य,

(२) अनुसूची-५ अनुसारका कुनै रोग लागेका कारण बधका लागि अयोग्य,

(३) ऐनले बधका लागि निषेधित गरेका कारणले अयोग्य,

(४) कुनै सङ्कामक रोग लागी तत्कालै नष्ट गर्नु पर्ने ।

(घ) आपतकालीन बध गर्नु पर्ने पशुहरुको ठहर गरी अनुमति दिने ।

८. **पशु वधपछि मासुको परीक्षण गर्ने सम्बन्धी व्यवस्था :** (१) बध गरिएको पशुको शरीरको बाहिरी भाग सफा गरी सकेपछि शरीरको पेट खोल्ने समयमा भित्र बाहिर पूरै भाग परीक्षण गर्नु पर्छ ।

(२) उपदफा (१) बमोजिम परीक्षण गर्दा अनुसूची-७ मा उल्लिखित रोग पाईएमा त्यस्तो मासु पूर्णरुपले हटाउनु वा नष्ट गर्नु पर्छ ।

९. **मासुमा छाप वा चिन्ह लगाउने सम्बन्धी व्यवस्था** : (१) मासु निरीक्षकले मासु जाँच गरिसकेपछि मानिसको उपभोगको लागि उपयुक्त मासुको किसिम समेत स्पष्ट हुने गरी बध गरिएको पशुको घाँटीदेखि तिघ्रासम्मको मासुमा नियमावलीको नियम १५ अनुसार छाप वा चिन्ह लगाउनु पर्नेछ ।

(२) चिन्ह लगाउने छापहरु मासु निरीक्षक आफैले प्रयोग गर्नु पर्नेछ ।

१०. **पशु वधशाला सञ्चालकले पालन गर्नु पर्ने शर्तहरु :** पशु बधशाला स्थापना तथा सञ्चालकले ऐनको दफा ३ र नियमावलीको नियम ४ मा उल्लिखित शर्तहरुका अतिरिक्त देहायका अन्य शर्तहरु पालन गर्नु पर्नेछ :–

(क) मानिसले उपभोग गर्न अयोग्य मासुमा भएका अनावश्यक पदार्थलाई निकाल्न वा नष्ट गर्न प्रत्येक बधशालामा क्षमता अनुसार रेन्डरिङ्ग प्लान्ट जडान,

(ख) मासुलाई रेन्डरिङ्ग गरेपछि मात्र नष्ट गर्ने वा हटाउने व्यवस्था,

(ग) रेन्डरिङ्ग गरेको मासु भेटेरिनरी निरीक्षकले उपयुक्त देखेमा मात्र पशु आहाराको लागि प्रयोग गर्ने व्यवस्था,

(घ) वधशालाभित्र कडाईकासाथ देहायको व्यवस्था लागू गर्ने :–

(१) पान, सुर्ती, धुम्रपान तथा अन्य पेय पदार्थ सेवन गर्न नदिने,

(२) अनुसूची-८ मा तोकिएको पोशाक बाहेक अन्य पोशाक लगाएर प्रवेश गर्न नदिने,

(३) क्षयरोग तथा अन्य यस्तै सङ्क्रामक रोग लागेका व्यक्तिलाई प्रवेश गर्न वा कार्य गर्न नदिने र

(४) वधशालामा काम गर्ने कामदार र कर्मचारीको प्रत्येक छ महिनामा स्वास्थ्य परीक्षण गराई निरोगिताको प्रमाणपत्र मासु सुपरीवेक्षक समक्ष पेश गर्ने ।

(ङ) बध गरिएका पशुको दैनिक विवरण अनुसूची-९ को ढाँचामा तयार गरी यथाशक्य छिटो मासु सुपरीवेक्षकलाई उपलब्ध गराउने व्यवस्था गर्ने,

(च) बधशाला वा वधस्थलले नियमित बन्द हुने दिन तोकेको र सोको जानकारी मासु सुपरीवेक्षकलाई उपलब्ध गराउने व्यवस्था गरेको,

(छ) जुन प्रकारको पशु बध गर्न इजाजत लिएको हो सो बाहेक अरु कुनै प्रकारको पशु बध नगराएको,

(ज) इजाजतपत्रमा उल्लेख भए अनुसारको पशु बध गर्ने कार्य छाडेमा महिना दिनभित्र इजाजतपत्र दिने कार्यालयलाई सोको जानकारी गराउने,

११. **पशु बध गर्नेले पालन गर्नु पर्ने शर्तहरु :** पशु वधस्थल वा पशु वधशालामा पशु बध गर्ने व्यक्तिले देहायका कुराहरु अनिवार्य पालन गर्नु पर्नेछ :–

(क) रोगको शङ्का भएको वा दाग, धब्बा देखिएको मासु, मासुसँग भएको झिल्ली जस्तो पदार्थ (सिरस् मेम्ब्रेन) र पशुको कुनै पनि भाग वा अङ्ग मासु निरीक्षकको आदेश बिना कुनै पनि तरीकाले नहटाउने वा नमेटाउने,

(ख) कुनै पशुको आपत्कालीन बध गर्नु पर्ने स्थिति भएमा कारण सहित मासु निरीक्षक समक्ष सूचना दिने,

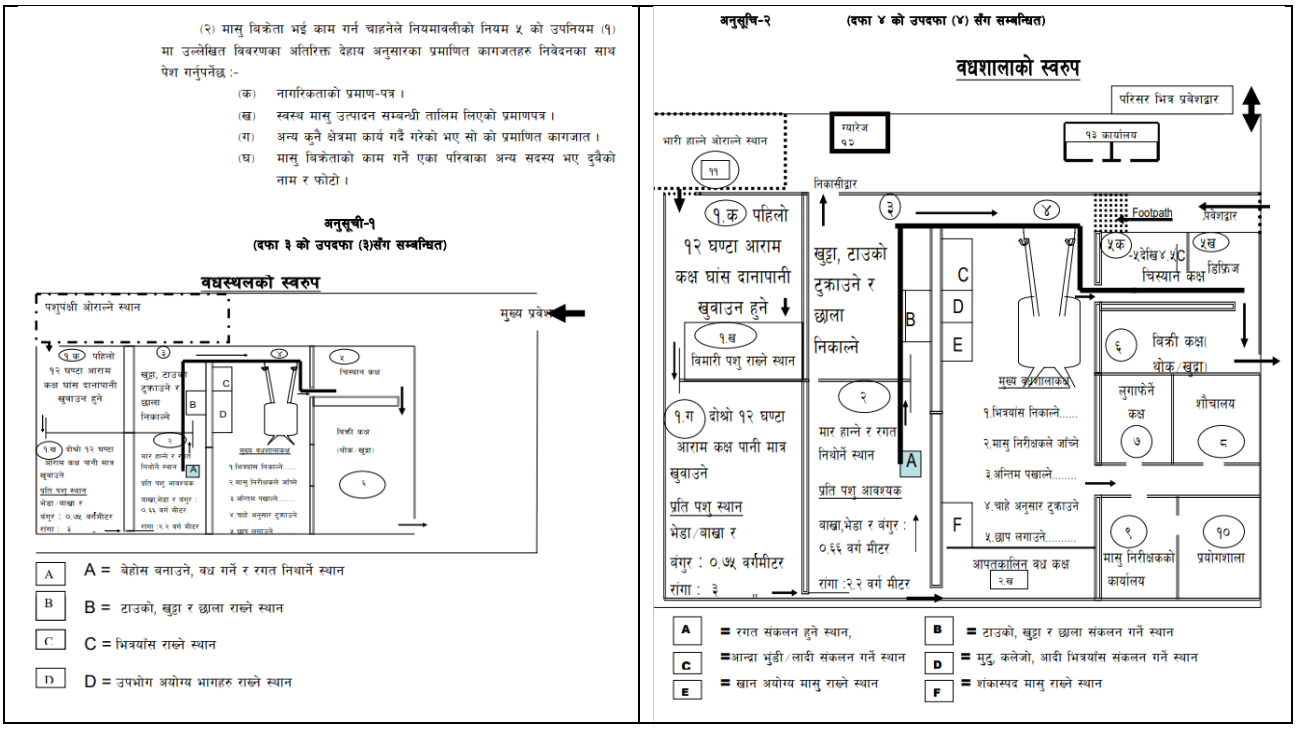
(ग) वधशाला एवं वधस्थलमा प्रयोग भएका कपडा, औजार, काट्ने हतियार रोगी पशुको मासुमा प्रयोग भएको भए लुगा धुने सोडा राखिएको पानीमा आधा घण्टासम्म उमालेर मात्र पूनः प्रयोग गर्ने,

(घ) बध गरिएको पशुको मासु मासु निरीक्षकले निरीक्षण गरीसकेपछि मात्र प्राप्त निर्देशन अनुसार गर्ने,

१२. **मासु बिक्रेताले पालन गर्नु पर्ने शर्तहरु :** मासु बिक्रेताले ऐनको दफा ३ र नियमावलीको नियम ५ र ८ मा उल्लेखित शर्तहरुका अतिरिक्त देहायका अन्य शर्तहरु पालन गरेको हुनु पर्नेछ :–

(क) पसलको बाहिरबाट स्पष्ट देख्न र पढ्न सक्ने गरी व्यवसायीको नाम, थर, ठेगाना, व्यवसायको प्रकार, इजाजतपत्र नम्बर, इजाजतपत्र लिएको वा नवीकरण गरेको मिति, मूल्य सूची र स्थानीय निकायले तोकेको अन्य विवरण राख्नु पर्नेछ ।

(ख) पशु बधशालाबाट ल्याएको मासु मात्र बिक्री गर्नु पर्नेछ ।



10.2 Implementing Rules and Regulations of Chapter IV "Markets and Abattoirs"

- OF THE CODE ON SANITATION OF THE PHILIPPINES

10.2.1 PRESCRIBED STANDARDS OF CONSTRUCTION FOR MARKETS

A. Site Requirements:

- The market site shall be located at least 50 meters (164 feet) from schools, religious institutions, public offices, funeral establishments, and other public gathering places and 25 meters (82 feet) from abattoirs and other possible sources of contamination.
- It shall be easily accessible to the public and conveyances or vehicles.
- The site and area shall be considered in relation to future town or city development plan. It shall comply with the local zoning laws and ordinances.

B. Building Construction Size:

- Building. The building shall be of adequate size as to allow smooth flow and convenient movement of both stallholders and cust0mers or the public.
- Stall. The minimum area of each stall shall be 3.10 square meters (33.35 square feet).
- Aisle. The minimum width of each aisle shall be 1.20 meters (3.94 feet).

C. Floors

- All floors shall be constructed of impervious materials and of such construction and finish as will make it easily and thoroughly cleaned.

- All angles between the floors and walls shall be rounded off to a height of not less than 7 .62 centimeters (3 inches) from the floor.
- All floors shall be kept clean and preferably dry at all times.

D. Walls and Partitions

- The walls and partitions shall be constructed of impervious and non-toxic materials to a height of not less than 1.22 meters (4 feet) from the floor, of such construction and finish as will make them easily cleaned.
- Walls shall be painted or finished with light color.
- Partitions shall not extend up to the ceiling to facilitate circulation or free movement of air within the building.

E. Display Tables and Counters

- Display tables and counters of stalls for carinderia, fish, meat and entrails sections shall be made of impervious materials· and of such construction and finish as will make them easily cleaned.
- Display tables and counters for fish. meat and entrails sections shall be provided with adequate and approved table drain.
- Display tables shall be made entirely open beneath 75 centimeters (2.5 feet) in height, without drawers, and shall be made and kept smooth and clean.

F. Roofing

- Market buildings shall be provided with adequate permanent roof that will provide both vendors and customers protection from heat, rain and other hazards.
- The ceiling shall have a minimum height of 3 meters (10 feet).

G. Lighting

- All areas in the market shall be properly lighted either by natural or artificial light.
- All area: where readily perishable foods arc displayed for sale shall be provided with a 20 foot-candle (215 .2 lux.) intensity of illumination. Aisles, passageways and stairways shall also be provided with the same level of illumination.
- Other areas in the building shall be provided with an illumination intensity of 10 foot-candles (107.6 lux).
- Light bulbs and fixtures shall be of the safe type or, otherwise. provided with protection in case of breakage.
- The lighting shall be reasonably free from glare and evenly distributed so as to avoid shadows.
- No colored lights or other materials that will alter the color of the food shall be used in all foods displayed for sale.

H. Ventilation

- The relative humidity within the building shall be maintained at 60 %.
- The building shall be provided with effective and suitable ventilation to maintain a temperature of 26.7°C (80°F).

I. Space Requirements

- There shall be a minimum area of 1 square meter (10.76 square feet) of open space per customer.
- All aisles shall have a minimum width of 1.5 meters (4.92 feet) to facilitate smooth flow of customers.
- Tables used in stalls for food, fish, shellfish, meat and entrails shall be elevated to at least 0.75 m. (2.5 ft.) from the floor.

J. Fire Exit

- All markets shall be provided with fire exits in accordance with the code.

K. Water Supply

- Each stall in the carinderia, fish, meat and entrails sections shall be provided with piped water supply facilities. Water supply shall be maintained at a pressure of 138 KPa (20 psi).
- Water supply of 40 liters/ capita/day shall be provided and maintained based on the number of vendors and average number of customers per day.

L. Toilet and Hand Washing Facilities

- Adequate number of toilet facilities shall be provided with two compartments, one for men and one for women, in accordance with the following:

Table 1. Minimum Requirements for Toilet and Hand-washing Facilities for Personnel and Stallholders

Number of Persons	Water Closet		Urinal	Wash-hand Basin	
	Female	Male		Female	Male
1 - 29	1	1	1	1	1
30 - 49	2	1	2	2	2
50 - 99	2	2	2	3	3

Note: Additional one (1) fixture for each additional 50 persons or a fraction thereof.

Table 2. Minimum Requirements for Toilet and Hand-washing Facilities for Consumers

Number of Persons	Water Closet		Urinal	Wash-hand Basin	
	Female	Male		Female	Male
1 - 29	1	1	-	1	1
50 - 100	2	1	1	1	1

One (1) toilet for differently-abled female and male customers, respectively, shall be provided.

Note: Additional one (1) water closet and one (1) urinal for each additional 100 males or a fraction thereof; additional one (1) water closet for each additional 50 females or a fraction thereof.

10.2.1 PRESCRIBED STANDARDS OF CONSTRUCTION FOR ABATTOIRS

A. Site Requirements

- The site shall be at least 200 meters away from residential areas, schools, churches, and places of public assembly, funeral establish-ments, courts or public office and 25 meters away from markets and other food establishments.

B. Size

The minimum size of slaughtering area for new or extensively altered/renovated abattoirs shall be as follows:

Table 4. Dimension of Slaughtering Area

Type of Animal Slaughtered	Area (m^2)
Swine only	21
Cattle only	23
Swine and cattle	28
Poultry	14

Note: These dimensions are minimum standards, and when the number of animals to be killed warrants it, the size shall be appropriately increased.

Table 5. Dimension of Offal Cleaning Area

Type of Animal Slaughtered	Area (m^2)
Swine only	10
Cattle only	20
Swine and cattle	20

C. Floors

- All floors shall be constructed of durable water-resistant materials.
- It shall be easily cleaned, free of cracks and indentation.
- It shall be non-slippery and all angles between the floors and walls shall be rounded off to a height of at least 7.62 centimeters (3 inches) from the floor.
- Floors shall be sloping toward drains. For cattle and swine pens, the floor slope shall not be less than 5.2 centimeters per meter and 4.2 centimeters per meter, respectively.

D. Walls, Partitions, Posts, Doors

- The walls, partitions, posts, doors and other parts of the workrooms shall be constructed of impervious materials to a height of at least 2 meters from the floor and of such construction and finish as will make them readily and thoroughly cleaned.
- Walls shall be free of cracks and crevices and shall be of white or light color.
- Doors shall be at least 1.5 m. in width to allow smooth work flow and those opening from parts of the slaughterhouse where meat is handled shall either be fitted with air screens or self-closing and snug fitting double action doors.

E. Overhead Rails

- Overhead rails shall be placed not less than 0.6 m. from walls, posts and other fixed parts of the building. Header rails shall be placed at least 0.9 m. from adjacent walls and columns.
- The minimum height of overhead rails and distance between rails shall be as follows:

Table 6. Minimum Requirements for Overhead Rails

DESCRIPTION	CATTLE		HOG	
	Meter	Feet	Meter	Feet
Vertical Distance:				
Bleeding rail (distance from rail to point of application of shackle to shackled foot = 1.22 m.)	4.88	16	3.05	10
			From sticker's platform	
Dressing (Trolley length = 0.38 m.)	3.35	11	3.20	10.5
Whole Carcass Rail	3.35	11	2.74	9.0
			Head detached	
			3.05	10
			Head Attached	
Quarter Carcass Rail	2.29	7.5	-	-
Horizontal Distance:				
Between Bleeding Rail	2.44	8	-	-
Dressing Rail	1.22	4	-	-
Chill Room Rail	0.99	3.22	-	-

F. Ceiling

- The ceiling shall be made of materials suited for the purpose and shall be of sufficient height to permit carcasses to hang in such a way that they do not touch the floor.
- Ceiling shall be well maintained, and shall be properly designed so as to prevent accumulation of dust and condensation.

G. Lighting

- Lighting shall be free from glare and evenly distributed to avoid shadows.
- Lighting shall be such that color of meat is not altered.
- Artificial light intensity shall not be less than the following:
  a. 50 foot candles (538 lux) at all inspection and workrooms;
  b. 10 foot candles (107.6 lux) at chilling rooms; and
  c. 20 foot candles (2 I 5.2 lux) in other areas of the establishment.
- The intensity of the required illumination inside the establishment shall be measured at a point 76.2 centimeters (30 inches) above the floor.

H. Ventilation

- Ventilation systems shall be designed and constructed to ensure that air flows from food areas to by-product areas, edible to inedible areas, and cooked or finished food areas to raw areas. Airflow from warm areas to cold areas shall be minimized to avoid condensation problems.

I. Equipment Layout

- Equipment shall be installed at least 30centimeters (1 foot) from walls, support structure and other stationary fixture. Distance shall be increased for large equipment.

J. Holding Pens/ Lairage

- Holding pens shall be located near the abattoir and shall be provided with roof and enough space to accommodate the number of animals to be slaughtered. The minimum area of the holding pen shall be 2.23 square meters per cattle and 0.6 square meter per swine.
- The holding pen of the abattoir where animals are confined before slaughter shall not be on windward side of the abattoir and shall be constructed of sufficiently strong materials to safely hold any animal that may be brought for slaughter.
- The pen shall be constructed so as to permit proper ante mortem inspection and provided with facilities such as a "squeeze" chute for large animals so that each animal may be closely examined by the meat inspector.
- When slaughtering is conducted after sunset or before sunrise, sufficient artificial lighting shall be provided to permit proper ante mortem inspection.
- The minimum width of aisle shall be 1.20 meters (4 feet).

K. Veterinary or Meat Inspector's Office

- The office shall be properly located, shall have enough office facilities and a minimum area of 25 square meters.

L. Water Supply

- Both cold and hot water under adequate pressure shall be available during operation. Hot water shall not be less than 82°C.
- The following minimum supply of potable water shall be provided in the process of meat production, preparation and marketing within the abattoir:
  a. 0.23 cu. m. {60 gal) per cattle;
  b. 0.12 cu. m. (30 gal) per swine;
  c. 0.06 cu. m. (15 gal) per goat and· sheep; and
  d. 0.008 cu. m. (2 gal) per bird

M. Toilet and Hand-Washing Facilities

- All slaughterhouses shall be provided with adequate and approved type of toilet and hand-washing facilities, which include water faucets, wash basins, lavatories, toilets and bath facilities.

Table 7. Toilet and Hand-washing Facilities Requirements

Number of Personnel	Water Closet		Urinal Stall	Wash-hand Basin		Shower Head
	Female	Male		Female	Male	
1 - 29	1	1	-	1	1	1
30 - 49	2	1	1	2	2	2
50 - 99	2	2	2	3	3	3

Note: Additional one (1) fixture for each additional 50 personnel or a fraction thereof, one (1) drinking fountain for each additional 75 personnel or a fraction thereof.

Small Accessible Public Restroom.

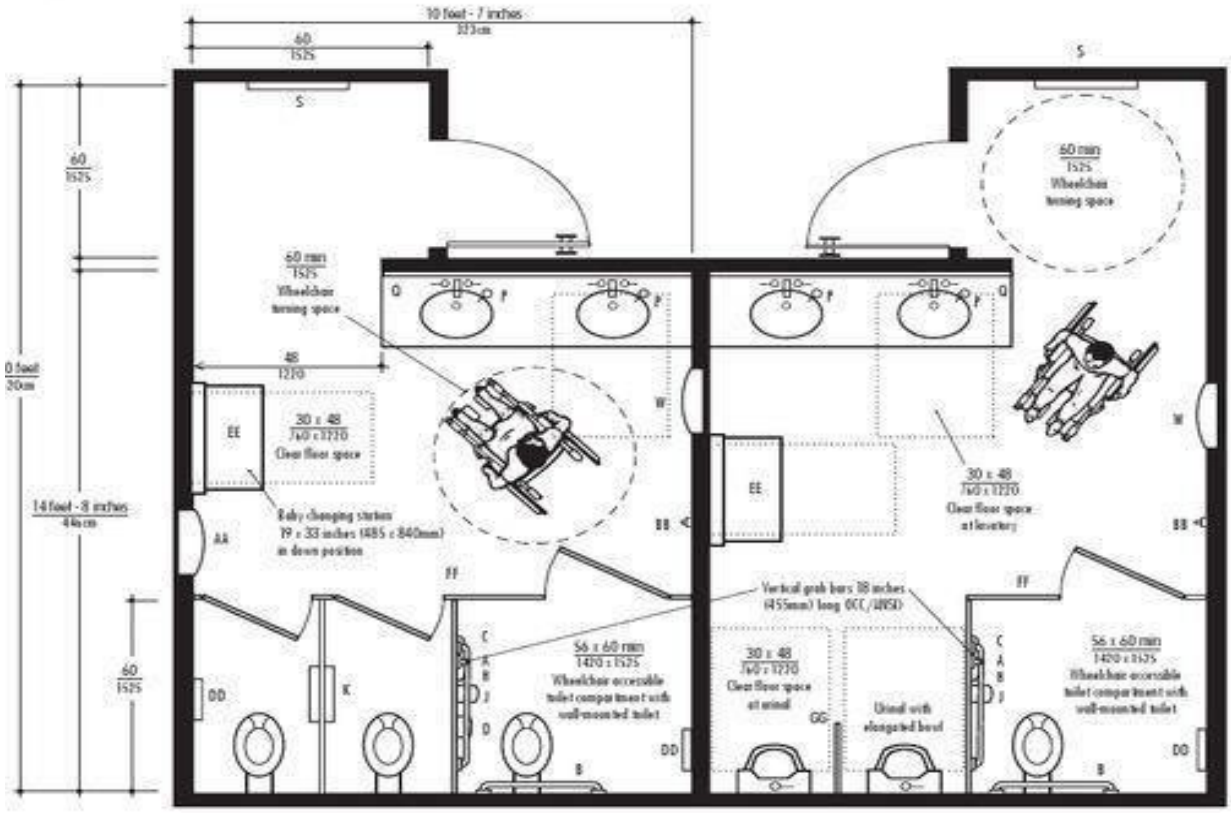


Figure 47: General Layout of Toilet

N. Sewage Disposal and Drainage

- There shall be at least one drainage inlet for every 372 square meters (400 square feet) of floor space. Slope shall be 0.64 centimeter per meter to the drainage inlet.
- The drains shall be at least 21 centimeters (8 inches) in diameter for the ruminal contents of cattle, 16 centimeters (6 inches) in diameter for swine, sheep and calves. The paunch and stomach contents shall not be connected to the regular drainage line of the abattoir.

O. Cold Storage Rooms

- Cold storage rooms shall be kept clean, free from objectionable odors, and in good repair. The following temperature shall be maintained:
  a. Chilling temperature= 0°C to 4°C
  b. Refrigeration temperature= 5°C to !8°C
  c. Freezing temperature = below 0°C

P. Poultry Handling Dressing Plant

- The walls shall have a height of at least 2.5 meters and shall have smooth internal surfaces which shall be painted with white, non-toxic oil or plastic paints.

10.3 INDIAN STANDARDS- BASIC REQUIREMENTS FOR AN ABATTOIR

- IS: 4393-1979

The flow and working system of an abattoir is greatly described in the code. Similarly, it describes about materials selection and other details with it.

IS : 4393 - 1979

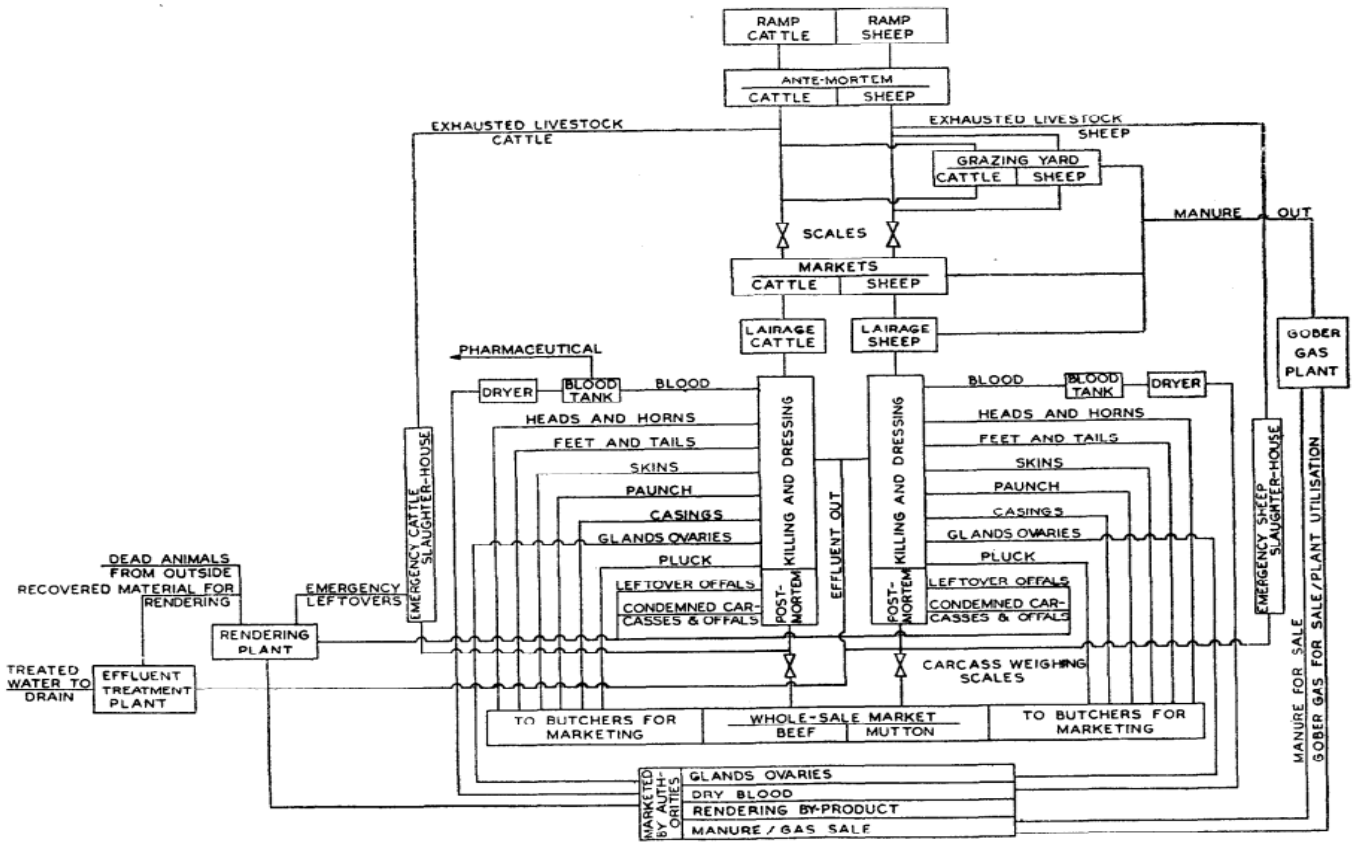
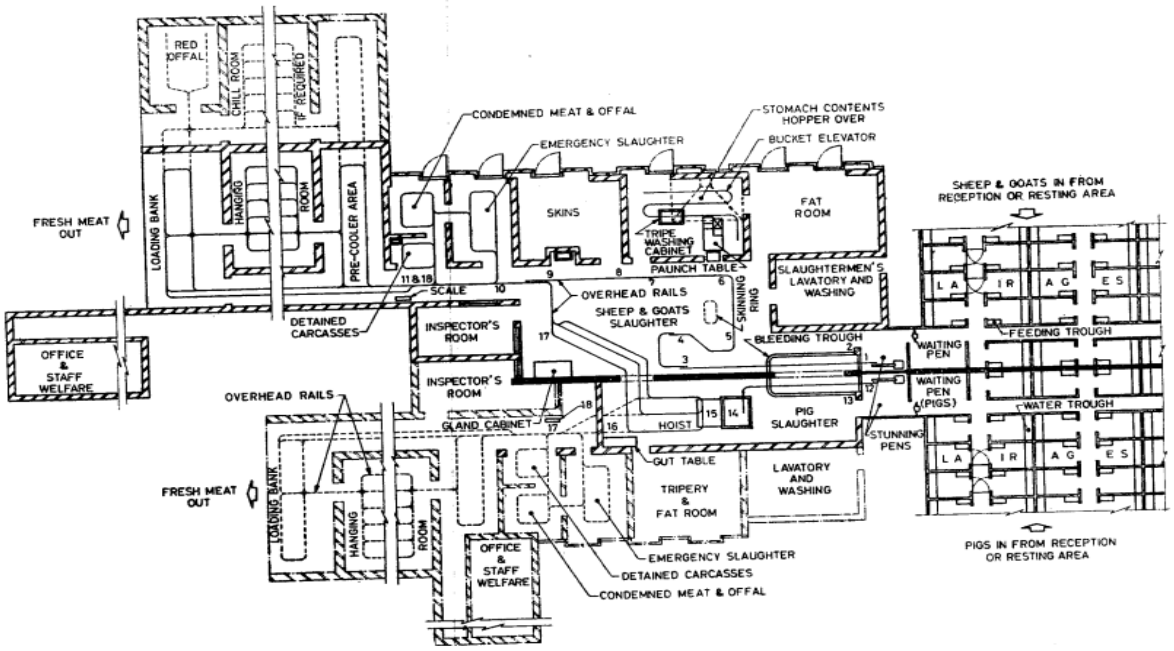


FIG. 1 ABATTOIR FLOW DIAGRAM



LEGEND

SHEEP AND GOATS OPERATION	PIGS OPERATION
1 Animal Stunned and Elevated to Bleeding Rail	11 Carcass Weighed, Transferred to Carrier and Passed to Pre-Cooler
2 Animal Stuck	12 Animal Stunned and Elevated to Bleeding Rail
3 First Legging	13 Animal Stuck
4 Second Legging	14 Carcass Lowered into Scalding Tank, Scraped and Lifted to Gambrelling Table
5 Shoulder and Breast Skinned	15 Carcass Hoisted to Dressing Rail
6 Belly Removed	16 Gut Removed to Gut Table, Fat and Edible Offal to Carrier
7 Red Offal Removed to Carrier	17 Carcass Finished and Wiped
8 Skin Removed to Skin Room	18 Carcass Weighed and Passed to Pre-Cooler & Hanging Area
9 Carcass Finished and Wiped	
10 Carcass Inspection	

—:— Indicates solid wall required for complete segregation (*HALAL* and *JHATKA*).

FIG. 2 TYPICAL LAYOUT PLAN FOR COMBINED SMALL ANIMAL ABATTOIR

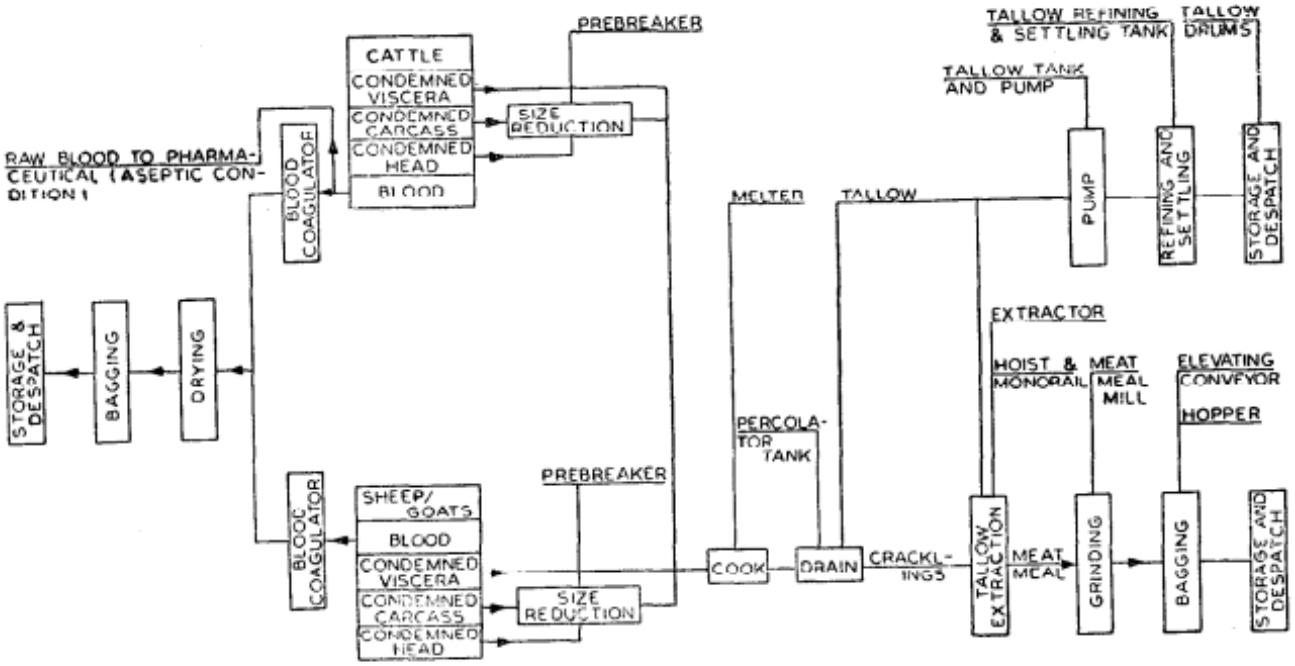


FIG. 8 BY-PRODUCTS (RENDERING) FLOW DIAGRAM

10.4 Construction Details of Abattoir

10.4.1 Materials Selection

A. **Ante-mortem and pen area** should be paved with impervious material such as concrete, non-slippery herring-bond type to be able to stand wear and tear by hooves, brick and must have drainage facilities. Curbs 150 to 300 mm high should be provided along the borders.

B. **Meat Plant Building** materials used should be impervious, easily cleansable and resistant to corrosion.

C. **Floors** should be non-absorbent with rough finish and must have suitable gradient. As a general rule, one drainage inlet should be provided for each 37 m^2 of floor space. A slope of about 20 mm per meter to drainage inlets should be provided for usual conditions.

D. **Interior Walls** should be smooth and flat and constructed of impervious materials such as glazed brick, glazed tile, smooth surfaced Portland cement plaster, or other non-toxic, non-absorbent material applied to a suitable base. It is recommended that the interior walls should have washable surface up to the height of 2 m from the floor so that the splashes maybe washed and disinfected.

E. **Ceilings** should be of good height (5 m or more is desirable in work rooms). So far as structural conditions permit, ceilings shall be smooth and flat. Ceilings shall be constructed of Portland cement plaster, large size cement asbestos boards with joints sealed with a flexible sealing compound, or other acceptable impervious material and finished so as to minimize condensation, mold development, flaking and accumulation of dirt. The walls (above glazed type portion) and ceiling may be painted with water-resistant paint to maintain them clean.

F. **Window ledges** should slope at 45^0 to promote sanitation. To avoid damage to glass in windows from impact of hand trucks and similar equipment, the window sills should be 1200 mm above the floor level. Proper ventilation through mechanical venting or through working vents should be provided in the roof structure.

G. **Doors** shall either be of rust-resistant metal construction throughout, or if made with rust- resistant metal having tight soft wood, they shall be clad or both side with soldered or welded seams.

H. **Vehicular Areas** for Trucks — Concrete paved areas, properly drained and extending at least 6 meters from building, loading docks or livestock platforms shall be provided at places where vehicles are loaded or unloaded.

I. **Uncolored glass** having a high transmissibility of light may be used in skylights and windows. The glass area should be approximately one-fourth the floor area of a workroom. This ratio should be increased where there are obstructions, such as

adjacent buildings, overhead catwalks, and hoists, which interfere with the admittance of direct natural light.

J. **Artificial lights** should not be less than 200 lux throughout the slaughter hall and on areas of meat inspection it mustn't be less than 500 lux.

K. Excepting such **equipment** as utility boards, other equipment shall be constructed either of rust-resisting metal such as stain- less steel or galvanized metal with smoothness of high quality commercial hot dip.

L. **Non-acceptable Materials** — The following materials shall not be used in an abattoir:

a) Copper and its alloys in equipment used for edible products;
b) Cadmium in any form in equipment handling edible products;
c) Equipment with painted surface in product zone;
d) Enamel containers or equipment is not desirable, and
e) Lead. (ISI, 1979)

10.4.2 Long Span Structures

Such plant requires large open spaces for working and various machineries in the factory. So open and unobstructed span is required for efficient flow and efficient organization of work. These types of spaces are usually achieved with long span structures which give span larger than 15-20m.

10.5 Building Typology of an Abattoir

The location of the slaughterhouse should be reasonably arranged in accordance with the principles of facilitating production and convenient transportation. The site must be located in downstream and downwind of residential areas to avoid pollution. The pavement of the plant area should be filled with cement to avoid dust and facilitate disinfection. A two-meter-high fence should be built around the plant to prevent other animals from entering. Greeneries should be set up, in order to regulate the air to prevent wind and sand. The plant should be set up in such a way that it has well lit up rooms and well ventilated working environment.

About the size, it is based as per the productivity in a single shift as per the slaughter capacity. About the exterior modern abattoirs must reflect the urban fabric of the space along with providing people with clean hygienic vibes and making the viewer comfortable to see the elevations of a slaughterhouse not regarding it as a place of horror. This can be done with sleek contemporary design with good materials choosing like bricks, steel, wood, glass construction and with proper shape of the building. (Wiles, 2014)

Figure 48: Modern Slaughterhouse Design

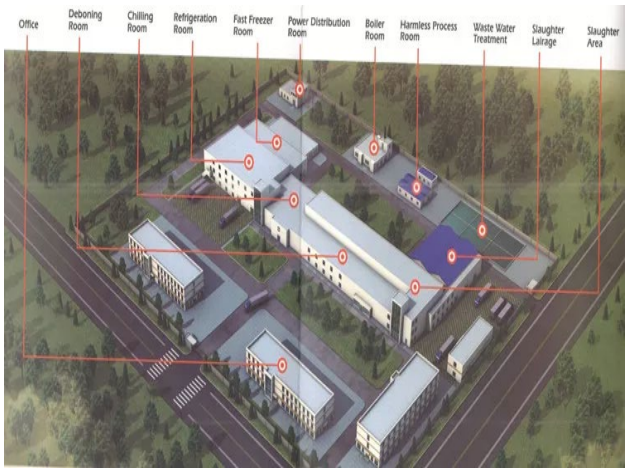


Figure 49: Slaughterhouse Park Components

10.6 Rainwater Harvesting

Rain water harvesting is the technique of collection and storage of rain water at surface or in sub-surface aquifers, before it is lost as surface run-off. Rain water can further be used for artificial recharging of ground water. It is a process by which the ground water reservoir is augmented at rate exceeding that under natural conditions of replenishment. Rain water harvesting overcomes the inadequacy of waters, helps maintain water levels. It increases infiltration of rain water in the subsoil which has decreased drastically in urban areas due to paving of open area and improves ground water quality by dilution. Further, it improves ecology of the area by increase of water in vegetation cover.

One such method to collect rainwater is Roof catchment system. Roof catchment systems channel rainwater that falls onto a roof into storage via a system of gutters and pipes. The first flush of rainwater after a dry season should be allowed to run to waste as it will be contaminated with dust, bird droppings etc. Roof gutters should have sufficient incline to avoid standing water. They must be strong enough, and large enough to carry peak flows.

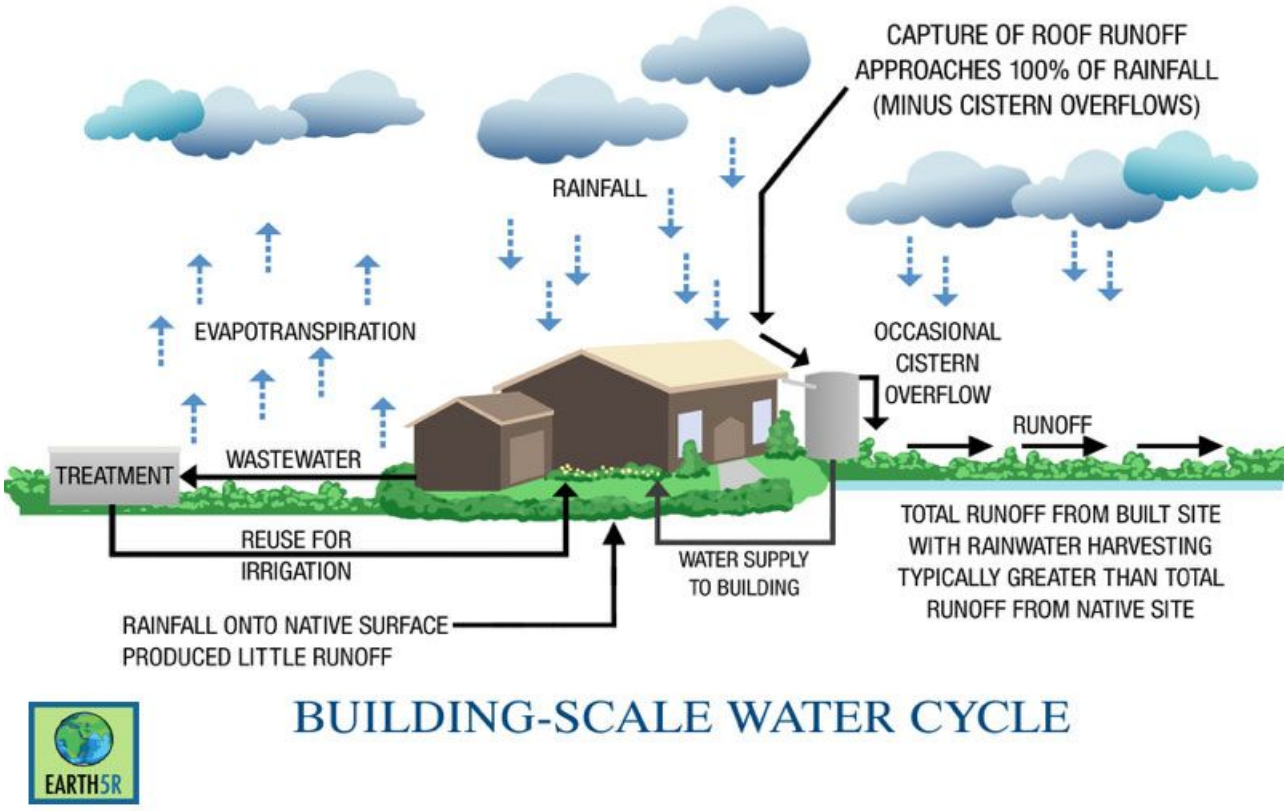


Figure 50: Rainwater Harvesting

10.7 Smell Repellents

Slaughter areas can create bad odors to people visiting the meat park. This problem can be treated with better orientation of slaughter hall from public space. Similarly, it can also be treated with a bit spacious gap between meat mart and slaughterhouse. Not only that, different plants can be used for smell repellent like:

- Bamboo Palm: The bamboo palm popular purifying plant due to its tropical look and insect-repelling quality. This plant also packs a big punch when it comes to purifying the air. The bamboo palm can remove substances like benzene, formaldehyde, chloroform, carbon monoxide, and xylene.
- Spider Plant: The long, grass-like leaves of the spider plant make an ideal hanging houseplant. These plants are also easy to care for and are quite hardy. The spider plant can remove xylene and formaldehyde from the air. To get the best results, place the plant near your kitchen or fireplace, since these areas are prone to carbon monoxide build up.

(Casandra, 2014)

Figure 51: Bamboo Palm

Figure 52: Spider Plant

10.8 Important Anthropometric Data

Other important spaces included in the meat park are as listed below. These data taken from Neuferts' Architect Data will help in design.

10.8.1 General Circulation

- General corridor width for circulation: 1.5 – 1.8 m
    - Minimum clear circulation: 1.2 m
    - Aisles which carry substantial traffic: 1.5 m
    - For moderate amount of traffic: 1.2 m
    - Aisles between rows of desk: 0.9 m
    - Space per person: 1.5 m^2 per person
    - Minimum Floor height = 2.7m
    - In case of false ceiling, min. Floor height = 3.9M

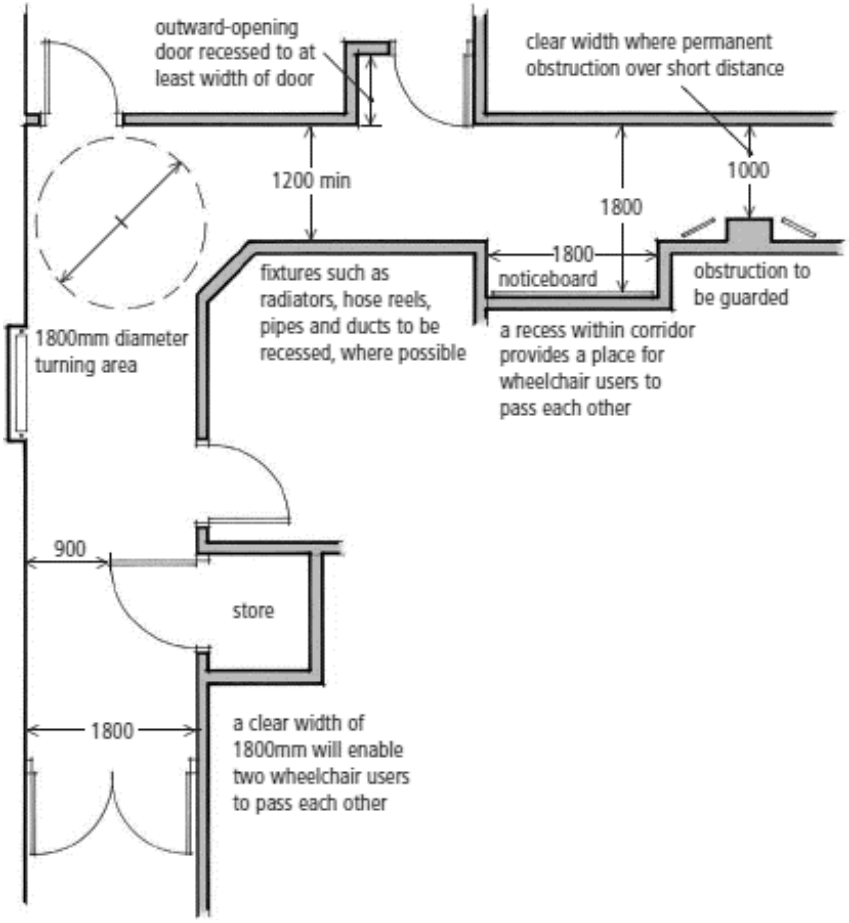


Figure 53: Minimum Corridor Dimension

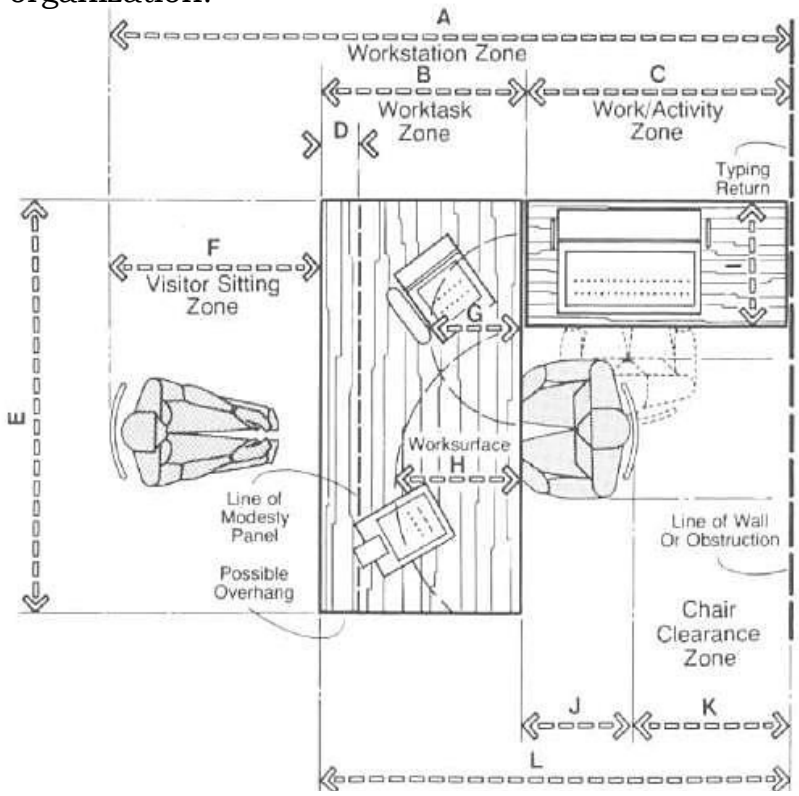
10.8.2 Administration

It is designed such that there is good communication between the workers.

- Staff room – 7-9 m^2 per person (individual 10 m^2 minimum)
- Additional spaces – Computer –2 m^2
- Photocopy – 2 m^2
- File storage – File cabinet –6-8 m^2 per 1000 files
- Chief and other head of section–18 – 30 m^2

10.8.3 Reception

Reception is welcoming space for visitors and serving them with the operation of the building. Its design consideration includes area between the entrance and reception, visitor seating, toilets and refreshment, and display area of the function of organization.



	in	cm
A	90–126	228.6–320.0
B	30–36	76.2–91.4
C	30–48	76.2–121.9
D	6–12	15.2–30.5
E	60–72	152.4–182.9
F	30–42	76.2–106.7
G	14–18	35.6–45.7
H	16–20	40.6–50.8
I	18–22	45.7–55.9
J	18–24	45.7–61.0
K	6–24	15.2–61.0
L	60–84	152.4–213.4
M	24–30	61.0–76.2
N	29–30	73.7–76.2
O	15–18	38.1–45.7

Figure 54: Reception Area

10.8.4 Office Spaces

The general space arrangement of office space includes:

- Office employees – 4.5 m^2
- Secretary- 6.5 m^2
- Departmental Manager- 9.3 m^2
- Director- 13.40 m^2
- Vice President- 18.50 m^2 (3 to 4 windows in length)
- President – 28.00 m^2 (4 to 5 windows in length)

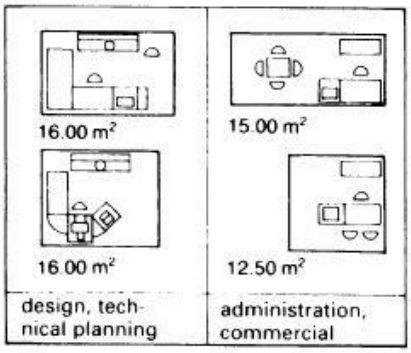


Figure 55: Office Areas

10.8.5 Lab Spaces

Laboratories are required for meat products research and detail chemical composition present in it. Some general considerations are:

- Normal measurements for standard workbench: 120cm width for practical, several times this for a research lab, 80cm depth of work surface.

- Benches and fume cupboards are usually part of a modular system, width of elements 120cm, fume cupboards 120 and 180cm.
- Benches are made of steel tubing, with work surfaces of stoneware panels without joints, less frequently tiles, or chemical-resistant plastic panels. Low cupboards are of wood or chipboard with plastic laminate. Supply services are from the ceiling void, or from below through the floor structure.

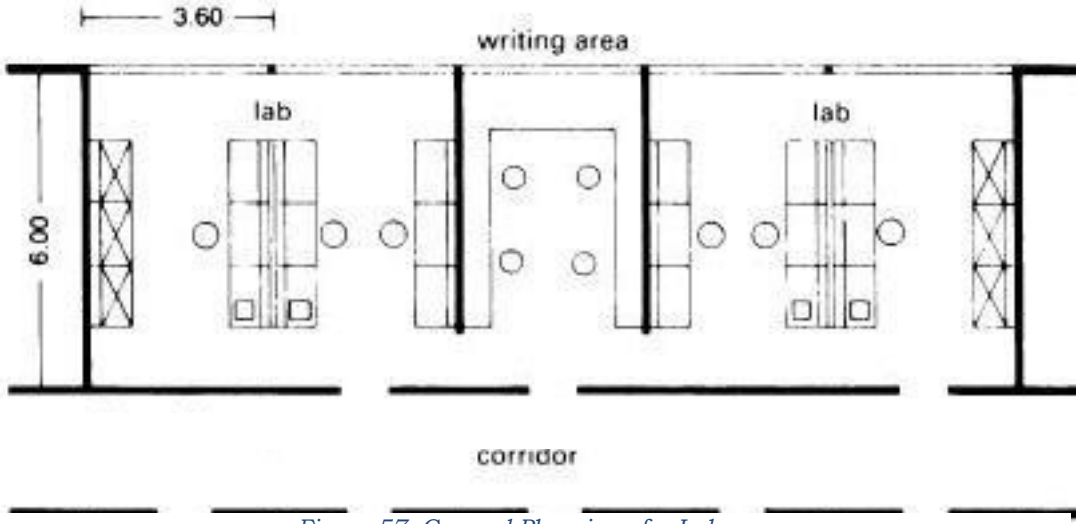


Figure 57: General Planning of a Lab

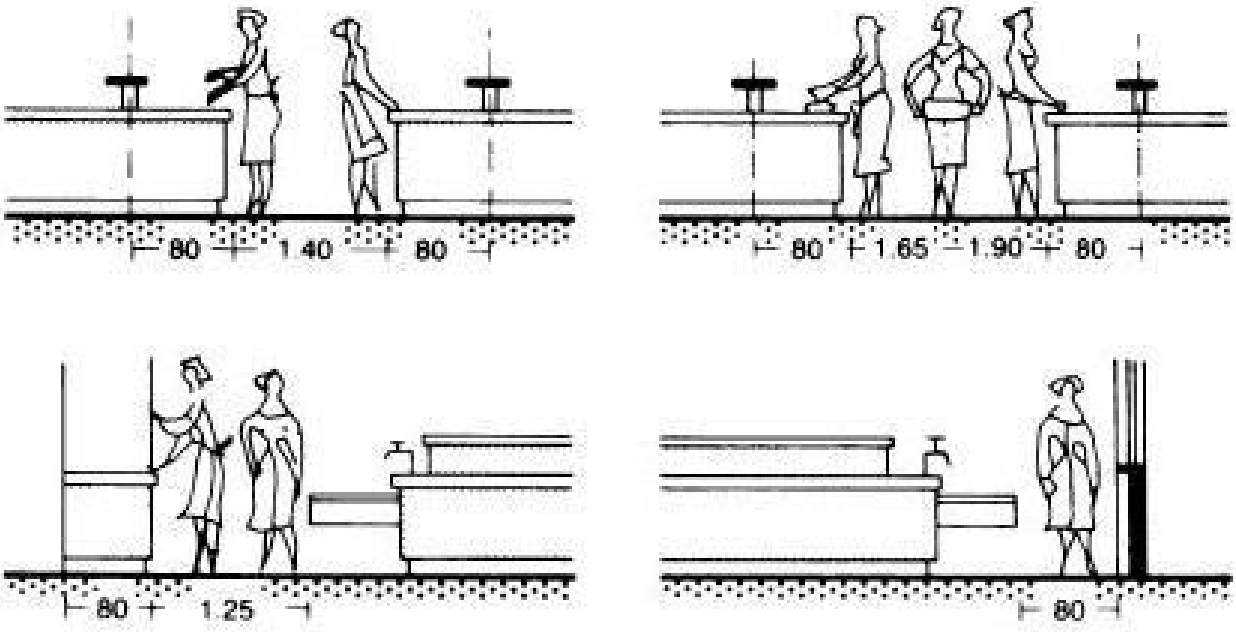


Figure 56: Minimum Passage between Workstations

10.8.6 Restaurants

Restaurants serve food and drinks to customers in exchange for money. They should be planned so that the variety of sitting can be achieved according to the number of customers visiting it and the planning of the restaurants should be flexible enough to accommodate variety of customers.

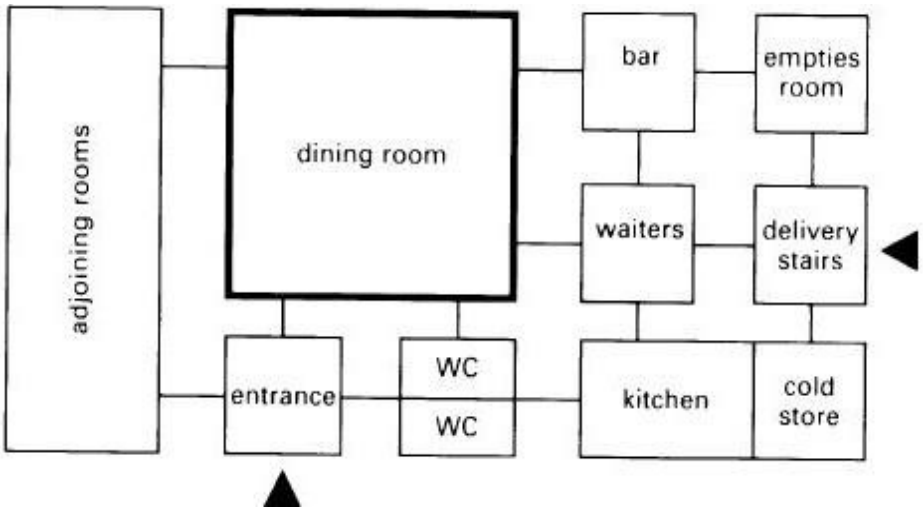


Figure 58: Functional Layout of a Restaurant

In primary space planning, "The rule of Thumb" for determining the area requirements of a restaurant is:

- Dining Room: 60% of total area
- Kitchen, cooking, storage, preparation, etc.: 40% total area
- Service aisles: 0.9-1.35m wide if used both by trolleys and guests
- The minimum width of escape routes: 1.0 m for 150 people
- General walkway width: Minimum 1.10 m with clearance height of minimum 2.1m
- Window area: ≥1/10 of area of the restaurant

dining floor area	walkway width
up to 100 m²	≥ 1.10 m
up to 250 m²	≥ 1.30 m
up to 500 m²	≥ 1.65m
up to 1000 m²	≥ 1.80 m
over 1000 m²	≥ 2.10 m

Figure 59: Walkway Width of Dining Area

Minimum width of service aisle	0.9 - 1.35 m
Waiter station	1 per 20-30 seats
Dining area per seat	1.5 - 2.15 m²
Kitchen area per seat	0.4 - 0.6 m²
Net kitchen area	
Ration of service area to total area	1/4-1/2

Figure 60: Areas per person in a Restaurant

Area of dining	**Ceiling height**
≤50m²	2.5m
>50m²	2.75m
≥100m²	3.0m

Figure 61: Ceiling Height in Restaurant

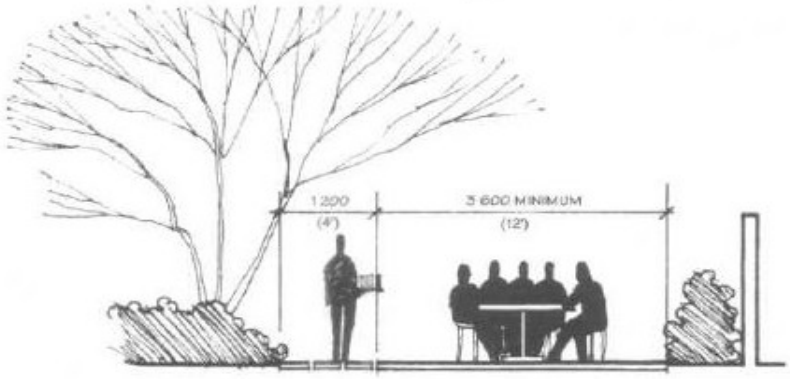


Figure 62: Outdoor Dining

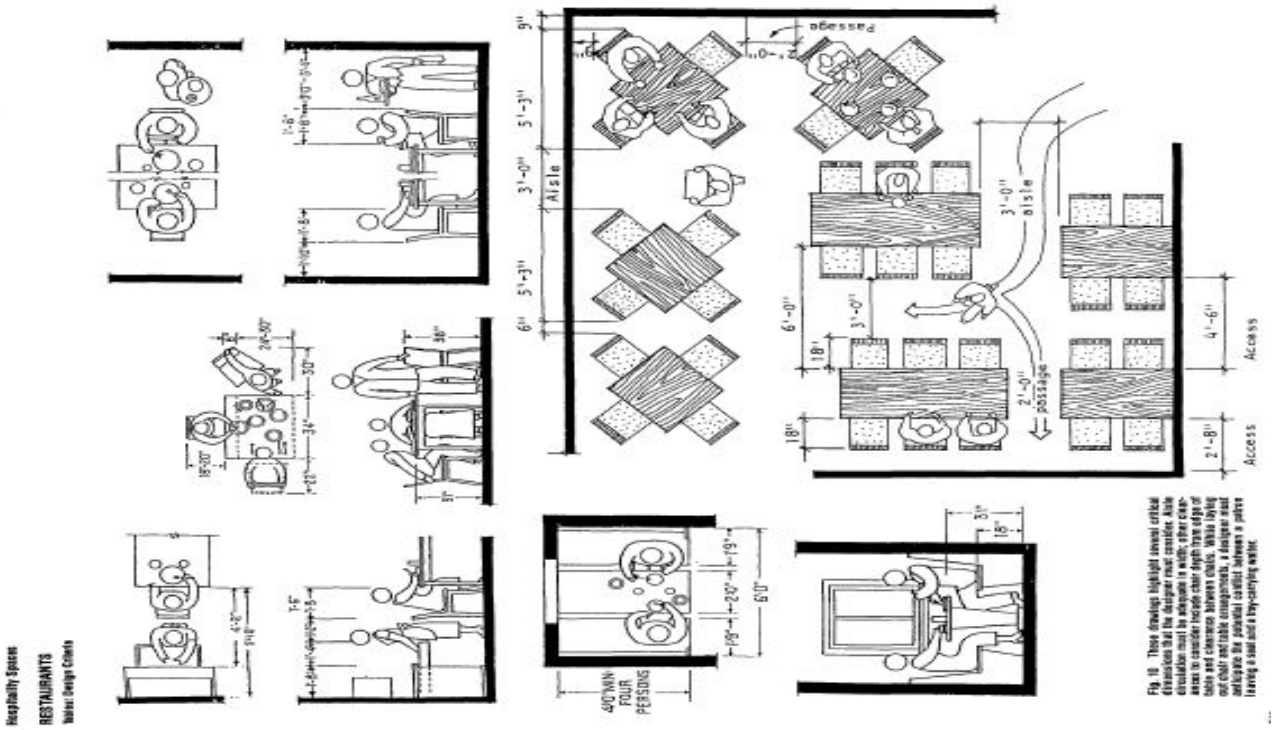


Figure 63: Seating Arrangements Data

10.8.7 Natural Lighting

In natural lighting the usual means of letting the natural light and air inside the building is through the
windows.

- Lateral lighting
- Ribbon windows
- Side lighting at high level

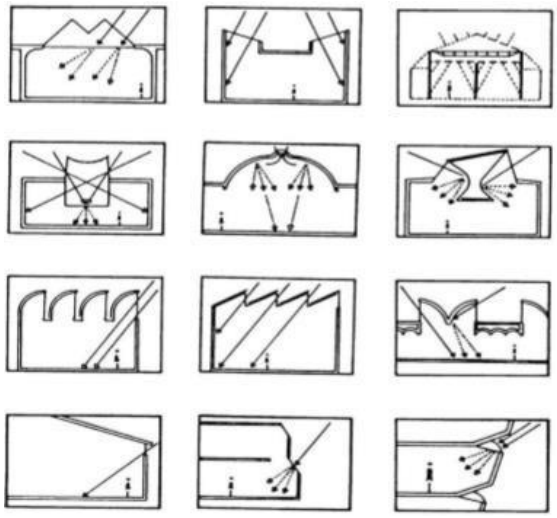


Figure 64: Lateral Lighting

10.8.8 Meeting/ Conference Hall

The conference room should be designed to accommodate average attendance; extra chairs can be provided for additional seating.

- Conference rooms - 1.39 m² per person
- Lighting requirement: 300 to 400 lux

Common room setup for Conference Hall

- U-shaped or Open-Eyed Style
- Theatre and Auditorium Style
- Conference or Board room Style
- Banquet Style or Rounds

Classroom Style

- Used primarily for presentation in which participants must work with the information they are presented.
- Generally, 6-8 ft. long and 18-30 inches wide tables are used. 2-3 people per 6ft. table and 3-4 people per 8ft. table.
- The benchmark is 14-16 sq. ft. /person for 18" table setup and 16-18 sq. ft. /person for 30" table setup. - Hollow Square Style

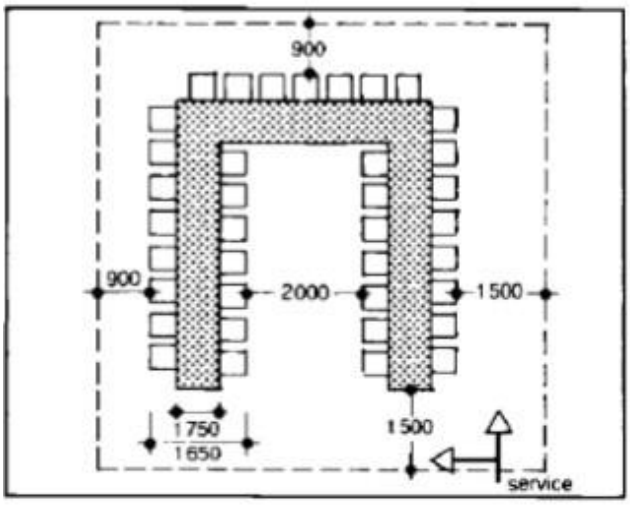


Figure 65: U-shaped Meeting Table

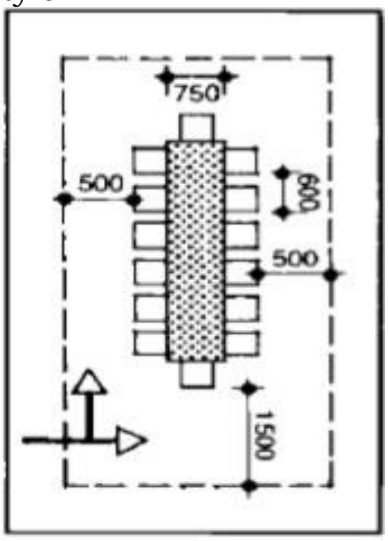


Figure 66: Normal Meeting Table

10.8.9 Parking

- Different Parking Layout are:
- 0 degree or parallel parking to road - entry and exit to parking area are difficult, suitable to narrow streets. (one-way traffic).

- 30-degree parking - easy entry and exit and used where large parking spaces can be provided, one-way traffic.
- 45-degree parking - good entry and exit, normal type of layout and small space used, one-way traffic.
- 60-degree parking - often used, good entry and exit can be achieved, less area
- 90-degree parking - sharp turn needed and used for compact planning, one or two-way traffic.

Type of Vehicle	Length (m)	Width (m)	Weight (m)	Turning Radius (m)
• motorcycle	2.2	0.7	1	1
• Car				
• Standard car	4.7	1.75	1.5	5.75
• Small car	3.6	1.6	1.5	5
• Large car	5	1.9	1.5	6
• Standard bus	11	2.5	2.95	10.25

Figure 67: Space Requirement for Vehicles

- Design issues and considerations:
- Car parking spaces for disabled should be more than 3.50 m wide.
- Turning circle for largest vehicle is an outer turning circle radius of 12 m.

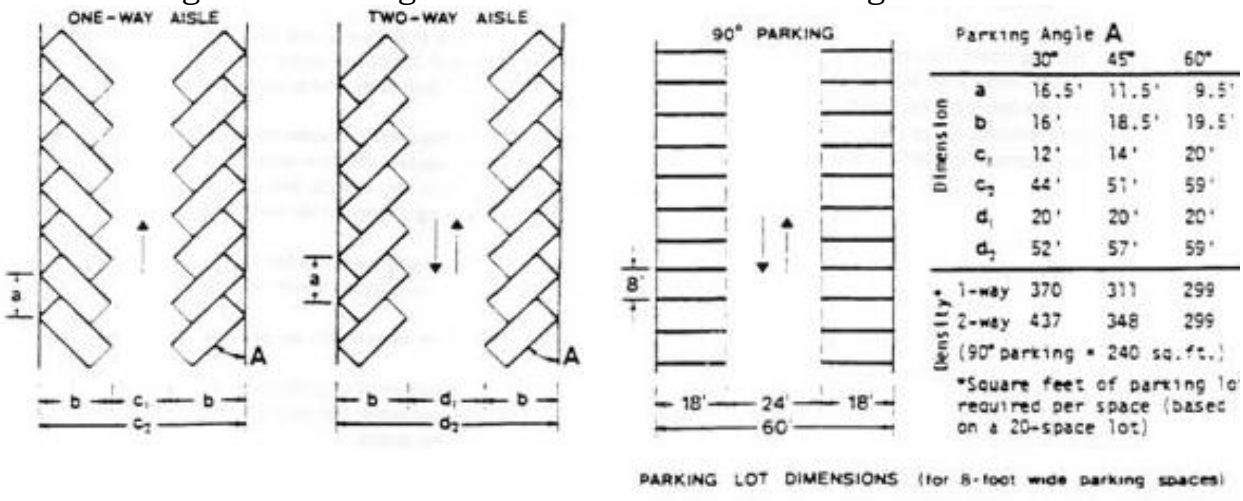


Figure 68: Angled Parking Layout

10.8.10 Outdoor Lighting

- Landscape lighting in resort is mainly focused on entrance, road, facade, inside courtyard, interior corridor, special features view and lawn.

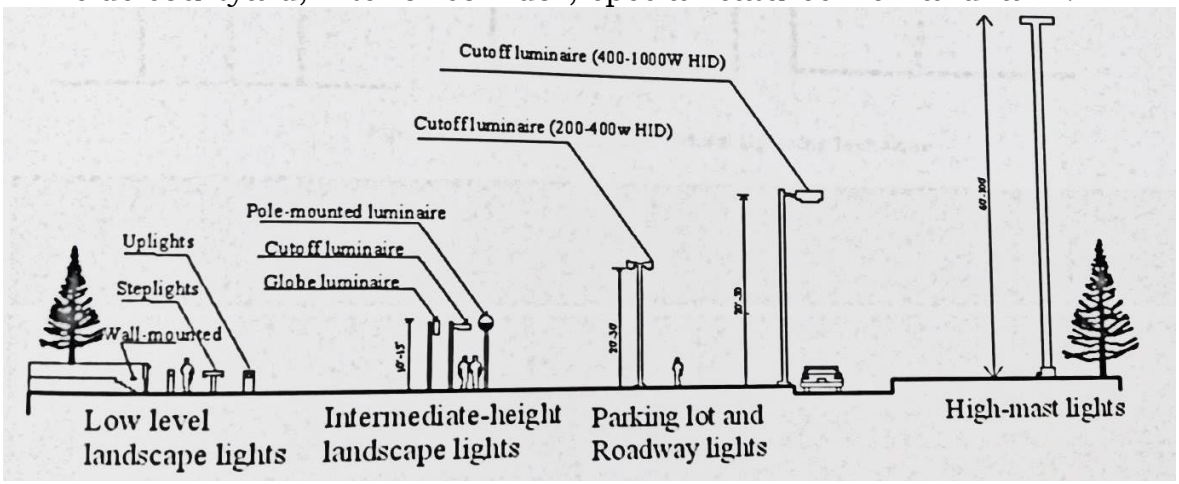


Figure 69: Types of External Lighting Features

10.8.11 Super Markets

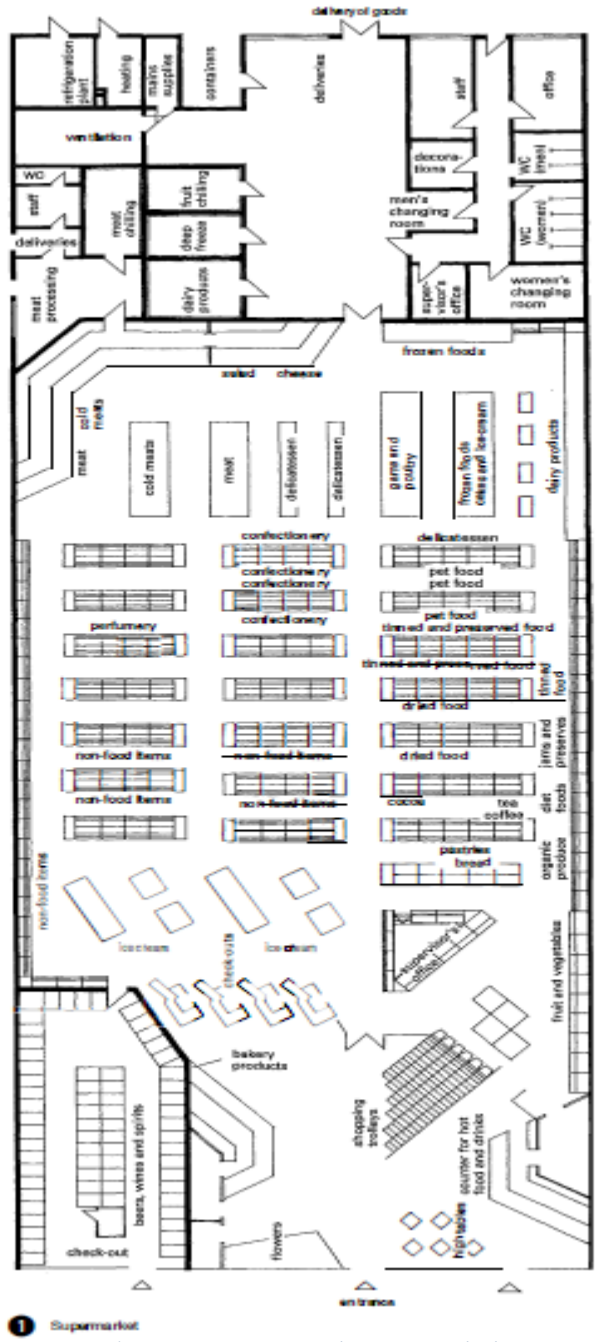


Figure 70: Supermarket General Plan

Important design parameters	up to 399 m²	400–499 m²	500–599 m²	600–799 m²	800–899 m²	1000–1499 m²
1. full-time staff needed	10.6	12.9	15.3	17.7	22.1	30.2
range	7–14	10–16	12–18	16–20	18–25	25–33
2. fresh and cold meat department						
a) turnover share (%)	22	21	20	19	18	17
	19–28	20–32	20–28	17–25	16–24	14.5–24
b) counter length (m)	6.50	7.60	8.75	9.08	9.75	11.75
	6.0–7.0	7.0–8.2	7.5–9.0	1.5–10.5	9.0–10.5	10.0–13.5
c) preparation room (m^3)	14	19	24	26	30	36
	8–20	13–25	18–30	20–32	23–38	23–50
d) cold room (m^3)	11	13.5	15	15	22	25
	7–15	9–18	10–20	10–20	14–30	16–35
3. dairy and fats department						
a) cool wall shelves (running m)	6.75	8.0	8.75	10.25	11.25	15.7
	6.3–7.3	6.5–9.5	7.5–11	9–12	10–13.5	12–18.5
b) cold room (m^2)	6.0	7.6	10.0	12.0	13.0	15.0
	4.0–8.0	5.0–10.5	8.0–12.0	8.0–15.5	8.0–18.0	10.0–20.0
4. frozen food (without ice cream)						
a) normal island (m)	5.5	6.1	7.5	8.75	10.1	13.5
	5.0–6.0	5.5–7.0	6.5–8.5	7.5–10.0	7.5–12.0	12.0–15.0
b) wide island (m)	3.85	4.1	5.5	6.75	7.75	8.75
	2.6–4.6	3.0–5.0	4.0–7.0	4.0–7.5	5.5–10.0	6.0–10.0
c) cabinets (m)	2.4	2.75	3.6	4.4	5.8	6.6
	2.3–2.5	2.3–3.2	3.2–4.0	4.0–4.8	5.0–6.5	5.5–8.0
d) freezer room (m^2)	2.4	3.25	5.0	5.75	8.25	8.5
	2.0–2.8	2.0–4.5	4.0–6.0	4.0–7.5	6.0–10.5	6.0–11.0
5. fruit and veg wall shelving (with 2 shelves) (m)	6.5	7.5	7.5	8.75	10.0	10.75
	5.0–8.0	6.5–8.5	7.0–8.0	7.0–10.5	8.0–12.0	9.0–12.5
6. no. cash desks						
– at checkout	2.5	2.9	3.4	3.9	4.9	6.3
	2–3	2–3	3–4	3–4	4–5	6–7
– in the departments	0.2	0.3	0.4	0.5	1.3	1.3
	0–1	0–1	0–1	0–1	1–2	1–2
7. no. shopping trolleys required	85	105	120	150	180	240
	70–100	85–130	100–160	100–200	150–220	200–300

Figure 71: Supermarket Space Requirements

11. Case Studies

11.1 National Case studies

11.1.1 Milijuli Badhsala

Figure 72: Milijuli Badhsala

General Information:

- Location: Parsa, Chitwan
- Area: Around 30 ropanies
- Meat animal: Buffalo
- Workers: 20-25
- 10 Crore Budget

Information on Slaughter:

- 14-15 slaughter of buffaloes
- Animals brought from Jitpur, Nepaljung, Parsa
- Slaughtering Method: Hammering
- Slaughtering as per the designated process
- Bones send to recollection for bone meal
- Leathers sent to India
- Electricity from NEA and water by deep boring

Why this case study?

- It is very first Modern Buffalo Slaughterhouse.
- It has designated spaces as required in slaughter.
- It has good space flow and functional linkage.
- It cares on waste management and almost all the waste produced is treated inside.

Space Zoning

The space has 9 different halls as per the function.

I. Shed- Block G
II. Lairage- Block D
III. Slaughtering Block- Block D
IV. Cold Storage block- Block F
V. Meat Processing Block- Block E
VI. Bone Boiling Block- Block A
VII. Bone meal preparation Area- Block B
VIII. Management Office- Block C
IX. Workers' Quarter- Block C

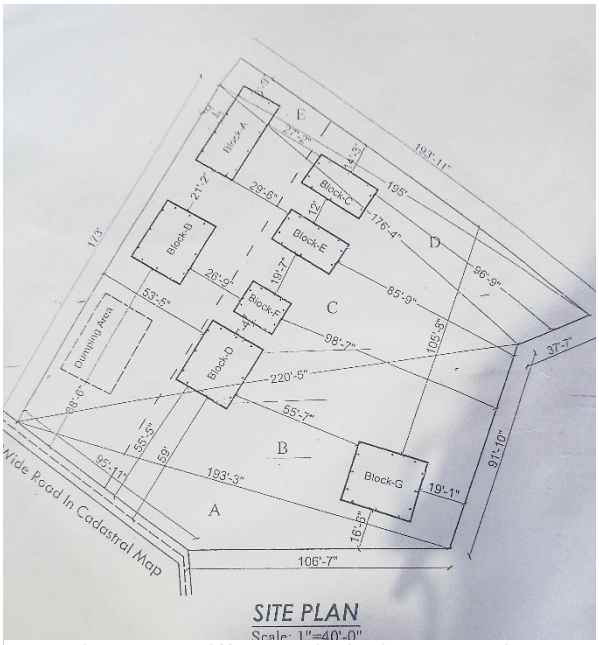


Figure 73: Different Blocks in Masterplan

Figure 74: Aerial View of Milijuli Badhsala

Space Flow and Planning

The boundary area is huge with different blocks but has a single entry within the site. From point A as in the masterplan, one enters the site. And, as per the fuction, like animal carrying vehicles, meat carrying vehicles or workers, they go to the designated spaces. The blocks are connected by normal concrete blocks pathways. The area has ample amount of green space and the designer has designed the block in such a way that it fits the abattoir flow.

Architectural Features

- As shown the blocks are simple geometric in shapes with sloped roof.
- The walls are simple plastered and given sky blue color which makes the environment cool as it is located in Terai and the floors are trowel finished punned cement floors.
- The roof is made up of Blue corrugated sheets.
- 2m pavement with cement blocks connects the blocks.
- The workers' quarter is a bit small with but cozy rooms.
- Huge lairage area that hold 35-40 buffaloes
- Presence of Management office, worker's quarters.

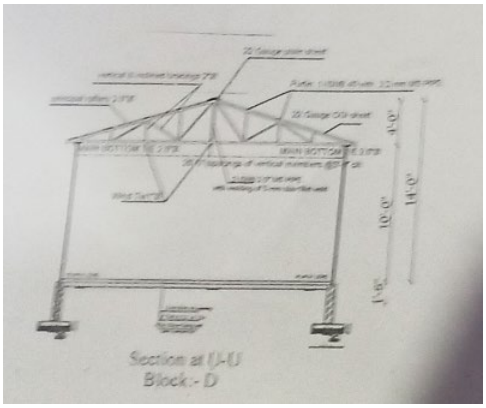


Figure 75: Section of Slaughter hall

Analysis

- There are no separate entries for services and other functions.

- There is presence of Bio-gas plant where the organic wastes are converted into gas used for cooking purposes.
- There is no presence of changing rooms as the workers change in their own quarters.
- Bones are prepared for bone meal and blood is collected and sold to fish breeders and pig breeders.

Figure 76: Holding Sheds

Figure 77: Slaughter Hall and Lairage Block

Figure 78: Interior of Slaughter hall

Figure 79: Interior of Cold Storage

11.1.2 Budhathoki Cold Storage

Figure 81: Budhathoki Cold Storage

Figure 80: Aerial View of Budhathoki Cold Storage

General Information:

- Location: Sitapaila, Kathmandu
- Area: Around 10 ropanies
- Meat animal: Chicken, Buff and Pig also processed
- Workers: Around 40

Information on Slaughter:

- 1800-2000 daily slaughter
- Birds brought from Dhading, Kathmandu and Kavre
- Slaughtering Method: Electrical stunning
- Slaughtering as per the designated process
- Bones send for Dog Food
- Electricity from NEA and water by deep boring

Why this case study?

- 2ND Largest Frozen Meat Producer in Nepal
- It has designated spaces as required in slaughter.
- It is modern Chicken Slaughterhouse and Meat Processing Facility.

Space Zoning

The boundary area is located in residential zone. It has different blocks but has a single entry within the site. On the entry, there is Administration on the left where there are meeting rooms, administration, staff rooms, account sections and director's room. Adjacent to this block another block is present where there is dispatch and storage section. Not only it processes the pig meat and buff meat into different products, it also has an area for Ice-Cream production. On the Southern most part, there is the main Block where Slaughter and meat processing of Chickens into different products takes place. In this very block there is a management section, lab and meat management director's office as noted by the green which keeps tracks of meat produced in a day.

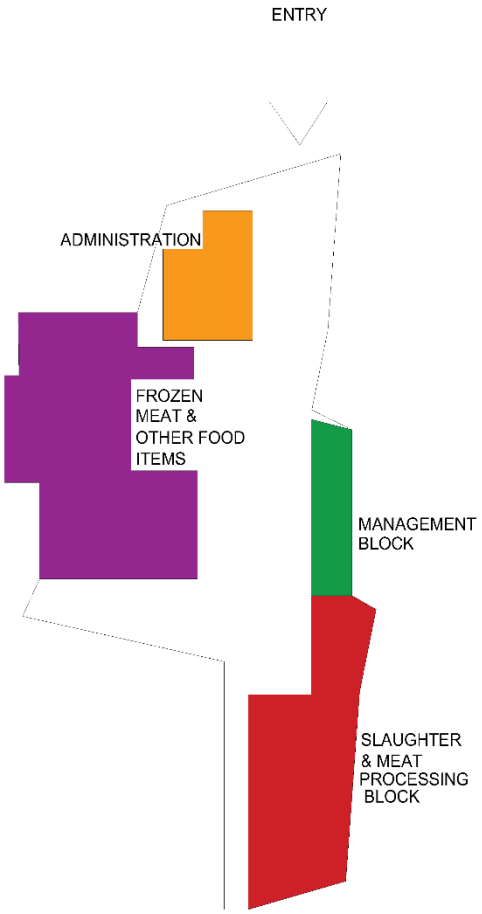


Figure 82: Masterplan of Budhathoki Storage

The slaughter block is 4 story building with a single entry to the block where birds are brought and kept into lairages and taken to various zones as per the slaughter facilities as shown in the figures below. The ground is the space where killing of birds and conversion of them into vacuum packaging is done and the first floor is the area where meat is stored into blast chillers and storage. And on second floor meat processing is done. The transport of meat and meat products is done through the lift. On the third floor there is continuation of management block and its facilities.

Space Flow and Planning

On Slaughter block, the birds enter through the entry and kept into lairages. They they are taken to hanging section, stunned, halaled by professional halals, scalded, deskinned/defeathered, eviscerated, leg cut and washed. Then they are chilled and taken to blast chilling and cold storage. Finally, they are packaged into vacuum packaging and sent to upper floors

Architectural Features

- As shown the blocks are made up of concrete construction which gives large inside span but covered with cement plaster.
- The roof is R.C.C flat roof.
- The inside flooring is made up of white tiles making it easier for cleaning.
- Both insides and outside is colored in plain white with purple tint as an accent coloring.
- The whole area is covered with concrete blocks with no greeneries.

Figure 83: Meat Processing and Dispatch Block

Analysis

- There are no separate entries for services and other functions.
- There is presence of all the slaughtering facilities.
- The building wasn't first made as slaughterhouse facility and later converted into it. So, the inside flow of the process interrupts at different functions which doesn't make the function linearly arranged.
- The blocks aren't separated as per the function as same block has management office, slaughterhouse and director's office.
- Except for Chiller Vans there is no desired parking space inside the area.
- There is no space for waste management.
- The inside spaces weren't quite spacious.

Lairage Space

Hanging Section

Stunning Section

Scalding Section

Bird Wash Section

De feathering Section

Leg Cutting Section

Screw Chiller

Drying Section

Meat Washing & Separation

Vacuum Packaging

Chiller Room

Lift

Cold Storage

Figure 84: Slaughtering Process Flow inside Budhathoki Cold Store

11.1.3 Valley Slaughterhouse

Figure 85: Valley Slaughterhouse

General Information:

- Location: Balaju Industrial State, Kathamandu
- Meat animal: Chicken
- Buff, Pig meat, Sea Food also processed
- Area: Approx.20 Ropanies

Figure 86: Aerial View of Valley Slaughterhouse

Information on Slaughter:

- 7000 daily slaughters
- Birds brought from Dhading, Kathmandu and Kavre
- Slaughtering Method: Electrical stunning
- Slaughtering as per the designated process
- Bones send for Dog Food, Offal and blood sent to pig food
- Electricity from NEA and water by deep boring

Why this case study?

- Largest Slaughterhouse in Nepal
- It has designated spaces as required in slaughter.
- It is modern Chicken Slaughterhouse and Meat Processing Facility.

- Fully Designed as Slaughterhouse to draw inferences from.

Space Zoning

The boundary area is located in industrial zone. It has different blocks and have double entry within the site i.e. one for slaughter process and another for staffs. On the main entry, there is Administration Block on the right where there is administration, staff rooms and managers room. Adjacent to this block another block is present where there is laboratory and quality checking labs. On the entry gate there is Guard House and adjacent to it there is Electrical Block with all heavy transformers. The back entry leads to 2 different blocks on the right side where there is Checking & Reviewing Counter and Staff Canteen. The back entry leads to service parking and import area where birds are landed. The main slaughter block is at the middle of the site where on the ground floor slaughter takes place while meat processing, labs and cold storage is on the upper floor. They are connected from 2 staircases and loading lift.

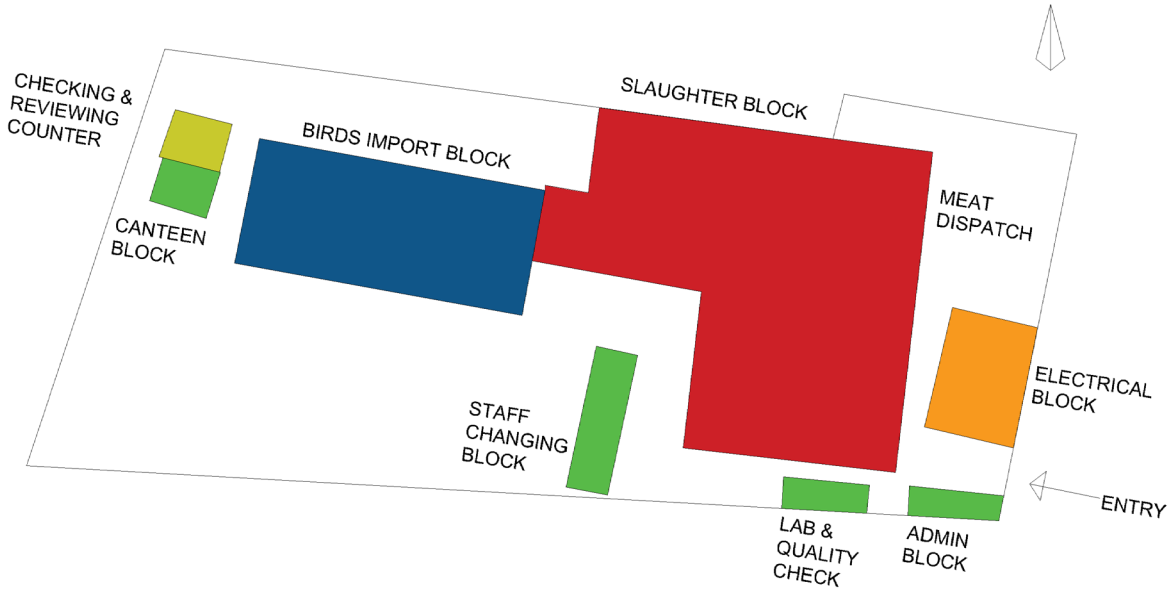


Figure 87: Masterplan of Valley Slaughterhouse

Architectural Features

- As shown the blocks are made up of steel construction which gives large inside span but covered with cement plaster.
- The sloped roof is Corrugated Blue sheets. While the main slaughter block has flat roof with Water Tanks and other facilities on the roof.
- The inside flooring is made up of white tiles making it easier for cleaning.
- Both insides and outside is colored in plain white.
- The area has pockets of green spaces which not only does the landscaping but also divides slaughter space from administrative section.

Figure 88: Checking & Review Counter with Service Entry

Figure 89: Unloading Section

Figure 90: Hanging Section

Figure 91: Evisceration Section

Figure 92: Chillers

Figure 93: Ice Room

Figure 94: Meat Processing Section

Figure 95: Meat Dispatch Section

Figure 96: Pockets Green Space

Figure 97: By-products Supply (Waste Management)

Space Flow & Planning

Birds are brought from service entrance and checked in review counter and then sent to lairage and hanged. Then it is Electrical stunned and halal takes place. Now, Scalding and defeathering is done, then Head removal and evisceration takes place. The leg is cut and sent to chillers and washed and sent to either fresh meat for packaging or upstairs on load lift as per demand. Then it is taken to Deboning section and send to blast room and cold room for chilling. Lab checking takes place between the processes. And on meat processing section upstrairs it is further processed into momo, sausages, peperoni, salami, chicken fingers, chicken nuggets and sent to cold room for storage. Then it is dispatched in chiller vans for market.

Analysis

- There are separate entries for services and main entry.
- There is presence of all the slaughtering facilities and various blocks like Slaughterhouse, Administration, Electrical Block, Review Counter, Canteen, Staff Block and Service import and export block.
- The functions are linearly arranged as per the flow and are quite spacious.
- The blocks are separated by green pocket spaces.
- There are spaces for waste management and by-products processing.

11.1.4 Valley Cold Store

Figure 98: Valley Cold Store

General Information:

- Location: Balaju, Kathamandu
- Meat animal: Chicken, Fish for fresh meat
- Buff, Pig meat, Sea Food also processed

Why this case study?

- Modern Meat Mart in Nepal
- It has designated spaces as required in Meat Park.
- Consumers can choose either Frozen meat, fresh meat or eat inside the fast food restaurant as per the liking.

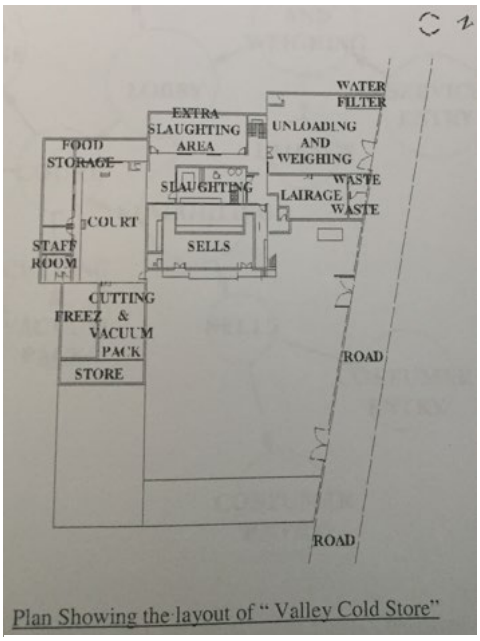


Figure 99: Floor Plan of Valley Cold Store

Space Zoning

This meat market is located just outside the ringroad and consists of mainly 3 major components i.e. Restaurant Block, Meat Sales Area and Administration. Ground Floor has supermarket area for various frozen meat products on the front side while fresh meat section is at the rear side of the block. The exterior stairs lead to administrative section on the upper floor where there are Reception, meeting room, HR room, Manager's room working cubicles and marketing section.

Space Planning

- 3 major spaces
- One: Valley Express
  - Fast food restaurant for different meat fast food products
- Two: Valley Mart at the main entrance
  - Super market consisting of various packaged meat products, frozen and processed meats
- Third: Fresh meat Cold store at rear side
  - For selling of freshly cut meat of chicken and fish as per customers' demand
- Ample parking space for users
- Upper 2 floors for marketing and administration offices.
- Courtyard Space which is utilized by both bank and valley store users.

Figure 100: Supermarket Area

Figure 101: Fresh Meat Section

Figure 102: Parking Space and Courtyard Space

Architectural Features

- As shown the blocks are made up of R.C.C. construction which gives large inside span but covered with cement plaster.
- The area has no pockets of green spaces and there are no areas defined in the courtyard which make the big space not so much mobile in activities and social interaction.
- The spatial flow can be directed in a proper way as at present it is too random.

11.2 International Case Studies

11.2.1 Sheung Shui Slaughterhouse

General Information:

- Location: Sheung Shui, Hong Kong
- Area: 5.8 hectares
- Cost: HK$ 1.858 billion in 1999
- Architect: Architectural Services Department Hong Kong

Figure 103: Exterior View

Information on Slaughter:

- The facility can slaughter up to 5000 pigs, 400 cows and 300 lambs per day.
- The slaughterhouse can accommodate 12,000 pigs and 2200 cows.

Why this case study?

- Biggest Meat plant in Asia.
- Has wide use of architectural features in the design.
- Best waste management techniques have been applied in this project.

Space Zoning

Abattoir's & quarantine facilities consisting the following elements:

- Lairage block 38,000 m^2 with 3 no. storeys
- Slaughter block 11,800 m^2 with 3 no. storeys
- Meat despatch block 2,200 m^2 with single storey
- Administration block 2,950 m^2 with 4 storeys
- Platform and railway siding area 2,520 m^2 with single storey
- Wastewater Treatment Plant (underground) 9,500 m^2 x approximate 12 m high

Figure 104: Masterplan showing different Blocks

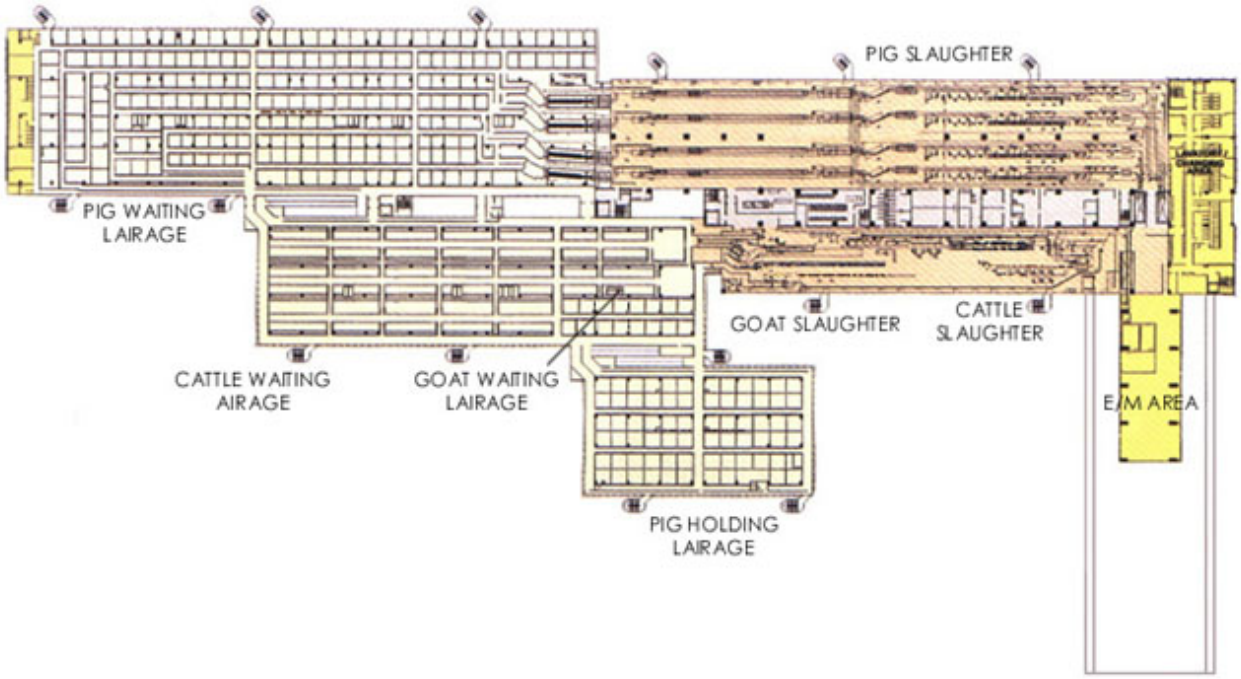


Figure 105: Floor Plan

Design Considerations

A. Hygiene

Figure 106: Slaughter Hall

- Physical separation between "dirty" and "clean" operations.
- The homogeneous clean area consisting of slaughter hall and meat dispatch area, including delivery vans, are fully air-conditioned to avoid contamination from outside.
- Floor and wall finishes in slaughter hall is seamless construction to avoid the accumula - adsorptive and can be easily cleaned by using water jet.
- Height of conveying belt is design at 2.40m high to meet the EC standard, so that the carcass will not be contaminated by splashing water.
- Equipment and knife sterilizers and wash hand basins are strategically and conveniently located along the slaughter line to ensure proper cleaning after slaughtering process of each pig/cattle.
- Chemical treatment is provided for the chilled water system and cooling tower.
- Hot water cleansing is provided for washing down the slaughter hall after slaughtering.

B. Safety

- Protection covers and facilities are installed to all equipment and plants. Warning signs and signals are displayed at appropriate locations. Adequate rails and barriers are provided to protect the workers.

C. Efficiency

- Automatic machine for almost all the slaughter process which reduces manpower and increases efficiency.
- Energy efficient and environmental friendly building services design is adopted. In particular, hot water is one of the main consumable resource in the slaughter operation, estimated at 630 m3 per day year round (equivalent to 8,000 households), solar hot water system is provided comprising 450 solar panels.
- Heat pump system is installed which allows the provision of cooled air to the Slaughter Hall and Meat Dispatch Area on one hand while the rejected heat is used to heat up the water for the hot water system making it an energy efficient design.
- Auto-occupancy sensors and temperature controllers are provided for air-conditioning control in non-operation areas.
- Effluent water from Shek Wu Hui Sewage Treatment Plant is used for cooling the condenser of the air-conditioning plant.
- Energy efficient discharge lighting and fluorescent fittings with electronic low loss ballast are provided. Building management system is used to provide time scheduled lighting control to save electricity consumption.
- Variable speed motors and fans are provided to meet with different operating conditions in various areas to save energy.
- Emergency generator power supply is provided to maintain two pig lines and one cattle line in operation during power interruption from Supply Company.

Figure 107: Solar Panels on the roof

D. Waste Water Treatment

- The slaughter house operations will normally create 5,000 m3 of waste water of which the concentration is approximate 10 times higher than the domestic wastewater levels. The new facilities operation efficiency will minimize the use of water by 20% whilst maintain a higher hygiene standard.
- The 5,000 m3 waste water generated daily from the slaughtering operation, lairage and unloading yards is pre-treated by an underground waste water treatment plant to achieve the Domestic Effluent Standards before passing to the Shek Wu Hui Sewage Treatment Plant for further treatment.
- An effective and extensive waste water collection system is provided with separate drainage for storm water. The dirty water generated from washing of unloading yards is directed into the waste water treatment plant while heavy rain water overflows into the storm water drain to prevent overloading of the waste water treatment plant.
- An on-line monitoring and logging system is provided to monitor the discharge continuously to ensure its compliance with the Standards.

E. Indoor Air Quality

- High efficiency particulate filters are provided for the fresh air supply to clean areas of the slaughter hall.
- Ultraviolet light air sterilization system is provided for the clean area of slaughter hall and meat dispatch area.
- Positive pressure is maintained by air-conditioning system in meat dispatch area to avoid ingress of outside air during loading of carcasses to the vehicles.

F. Odor Control and Gas Emission

- Odour sensitive receivers were identified and odour emission computer modelling was carried out to ensure that the odour level at the sensitive receivers complies with the environmental guidelines.
- Odour removal systems are provided to reduce the odour below nuisance level at the sensitive receivers. These include the provision of chemical scrubbers, the largest in Hong Kong, and the use of odour neutralising agent system.

Figure 108: Water scrubber to reduce odours

- Gas emission from chimney provided for emergency generator and boiler exhaust is designed to comply with the air control standard.
- Water hose points are provided for floor cleansing of the lairages and external unloading and holding areas to reduce odour.
- Lorry washing bay is provided for washing the lorries before transporting the livestock to Tsuen Wan Slaughter House.
- Collection skips and containers for transporting coagulated blood, condemned carcasses and sludge are of enclosed design to minimize odour emission.

- Chutes are provided for direct dumping of manure into the collection skips to reduce odour.

G. Noise Mitigation

- Noise control measures are adopted to meet with statutory requirement for night time in the rural areas at the sensitive receivers. These include acoustic louvres for lairages, acoustic enclosures and silencers for plant, acoustic linings for plant rooms, and enclosed building fabric design with double glazed glass panels for slaughter hall.

Figure 109: Acoustic louvres for noise mitigation

- Perimeter noise barrier walls of 2 to 4m high are erected to reduce noise impact due to train unloading and lorry loading.
- Offsite noise barrier walls of 3m high are erected at Po Wan Road to reduce road traffic noise impact to the Sheung Shui Village as close as 50 meters.

H. Solid Waste Disposal

- Vehicles with close containers will be provided for the disposal of various solid waste up to 14 tons.
- Sludge and coagulated blood are de-watered to meet with 30% solid content requirements before being disposed to designated landfill site.
- Condemned carcasses and meat are stored in chilled room and put in plastic bags before being disposed to designated landfill site.

(Hui, 2003)

11.2.2 Modern Slaughterhouse Gazipur

General Information:

- Location: Gazipur, New Delhi, India
- Area: 36167.4 m^2
- Ground Coverage: 43%

Figure 110: Gazipur Slaughterhouse

Why this case study?

- Regional Slaughterhouse.
- Two different slaughter method with convenient flow inside a single building.

Design and Planning

This abattoir consists of five main functioning blocks: The rendering plant, Lairage unit, Slaughtering plant, Power plant and Administration Blocks.

The complex has 2 gates i.e. one for administration block while other for slaughter plant.

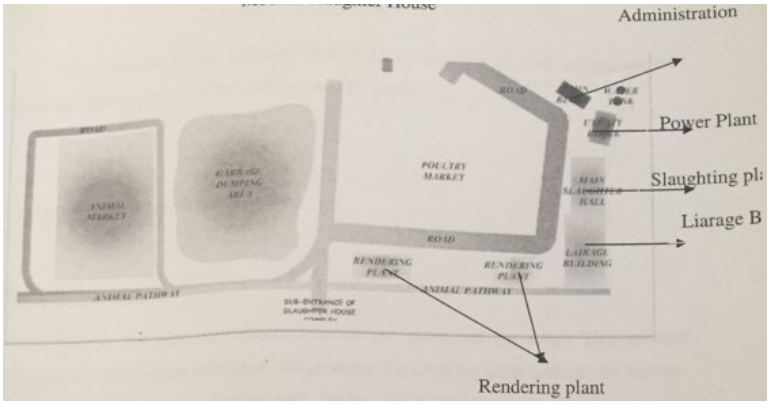


Figure 111: Various Blocks inside Meat Plant

The administration block consists of MD room, CEO room, Manager's room, Marketing section, accounts and administration. It is located near the first entrance as it controls the plant. Along with it there is a power plant which contains Boiler plant, Electrical room, Pressure plant, Generator Room, etc.

It is followed by the main slaughtering plant which is further divided into Slaughtering Clean Area, Slaughtering Unclean Area and Storage. It is followed by lairage unit where animals have 24 hour fasting period before slaughter and rendering plant where meat is processed into various meat products.

Planning of Important Blocks

A. Slaughtering Plant

It has 3 slaughtering lines 2 for goats and one for buffalo. The 2 goat's lines are due to religious differences i.e. Jhatka method used for Hindu Customers and Halal method used for Muslim Customers. The animals are first brought into lairage and 24 hours of fasting and ante mortem inspection is done and sent to slaughter runway. The runway is 700 mm width for buffalo with 1400 mm high side wall. It leads to unclean, clean and cooling are. The activity up to removal of skin takes place in unclean area while other activities before storage takes place in clean area.

a) Slaughtering Unclean area- It contains Stunning unit, Blood Removal unit, Space for limbs removal, Pre de-hiding space and Final de-hiding Space.
b) Clean area- It contains Washing Space, Carcass Open space, Offal Removal area, Carcass Inspection, Trimming, Weighing Classification, Storage.

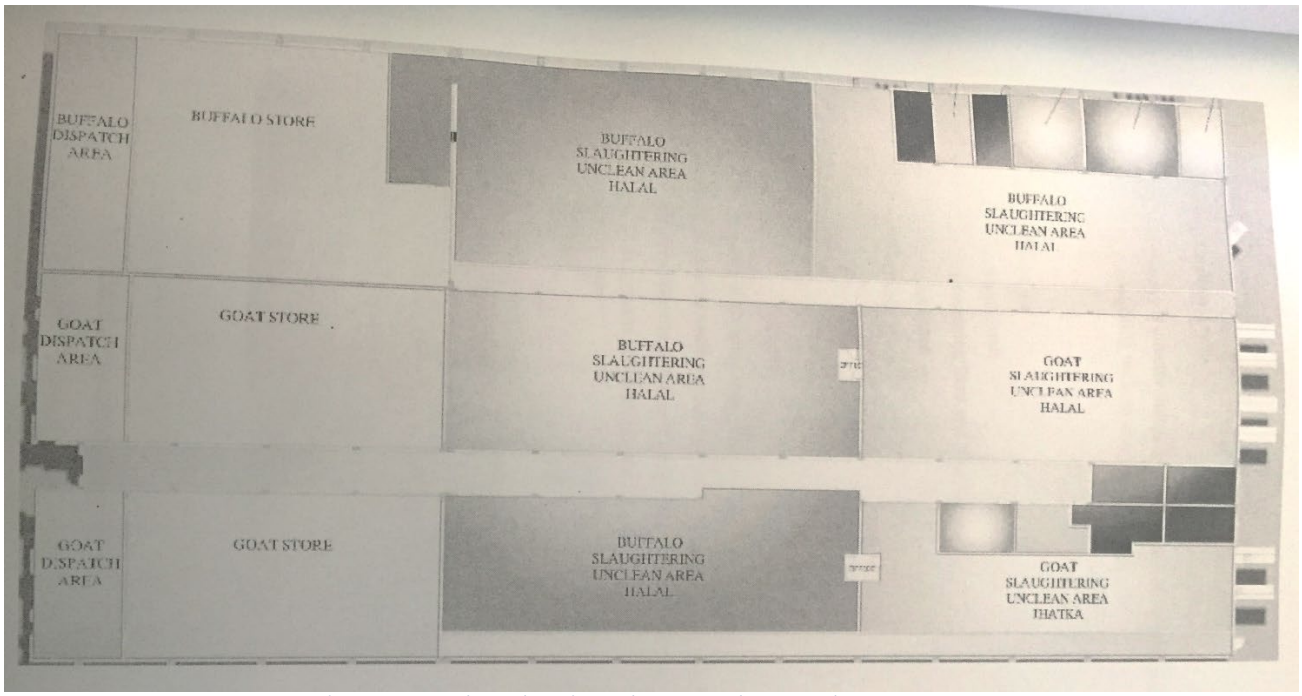


Figure 112: Plan showing Clean, Unclean and Storage Area

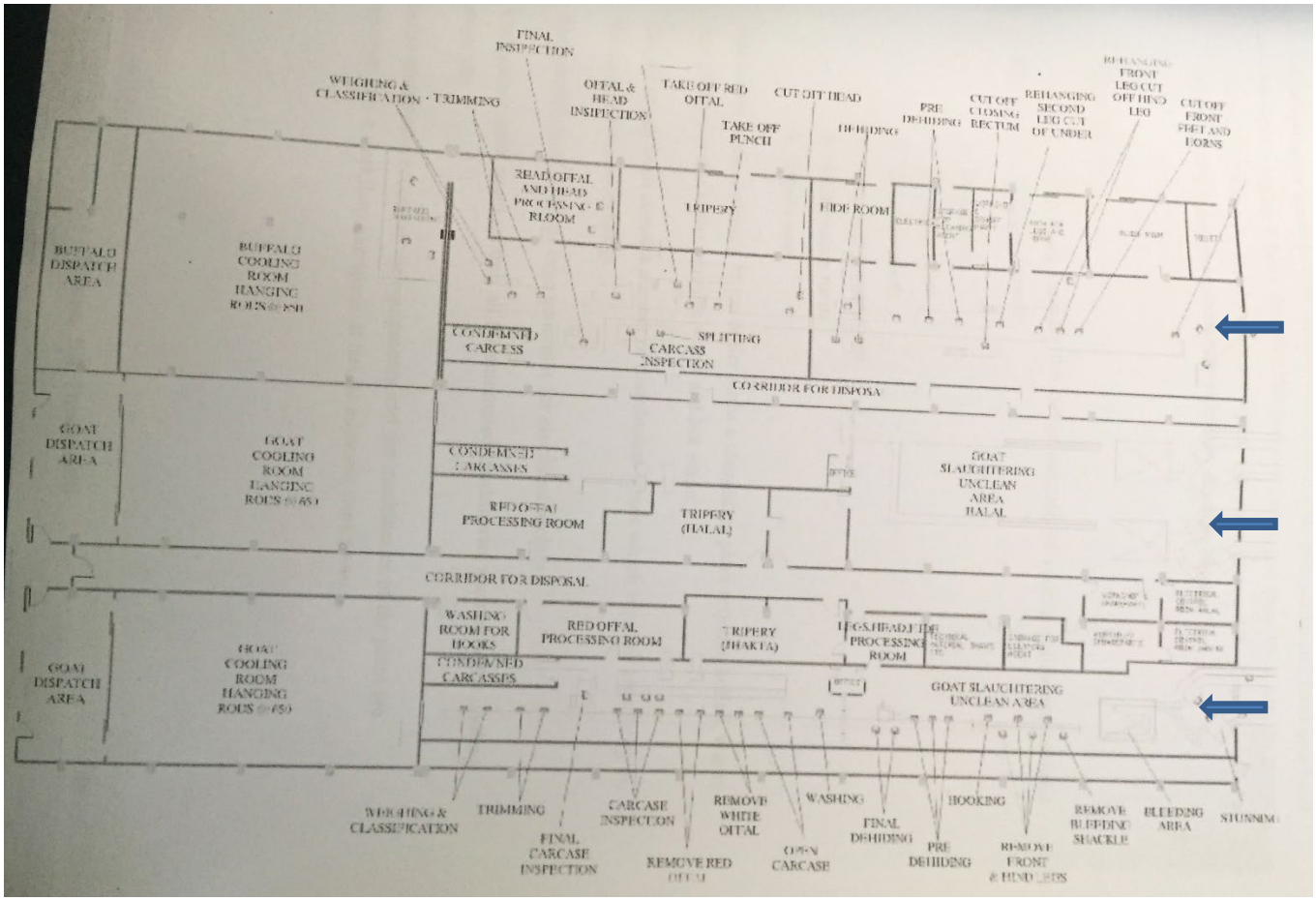


Figure 113: Ground Floor Plan of Slaughter Hall

B. Utility Block

This slaughterhouse has capacity of 500 buffalo, 1500 goat Jhatka and 3000 goat Halal slaughter per day working 8 hrs. The power demand is 800 KVA. So, there is presence of Utility block where there are Boiler room for hot water, Electrical room, Generator room for backup, Computer Control room for automated machines, Maintenance room and Store room.

Architectural Features

- It is in fringe of city of Delhi away from Residential areas.
- It has a bold rectangular shape having size 88 m X 44m.
- Slaughter hall is huge span structure with span 10m x6 m. It is held by heavy R.C.C. columns of 730 mm x 480 mm. The clear height for buff space is 7.5 m while goat area has 6.5 m
- The floor is finished with grey colored Marble.
- Walls id cladded with White colored square glazed tiles.
- The natural light comes from non-opening windows and ventilation through central air conditioning system.
- Cooling room uses perforated puff materials for insulation.
- Ceiling uses thermcol board for False ceiling.
- The roof is flat R.C.C roof. The overall building is coated in plain white while the upper administration section is painted in Yellow.

11.2.3 T-HAM PABP Factory

General Information:

- Location: Pingtung, Taiwan
- Area: 24000 m^2
- Year: 2019
- Architects: WZEX Architecture Group

Figure 114: Location Plan Showing T-HAM Factory

Information on Slaughter:

- The facility can produce 1200 tons of processed meat of hams, sausages and bacon.

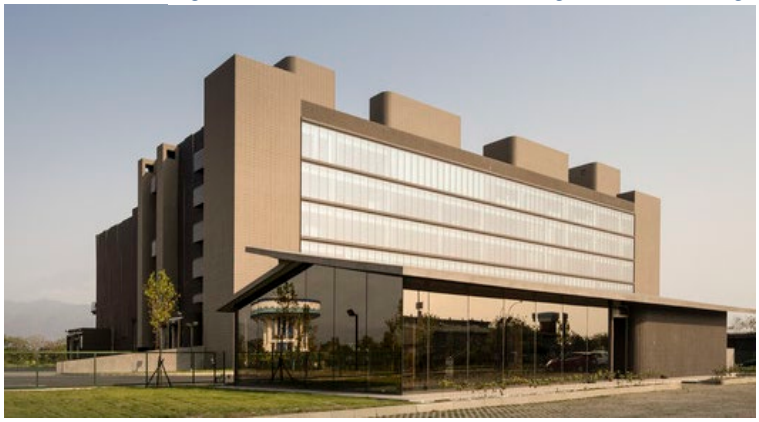


Figure 115: T-HAM PABP Factory

Why this case study:

- This facility is one of the very best in meat processing.
- It is designed in such a way that it incorporates much daylight and views of the outside to improve users' experience as "happy employees make better products" and also connect with the outside people.
- It provides quality products with sustainable development and environmental friendliness as one of their main principles.

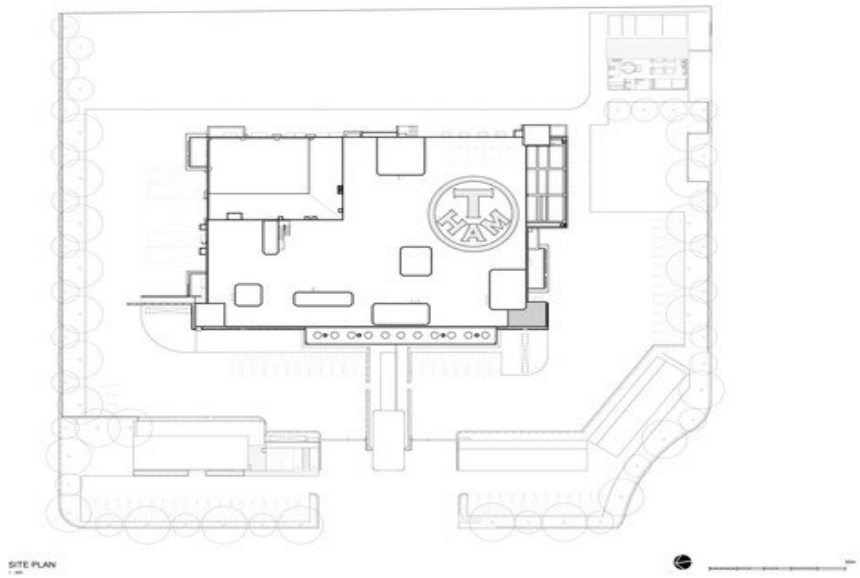


Figure 116: Site Plan of T-Ham Factory

The pink space shows the cooked zone and the blue space shows the main zone inside the building.

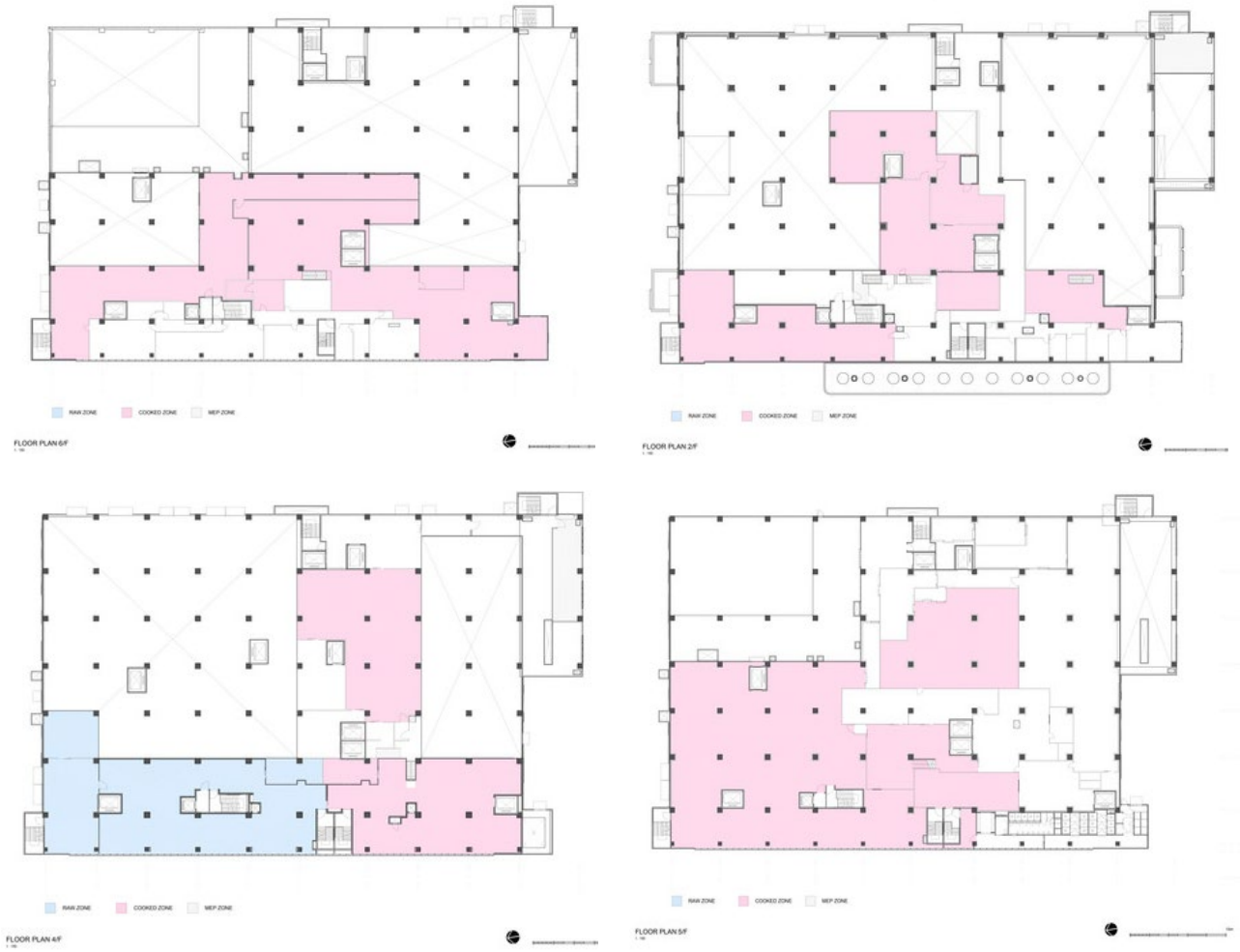


Figure 117: Floor Plans Showing Interior Planning

Concept:
The design concept of introducing good views and daylight into the workers' office and social areas has made the factory workers' daily experience much more pleasant. This has been translated into better motivation and improved product quality.

Architectural Features & Planning:
The factory had to be strictly separated between the production areas of raw meat and cooked meat. The separation of circulation starts at the factory entrance. Staff working in the raw and cooked meat sections enters from different entrances.

Front Part
The factory's various so called ancillary functions were identified and organized to the "front" of the building behind a curtain wall facade in order to provide plenty natural light and views for these human activities. The glazed front façade also gave the factory a more open identity, offering visitors and neighbors visibility of the activities taking place inside.

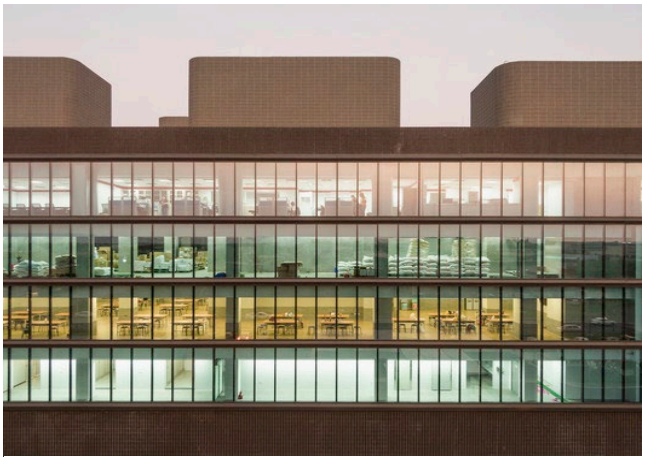


Figure 118: Front Facade

Ancillary functions include offices for admin, R&D, quality control, a seasoning laboratory, as well as staff canteens, changing rooms and toilets. Office staff and more importantly factory workers receive plenty of sunlight and views of surrounding plains when they use the canteens on their breaks and during their visits to the lavatories by passing the light filled corridors.

Rear Part
Storage and production functions were organized to the "rear" of the factory, with highly insulated walls to help maintain internal temperatures. Most production zones are refrigerated spaces with temperatures ranging from -20 to 13 degrees.

Figure 119: Rear Elevation showing Blank Facade

Materials, its use & design Inferences:
The outer skin of the factory was clad in rough textured clay tiles, a typical Taiwanese cladding material, which was chosen to effectively protect the building from the region's harsh southern sun and torrential rains in the rainy season.

The dark purplish-brown tiles have rough textures which mimic the fertile agricultural lands of this southern county. A touch of finesse and detail has been introduced by patterning the textures to give the skin a woven quality much like the premium hand-timed hams.

The walls on the south and north façade were slightly tilted in alternating angles so that the shadows on the walls form delicate patterns that vary as the day changes.

Within, circulation routes, changing rooms, and canteens have all been color coded according to raw product and cooked product zones in order to prevent any cross contamination.

Unique Architectural Features:
Circular skylights on the roof of the entrance tunnel give the staff glimpses of daylight as they enter and exit the factory.

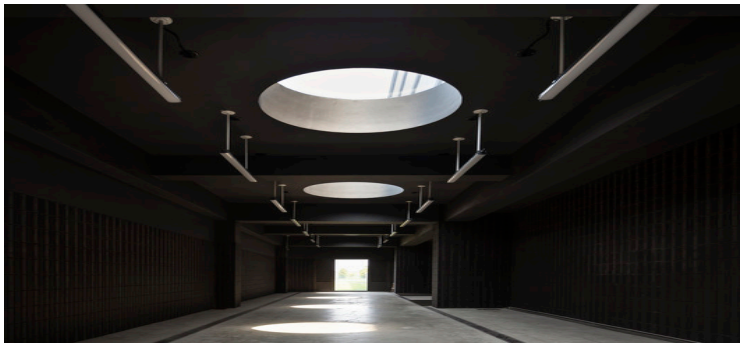


Figure 120: Circular Skylights in Main Entry

On the rooftop, seven elevator shafts required for the production rise prominently into the sky. Their individual heights were dictated by their functions, but their forms were given sculptural expression - referencing the rocky central mountain ranges of Taiwan visible in the far distance. These rooftop forms give an abstract mountainous landscape.

Carbon emission was minimized by using a high proportion of locally made and recycled materials, such as the tiles, concrete and glass, which reduced the carbon emission related to transportation.

Figure 121: View Showing Uneven Heights of Lift

Sustainability Features:
Energy savings came from highly efficient MEP and HVAC design which saved about 20% of electricity.

A rain water capture and reuse system was implemented to provide water for toilets, irrigation and car washes. The planting of local species of vegetation have been done around the area for landscape design.

(Shuangyu, 2019)

11.3 Inferences from Case Studies

A. Milijuli Badhsala
- Different Blocks given for different functions connected beautifully in a linear flow.
- Use of Bone Boilers, Bio-gas plants, etc. to make the project sustainable.

B. Budhathoki Cold Storage
- There should not be any crossovers to interrupt the slaughter process flow.
- Buildings should be used as it is designed for its original purpose.

C. Valley Slaughterhouse
- How two separate entries can help in proper flow of the process.
- Pockets parks can be provided for separating different blocks which not only used as a landscape but also as a separator.
- This project teaches about how industrial level production takes place in a linear way.

D. Valley Cold Store
- How space can be designed as per the customer's choice providing spaces for fresh meat, frozen meat mart and restaurants.
- The unused courtyard space can be brought to life by providing spaces for human interaction or socializing space.

E. Sheung Shui Slaughterhouse
- This project teaches how acoustic louvers, lining & enclosures can help for noise mitigation and water scrubber can be used for maintaining odor.
- It teaches about energy saving through Solar Panels and having a huge water treatment plant before releasing off the water.

F. Modern Slaughterhouse Gazipur
- This project teaches about how the interior flow can be maintained for different kinds of slaughter inside a same building which a perfect work flow.

G. T-HAM PABP Factory
- Use of local materials like Taiwanese cladding tiles, use of uneven elevation to reflect the Taiwanese Mountain landscapes. Walls slightly tilted to form shadow patterns and excellent use of skylights on the entry.
- Use of curtain wall on the front side to increase the interaction with people outside. And interior space uses various color themes to separate the spaces.

11.4 Comparison of Case Studies

CASE STUDIES	PLANNING & FUNCTION	CIRCULATION	MATERIALS	INFERENCE
MILIJULI BADHSALA	Nine rectangular blocks are arranged as per the flow and is connected by 2.5 m pathway.	Single entry which makes all the functioning difficult but blocks are linearly arranged.	Exterior plastered , blue colored with corrugated sheet roof & cement floor	Different blocks for different function, proper waste management
BUDHAT-HOKI COLD STORAGE	Poor planning as same block carries Slaughtering as well as offices.	Cross over in flow as it is not in a linear way and small congested spaces in interior.	RCC building with plaster white paint and white tiles on inside.	No cross over in flow should occur
VALLEY SLAUGHTER HOUSE	Birds enter from service entry, then to slaughter house and meat is processed from Main entry to the market.	Different entry spaces for slaughter and administration makes the functioning effective.	Steel construction with plastered walls and corrugated roof. White tiles on inside.	How 2 separate entries help in flow, how landscape used as separator

VALLEY COLD STORE	Mart, Fresh meat, Restaurant is arranged along a courtyard.	Common space used by both Valley and bank so it is non effective.	RCC building with marble finish inside the super mart.	Space designed as per customers' choice
SHEUNG SHUI SLAUGHTERHOUSE	Five blocks are connected as per the slaughter flow as a single complex building unit.	Pig, Goat and Cattle slaughter spaces are arranged so that it has a proper flow till Dispatch unit.	RCC building with seamless floors on the inside, acoustic louvers, double glazed glass,	Use of acoustic louvers, water scrubber for odor, Energy saving PV cells
MODERN SLAUGHTERHOUSE DELHI	Administration, leads to Utility, Slaughterhall, Lairage and rendering unit respectively.	Service and main entries make circulation proper as slaughterhouse and rendering unit are side by side.	RCC with big columns for big spans, White exterior in Slaughterhalls & yellow for office	Interior flow for different types of slaughter in same building
T-HAM PABP FACTORY	Single building but arranged in different flow as per uncooked meat and cooked meat section.	Front part has ancillary spaces, rear part has processing unit. Two separate entry for cooked and uncooked section.	Taiwanese Tiles for cladding, curtain walls and color coding as per interior spaces.	Use of local materials, architectural characters like color, height, atrium can be played with

12. Site Analysis

Site is the place where any building lies or is going to be constructed in. The architecture of any building should respond to the characteristics of the site, otherwise the design will fail. For this reason, proper site selection and site analysis is required before designing and building in any site.

Till now, there are no such meat parks in Nepal from which we could study the about it. Understanding the purpose of the project, site selection is done. The main aim of this project is to provide a space with most modern abattoir and meat mart and also to educate the people about the type of meat we are having. Basically, the aim of this project is to provide the facility for Slaughterhouse, Meat Mart, Restaurants and Quality check and Research center for better meat products.

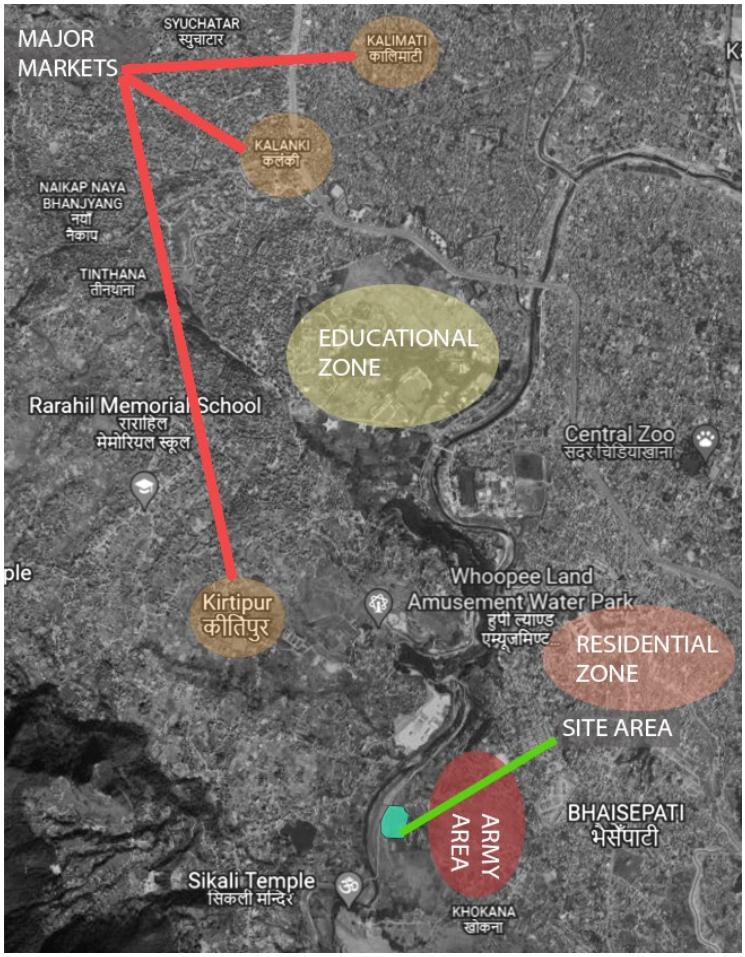


Figure 122: Site Location of proposed site

The intended site is Karya Binayak, Kathmandu which is far away from residential chaos and is a free site which can be developed as a "Healthy Meat Park" in the urban fabric of Kathmandu.

12.1 Site description

Location: Karyabinayak, Kathmandu (near Chobar)
Area: 24578.3 sq m (48.31 ropanies)
Unused Barren land
Flat Land with some Hillocks
Site surrounded by road on 3 sides
Ownership: Under Army but neglected

Characteristics of Site:

- Main road facing West
- 115 m away from the river

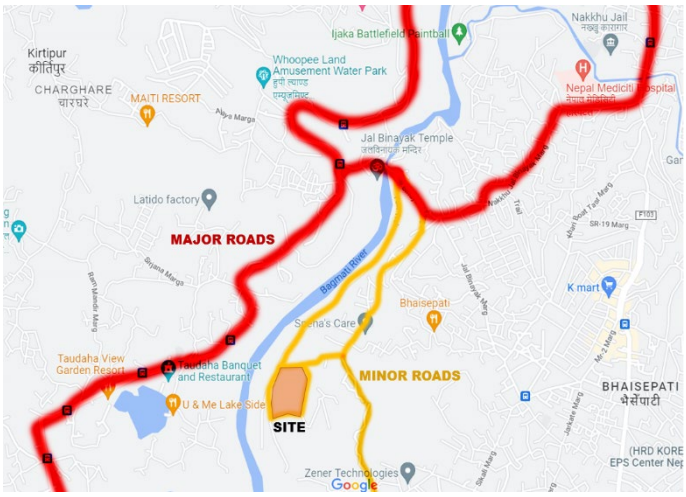


Figure 123: Map showing Major and Minor Roads of the site

- Flat land with small hillocks present
- Roads on 3 sides

Figure 125: Site View from Dakshinkali Road

12.2Access and Approach

- Accessible through 2 roads one from Jalbinayak Bridge from Chobar and another through Baisepati road
- The site is around 4.5-5 km form Balkhu, Ringroad
- Site is 2.5 km from main city of Kirtipur and 1.5 km from Baisepati
- Site is accessible by transport and is covered by roads on its 3 sides.

12.3 Current Use

The sit at present neglected and sometimes used as a grazing field for cows and buffaloes by the farmers around. It is mostly flat in nature with some uneven hillocks.

Site Surroundings:
West: Main Road to the site and Bagmati River
East: A small hill is present on top of which there are the Army Offices.
North: Side entry road with Green House for vegetable farming
South: Side entry road with unused barren land

Figure 126: Site showing small hillocks

Figure 127: Site distance from the River

12.4 Why this Site?

- Free from core residential areas
- Flat land as per slaughter requirements
- Optimum area for Meat Park
- Site surrounded by roads on all 3 sides which helps in separate service and main entry

- Can be developed as a place for meat tourism attracting Chobar tourists
- Near to main markets like Kalanki, Balkhu, Bhaisepati & Kirtipur
- Neglected site can be developed into an inter-active Meat Park fulfilling all the users demands.

12.5 Physical Features

Figure 128: Site Section

- **Topography**
  The site has almost flat terrain with gentle slope towards the south. The average elevation difference is just 8 Ft. at maximum length as per the Google Earth.
- **Vegetation**
  Entire site is covered with grasslands with no trees.

12.6 Climatic Analysis

The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for Karyabinayak. Likewise, "mean daily minimum" (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years.

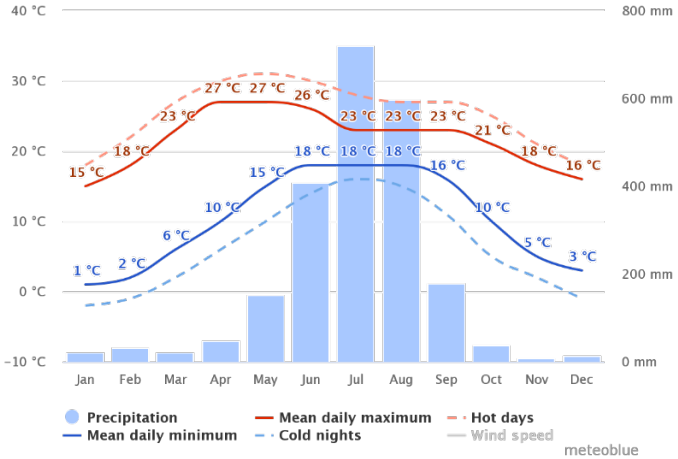


Figure 129: Average Climate and Precipitation Data

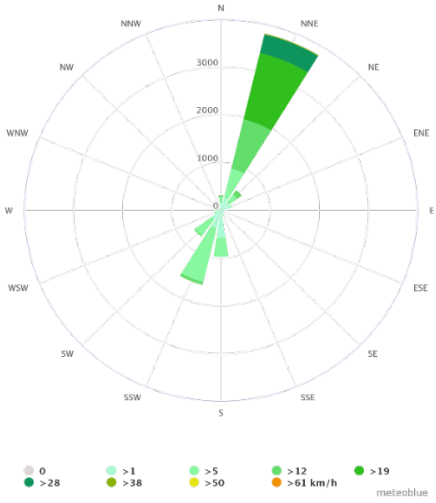


Figure 130: Wind Rose Data

The wind rose for Karyabinayak shows how many hours per year the wind blows from the indicated direction. Example SW: Wind is blowing from South-West (SW) to North-East (NE).

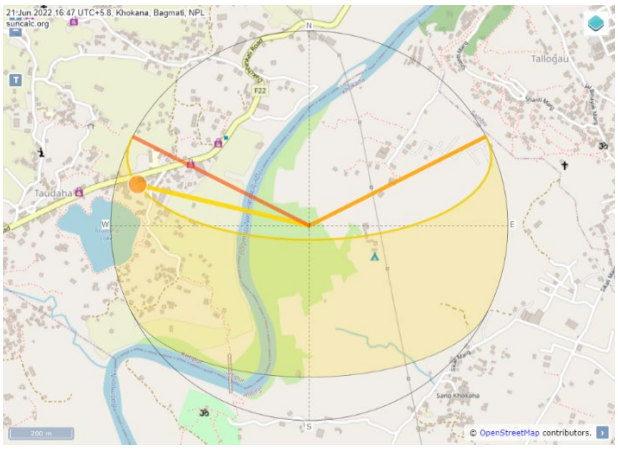


Figure 131: Sun Path in Summer Solstice

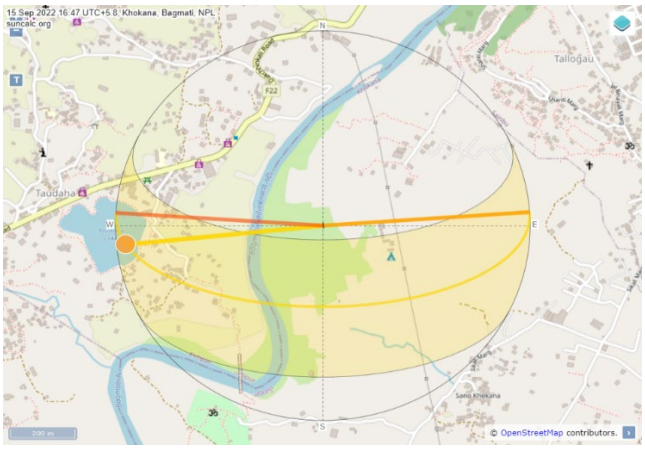


Figure 132: Sun Path in Winter Solstice

12.7 Socio Cultural Analysis

The site is located near Kirtipur and Bungmati two of the ancient settlements of Kathmandu Valley. Enrich in Newari culture Kathmandu Valley holds rich meat culture. Previously only Newas used to eat buff while it was looked down by higher caste people. While Brahmins only used to consume goat meat and disregard chicken. Now almost all people consume Chicken which is the largest meat demand in country as per the statistical data. (Khanal, 2020)

In Kirtipur two of the most famous Restaurants namely Sa:Sa and Lahana have made their name in providing people with various meat products. In same way this site can be turned into an urban Meat Park for people to either come and enjoy their meat choices, choose frozen meat products as their liking or even the site's meat plan can cater to some meat demands in the valley.

12.8 SWOT Analysis

Strength:

- Easily accessible from Ring Road and very close to towns of Kirtipur and Bhaisepati. The site is also accessible from two different roads i.e., one from Chobar and another from Bhaisepati
- The site is oriented towards West direction with uninterrupted green landscapes around.
- Chobar is a popular tourist destination which is 500m from the site
- The site lies free from residential areas and has flat terrain as per the requirements.

Weakness:

- Presence of Graveled Road.
- The presence river 115m West of the site so it must be taken care of without polluting it.
- No presence of any building around the site.

Opportunity:

- The site is almost flat with gradual slope which will result in easy and effective design
- The site has multiple access
- Institutional zone will support the academic function of the center
- View of the Chobar hills, Green Spaces around and Kirtipur city from the site
- Opportunities to develop it as a vibrant Meat Park and Meat Plant and create employments.

Threat

- Can pollute the river and its eco-system if waste not treated properly.
- Smell from the Plant can affect the people in the Meat Park do it must be treated effectively.

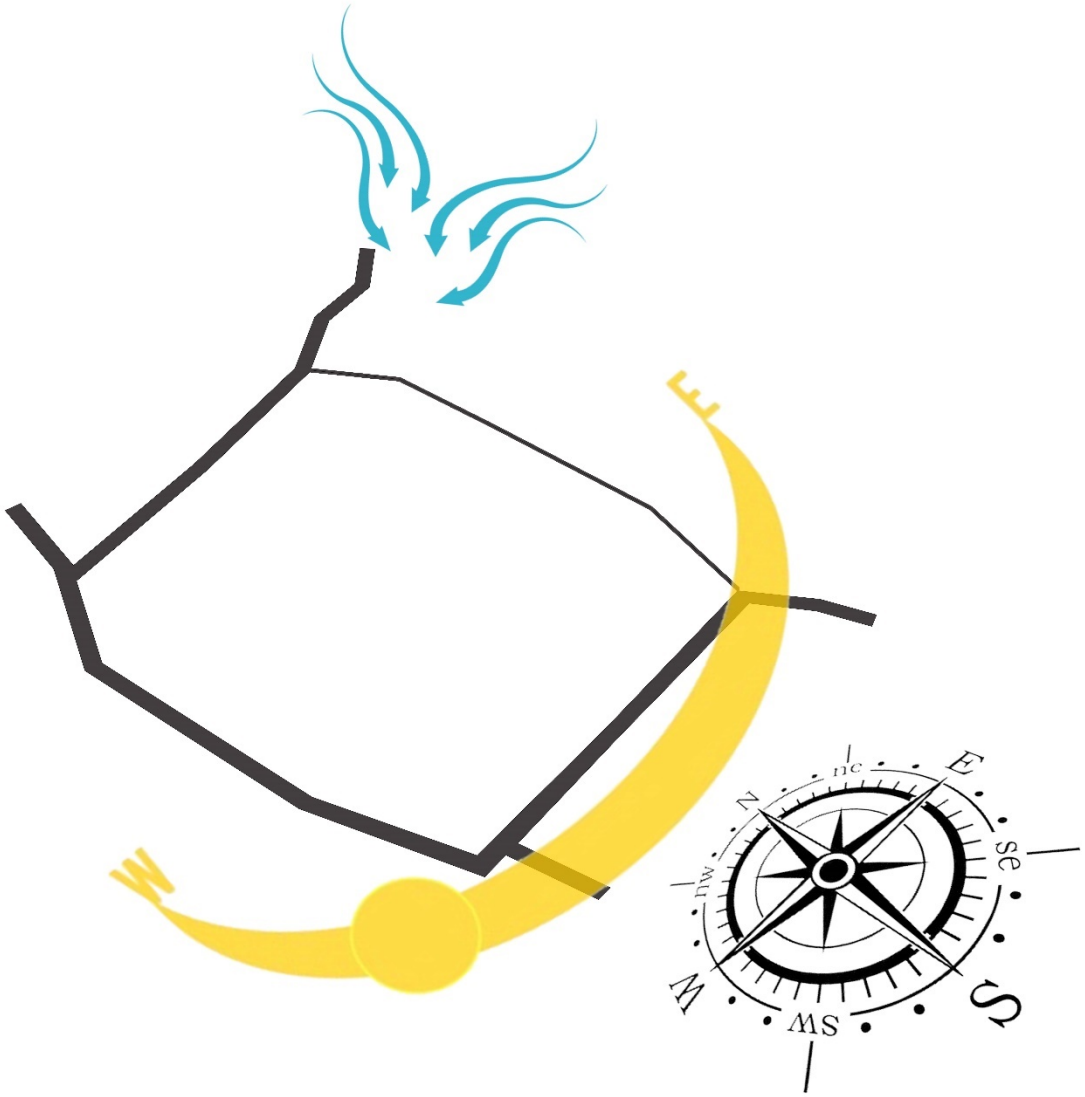


Figure 133: Site Analysis Diagram

12.9 Bye-Laws

३. **पशु वधस्थल स्थापनाको लागि स्थान छनौट** : (१) पशु वधस्थल निर्माण गर्न स्थान छनौट गर्दा नियमावलीको नियम ६ को उपनियम (१) मा उल्लिखित मापदण्डका अतिरिक्त देहाय बमोजिमका अन्य मापदण्ड भएको स्थान छनौट गर्नु पर्नेछ :–

(क) मासु पसलबाट अलग्गै रहेको,

(ख) फोहोर मैला फाल्ने सार्वजनिक क्षेत्रको नजिक नभएको र

(ग) जङ्गल तथा मानिसको बसोबास वा घना बस्तीसँग नजोडिएको ।

(२) पशु वधस्थलको निर्माण गर्दा देहायका मापदण्ड पूरा गरेको हुनु पर्नेछ :–

(क) वध गर्नुभन्दा अगाडि पशुलाई कम्तीमा चौबीस घण्टासम्म विश्राम गराउन छाना समेतको टहरा (ल्यारेज) भएको,

(ख) खण्ड (क) बमाजिमको टहरामा जमीनबाट ५० से.मी उचाईमा पिउने पानीको व्यवस्था भएको,

(ग) वध गर्नु अगाडि पशुहरुलाई सफा गर्ने र तौल लिने व्यवस्था भएको,

(घ) वध गर्नु अगाडि पशुहरुको स्वास्थ्य परीक्षण गर्ने र रोगको आशङ्का भएका पशुलाई राख्ने छुट्टा छट्टै स्थान भएको,

(ङ) भूईंको सतह पानी नजम्ने किसिमबाट बनाईएको,

From The Bye-Laws:
- Zone: Non-Residential zone
- Max. Ground Coverage: 50%
- Minimum Parking space: 25%
- FAR: 2.5
- Set back: 5.5 m from the main road for road side land
- Total permissible Built-up Area: Site area x FAR

13. Program Formulation

The Meat Park will accommodate an area which many facilities inside. It will include Administration to regulate the activities, Pre-slaughter space to bring the Chickens, check and hold them and send to Slaughtering space. Then, it is taken to Meat processing unit and from there it will be taken to meat supermarkets and restaurants for people to enjoy it. This space will be away from Urban Chaos and be an urban park for social activities for the customers' coming in.

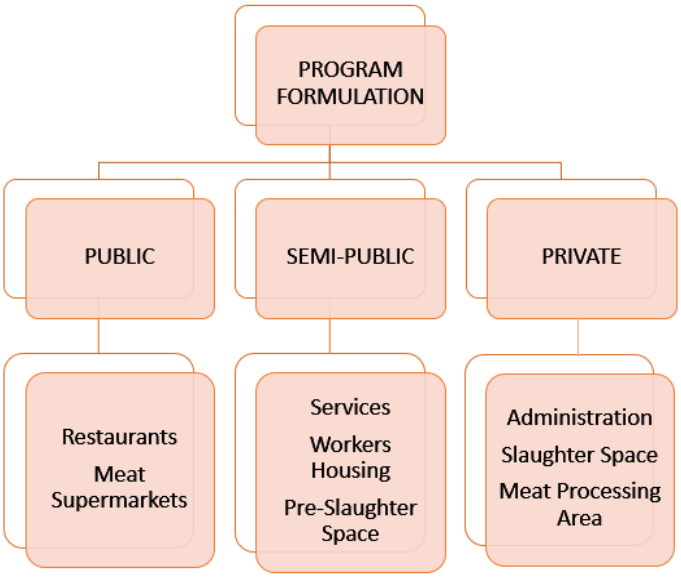


Figure 134: Program Division

S.NO.	COMPONENTS	SPACE REQD.	MIN NO. OF USERS	NOS.	AREA (SQM)
1	**PARKING AREA**				
	Bikes	2.5 sqm/bike		131	327.5
	Cars	12.5 sqm/car		101	1262.5
	Trucks	48 sqm/bus		4	192
	Sub-Total				1782
	Circulation				712.8
			Total		2500
2	**MEAT SUPERMARKET**				
A	**MART**				
	Supermarket Area			2	1000
	Counter			2	60
	Cold Room	20%		5	160
	Cold Storage	30%		2	240
	W/C			6	210
B	**OFFICES**				
	Private Offices	10 sqm/p		16	160
	Open Offices	6 sqm/p	60	2	360
	Meeting Rooms	2.5 sqm/p	40	2	100
	Reception & waiting	25 sqm		2	50
	Pantry	10 sqm		2	20
	Conference	1.5 sqm/p	200	1	300
C	**RESTAURANT**				
	Dining	2.5 sqm/p	100	1	250
	Kitchen	40% of dining		1	100
	Store			2	40
D	**UTILITY & STORES**	40		4	160
			Total		3210
3	**SLAUGHTERHOUSE**				
	Changing Rooms	3 sqm/p	40	2	120
	Lairage	0.5 sqm/bird		500	250
	Slaughtering Area	0.5 sqm/bird		1	60
	SLAUGHTERHALL				
	Bleeding Section			1	150
	Scalding Section			1	150
	Evisceration Section			1	150
	Reinspection			1	150
	Cleaning Section			1	150
	Packaging Section			1	50
	W/C			4	150
	Cold Storages	30%		3	240

	Private Offices	10 sqm/p		8	80
	Open Offices	6 sqm/p	6	2	40
	Training Room	2.5 sqm/p	48	2	120
	Waste Collection	25 sqm		4	100
	Meat Processing Area	180 sqm		4	720
	Staff Rooms	2.5 sqm/p	16	2	40
			Total		2720
4	**RESIDENCE**		48	8	768
5	**ADMINISTRATION**				
	Private Offices	30 sqm/p		16	480
	Open Offices	6 sqm/p	50	2	300
	Meeting Rooms	2.5 sqm/p	80	2	200
	Reception & waiting	25 sqm		5	125
	Pantry	10 sqm		4	40
	W/C			4	140
	Store			4	80
	Pre-Event Space			1	350
	Training Room	2.5 sqm/p	20	1	50
			Total		1765
6	**R&D SECTION**				
	Labs	6 sqm/p	10	4	240
	Changing Rooms	3 sqm/p	26	2	80
	Private Offices	10 sqm/p		1	10
	Open Offices	6 sqm/p	4	1	24
	Pantry	10 sqm		1	10
	W/C			1	10
	Conference	1.5 sqm/p	100	1	150
	Meeting Rooms	2.5 sqm/p	30	2	75
	W/C			1	35
	Training Room	2.5 sqm/p	28	1	70
	Observation Room			1	70
	Library			1	70
	UTILITY & STORES	40		2	80
			Total		924
7	**CANTEEN**				
	Dining	2.5 sqm/p	100	1	250
	Kitchen	40% of dining		1	60
	Store			2	30
			Total		340

8	**HEALTH CENTER**				
	Waiting	15 sqm		2	30
	Emergency			1	25
	Pre-OP			1	25
	Operation Theatre			1	25
	Post OP			1	25
	Changing Rooms	3 sqm/p	8	4	24
	Doctor's Lounge			2	40
	Nurse Room			1	20
	W/C			2	40
	General Checkup			2	20
			Total		274
9	**POULTRY FARM**	0.45 sqm/bird	400	1	170

- Built-up Area = 12671 sqm
- Percentage added for Circulation and Structure = 30%
- Total Built-up Area = 3801 sqm
- Adding Circulation and Structure:
- Total Built Up Area= 16472 sqm

  - Total Site Area = 31446 sqm
  - Permissible Ground Coverage = 50% (15723 sqm)
  - FAR = 2.5
  - Permissible Built-up Area = 39307 sqm

AREA CALCULATION	
Total Built-up Area	16472
Total Ground Area	7696
Total site Area (sqm)	31446
Ground Coverage	24%
FAR	0.42

14. Concept and Design Development

14.1 Concept

The concept of this design is to revise all the problem statements and to create spaces catering to solve those problems. The main objective is to create a vibrant meat park providing spaces for modern meat production industry with commercial marts where people can buy meat products or even enjoy the products within urban landscape improving public interaction. The design approach of this meat park is to provide spaces where the functions are arranged along with creating pockets of spaces for customers and the workers.

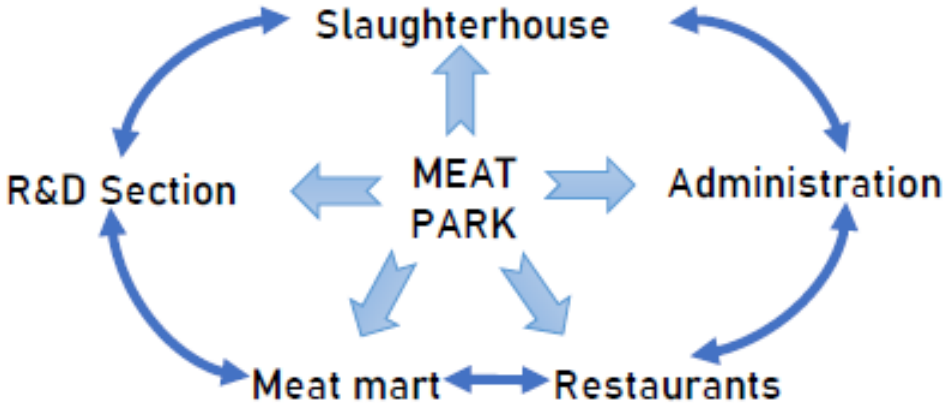


Figure 135: Functions in Meat Park

14.2 Ideology

14.2.1 Conglomeration

Conglomeration in simple words is a number of different things, parts or items that are grouped together i.e., a collection. And in architecture it simply means to present the buildings that have a complex or diverse range of functions as opposed to those that are designed to serve a single purpose. In this project this idea is taken to combine different functions together under a single complex. Similarly, there is also conglomeration of materials in this project by the incorporation of brick, glass, stone and metal to create visually interesting structures.

Figure 136: Conglomeration of Functions

14.2.2 Place Making

"A multi-faceted approach of design and management of public spaces."

-Fred Kent

Place making is a popular architectural concept. As per the idea of Fred Kent a place should be so designed in a way that it must have some sort of uses and activities going on it giving the users a sense of comfort and eye-pleasing aesthetics and that very place should be accessible to the users where the users can come for social interaction.

This project also uses this idea to create urban vitality attracting the heterogeneous people using different activities improving the interactions making it an urban marketspace. Similarly, other spaces have been created

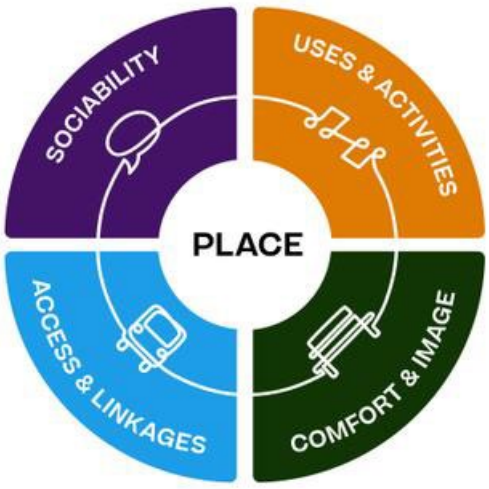


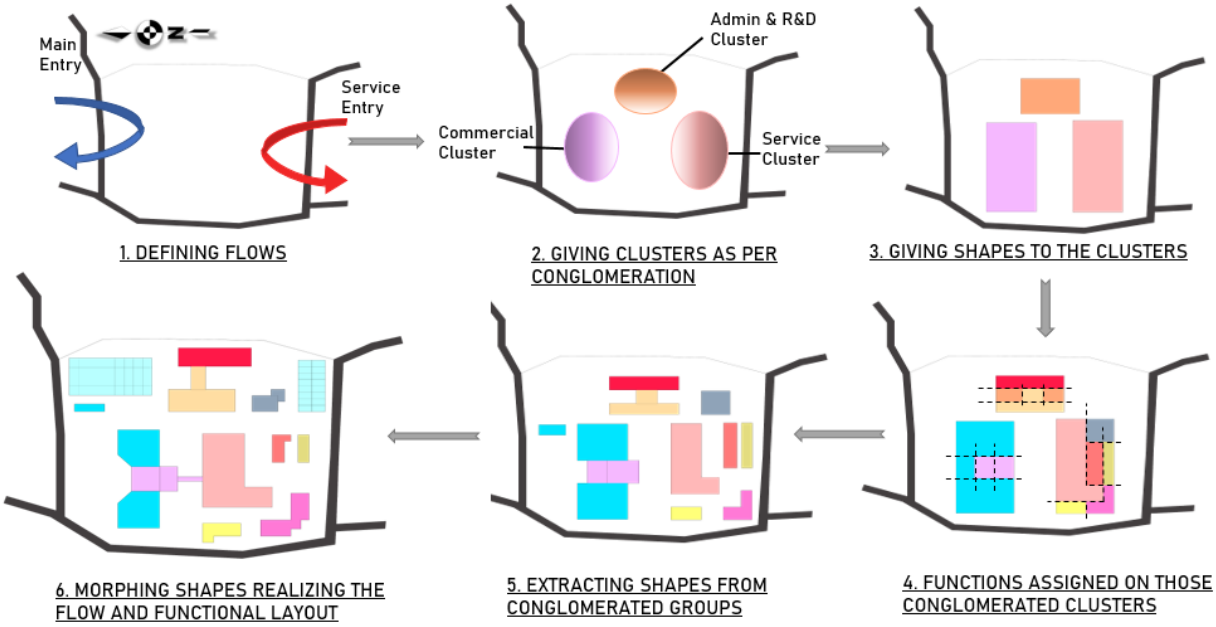
Figure 137: Place making Concept

inside the complex where staffs and workers can have a breakout to freshen up from their hectic work schedules.

14.3 Design Development

Commercial Meat Mart, Industrial Slaughterhouse and Research & Development Centre are the three main functions of this meat park. These functions are placed in the site considering various factors.

Since the major wind flow on the site is from North East to South West so the slaughterhouse is kept on the south west part of the site to restrict the smell coming from the slaughterhouse to the major public zone.



At first the site is taken and the major public and service flow is defined as per the road alignment. Then the clusters or zones are placed such that the front entry leads to the Commercial zone and back road leads to the service entry. While the administration and Research center is in between those two as it is linked with both the major functions. Then the shapes are given to the zones and functions are accumulated as per the requirements then extracted and morphed considering the flow and functional layout within the site.

Figure 138: Form Development Process

Pockets of Spaces

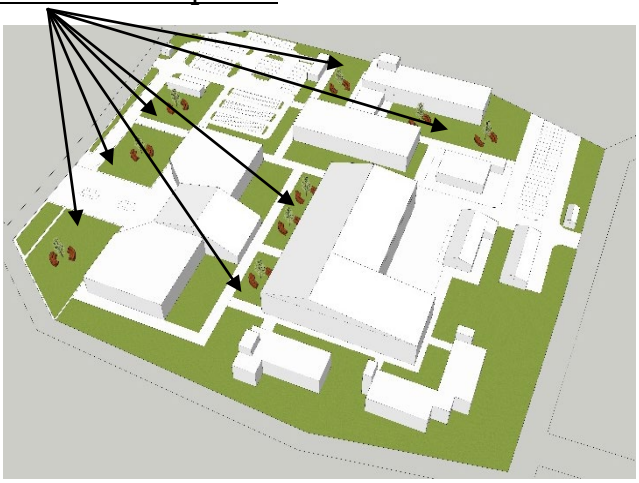


Figure 139: Pocket of spaces as per Place making Idea

At last various pocket of spaces are introduced between the buildings as per the place making approach to create vibrant spaces for interactions among different people. The green urban landscapes at the front will cater to public and the commercial space as a plaza while the pockets in between the slaughterhouse and administration will work as a breakout space for the staffs and also as a barrier from the general public to the industry. In the same way two different quality spaces have been given right next to administration section and R&D section focusing on the staffs of those respective buildings to come and spend some peaceful time amidst their hectic work schedule.

14.4 Design Development

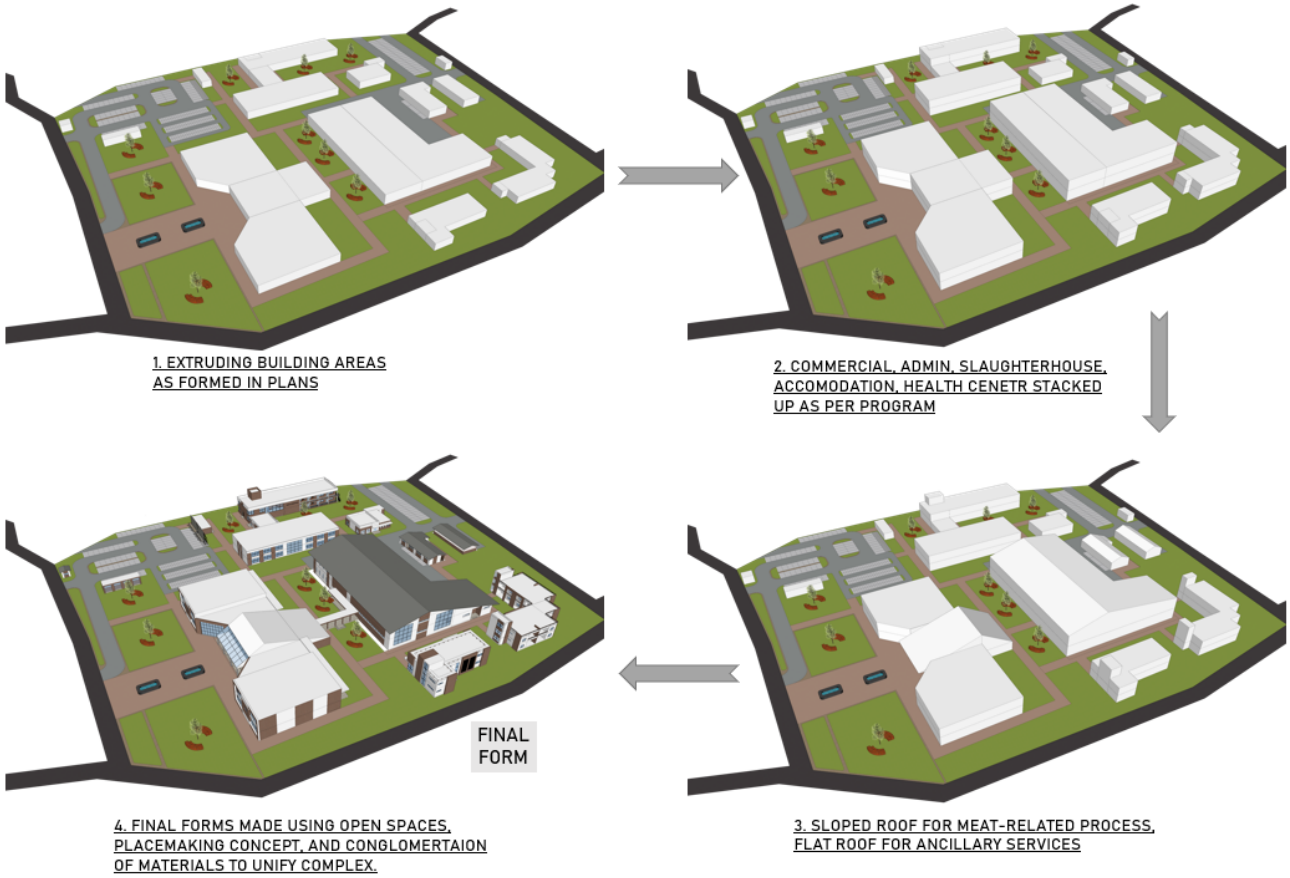


Figure 140: 3d development process

At first the plan as formed due to form development is extruded. Then, the extruded buildings are given story as per the program formulation like a bigger commercial building with marketspace and plaza, bigger slaughterhouse building, administration and R&D building to accommodate the various functions. The entry of commercial is aligned to welcome the public and connect it with open green space in front. Next, the slaughterhouse roof is sloped to give its huge interior span and other building roofs in the industrial zone is done the same. Commercial building roof is also aligned to unify the activities of meat taking place in these building. While the buildings not related to meat are given a flat roof in unison.
Finally, the buildings are enhanced trying to relate with pocket of open spaces as per the place making concept. Similarly, the finalized form is designed by conglomeration of materials like brick, glass, metal and stone to unify the building complex as a whole.

15. Design Description

As per the zoning the form is developed as relating to the concept and ideology the masterplan is formed.

Figure 141: Aerial View of the complex

15.1 Individual Functions

15.1.1 Pubic Entry

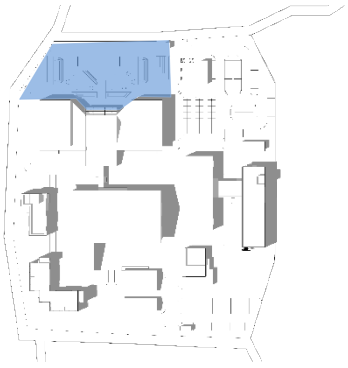


Figure 142: Key Plan with highlighted public entry

Main public entry is located on the northern part of the site. The reason is mainly due to the location of two main roads leading the site i.e., one from Chobar and another from Bhaisepati. The entry leads to plaza in front of the Commercial Building where there are landscape designs with seating spaces, green urban parks, food stalls. The activities seen from the entry magnets people to the meat park and main entry leads to the commercial building in the front.

15.1.2 Service Entry

On the southern part of the site, the small road leads to the service zone of the site. This zone consists of Slaughterhouse and its functional spaces. The reason of placement of service entry is to restrict the general public sight to the most private zone of the site and to create an individual zone where meat production and processing takes place which has a separate entry and function.

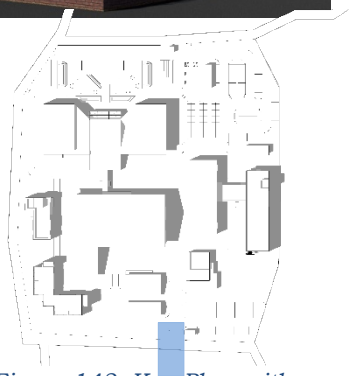
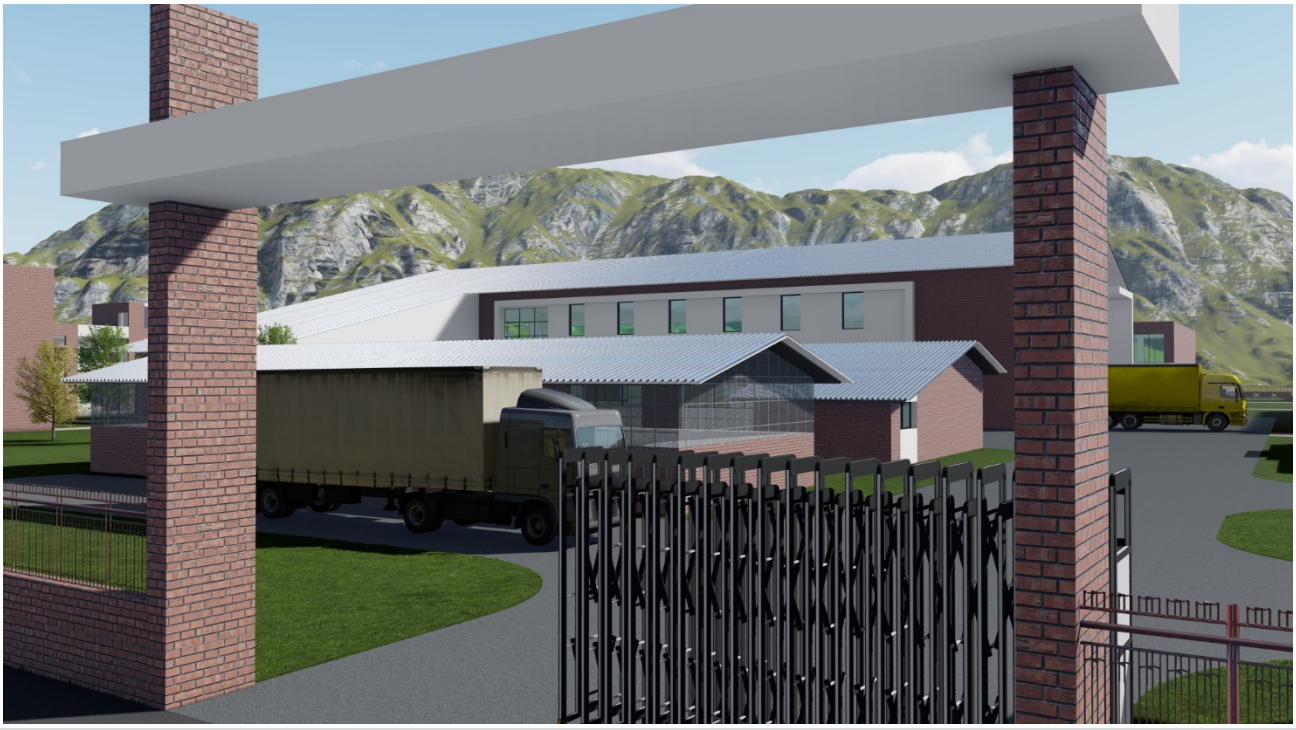


Figure 143: Key Plan with highlighted service entry



15.1.3 Parking Areas

On the North West side of the entry there is a surface parking space for the public. It has a capacity to hold 61 cars and 138 bike at the same time. At the edge of the parking space there a parking ticket counter and on top there is a massive Hoarding board advertising the Meat Park.

Figure 144: Key Plan with highlighted Parking Areas

While on the South West side there is a surface parking for the staffs with the capacity of 40 cars targeting the staffs from Slaughterhouse, Health Centre, Administration and R&D Centre. Not only that, the hard surface in front of the Slaughterhouse can hold up to 8 Trucks. All these make Service functioning easy without disturbing the commercial activity.

15.1.4 Commercial Centre

The main entry leads to the plaza and the plaza leads to the Commercial Centre. The block is modified giving welcoming entry to the customers. On the ground floor it has mart spaces for sales of meat and meat products on the front part while on the rear part there is a massive cold storage zone which is connected to the slaughterhouse where products are brought as per the sales demand.

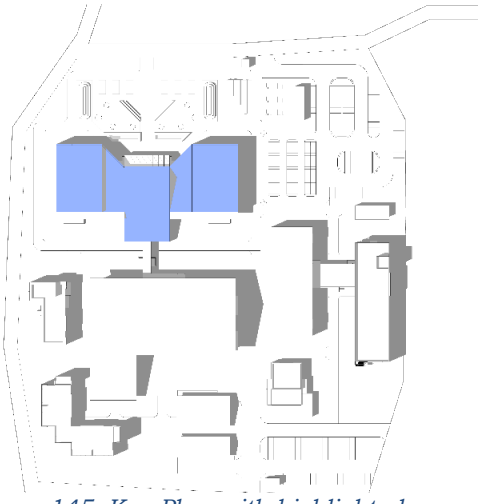


Figure 145: Key Plan with highlighted Commercial Center

On the upper floor there is a restaurant catering to the public where public can enjoy the view of open

green spaces at the plaza. Restaurant is designed and placed in such a way that it is isolated from the back so that the people don't know about the slaughter taking place. Similarly, the restaurant is only front facing towards the main plaza. It also has office spaces for PR, Management, Data Collection, Board of Directors and also a conference hall where activities relating to the sales can be performed.

To give a commercial feel, its facades are designed with curtain wall and brick facades have been used as a design element to bind into the design.

15.1.5 Slaughterhouse Block

The position of slaughterhouse is fixed on the site considering the wind flow as it flows from north west to south east. This will help to mitigate the smell from Slaughterhouse to the Commercial space. Service entry leads to the hardscapes and blocks are arranged as per the slaughter process.

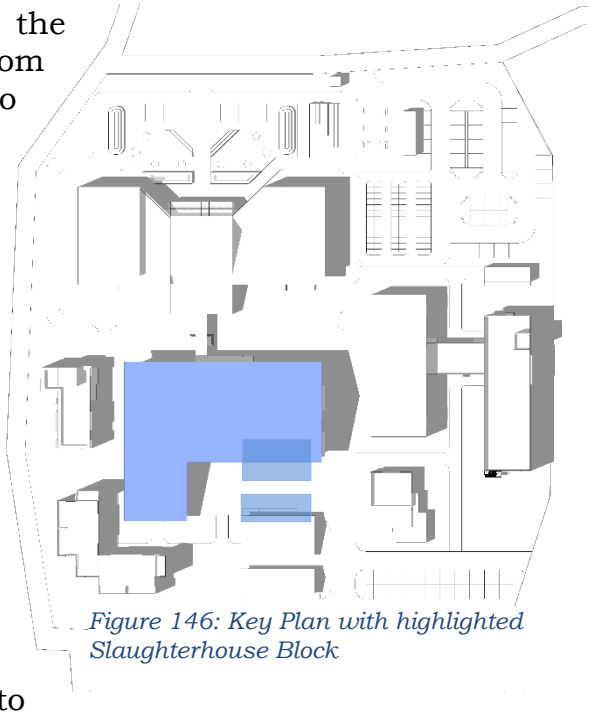


Figure 146: Key Plan with highlighted Slaughterhouse Block

Right next to the entry there is a poultry farm where birds are reared and also the birds brought are held for few days before the slaughter. Adjacent to it, there is a Reviewing block where birds imported are taken into data and also there is a preliminary check of birds are done before entering to the Slaughterhouse.

On the ground floor of the Slaughterhouse, the birds enter from the holding space onto many different slaughter functions and meat production takes place. While on the first floor, there are meat processing space and spaces for storage of processed meat. The building is also connected to the cold storage of Commercial Building for easy transport of meat products for sales.

This building is given typical industrial design with huge truss spans and ribbon windows and also the windows level is a bit heighted to prevent people from viewing inside the restricted spaces.

15.1.6 Administration and R&D Center

Administration position is located at the top of both commercial and slaughterhouse. Metaphorically, it is the head regulating the functions on this complex. It consists of various functions like HR department and Account sections on the ground floor and Board of directors and meeting rooms on the first floor.

Next to the Administration building there is a Research & Development building. It consists of functions like Research labs and Changing rooms for the lab researchers on Ground floor while Conference, Library and Meeting Rooms on the top.

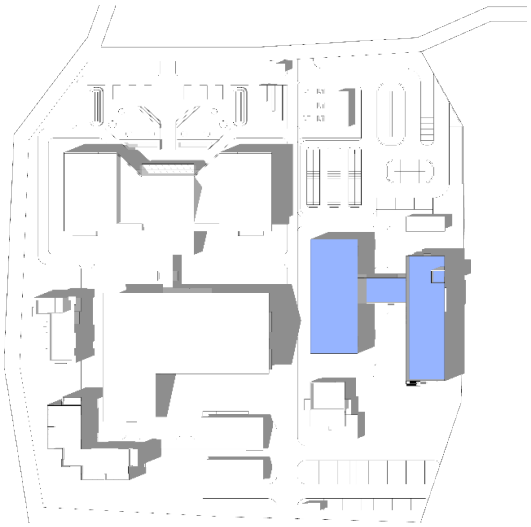


Figure 147: Key Plan with highlighted Admin and R&D Blocks

These buildings are designed giving them a proper office exterior design with the use of typical brick facades and adequate windows in the design.

15.1.7 Accommodation Block

This L shaped block is at the South East part of the site. The placement is done is such a way that the workers get to enjoy ample amount of sun throughout the day making them much more efficient in their works. This block has 4 units on each floor and one unit can reside 6 people at once.

This block is two storey. There is a communal space provided between each 2 units so that there are some interactions among them.

The building is designed using the brick facades with windows and balcony spaces making it easy for the users to enjoy the sunlight after their morning hectic work life.

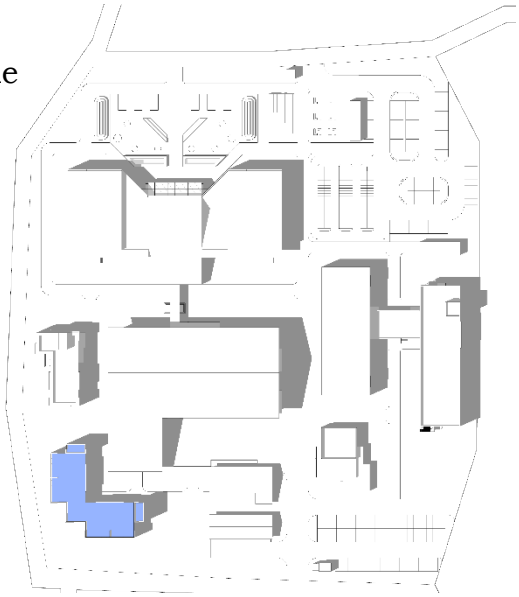


Figure 148: Key Plan with highlighted Accommodation Block

15.1.8 Health Center

This block is right next to the accommodation block. Since there are large number of workers on the complex so the risks to the emergency accidents should be considered.

The ground floor consists of Emergency treatment area and an Operation Theatre along with post recovery room while the upper floor has spaces for General Checkup.

The design of the building is done with exterior view looking like a general health center with blank brick facades and long horizontal windows like in hospitals.

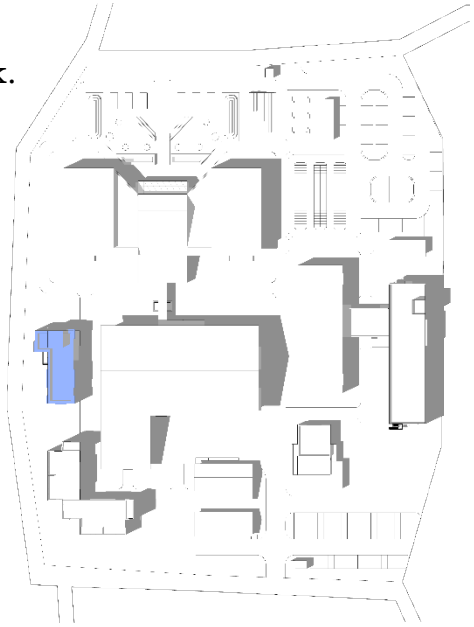


Figure 149: Key Plan with highlighted Health Center

15.1.9 Staff Canteen Block

The block is positioned right next to the service parking site making it easier to load the goods to the kitchen. Similarly, the block is right next to the industrial and administration block making it easy for the staffs.

It is a single storey block with kitchen and stores right next to the parking and the dining space is accessible from both front and back of the block making it for an easier flow.

The design is done using glass curtain walls and brick elements to make the place vibrant to the staffs during their off-work hours.

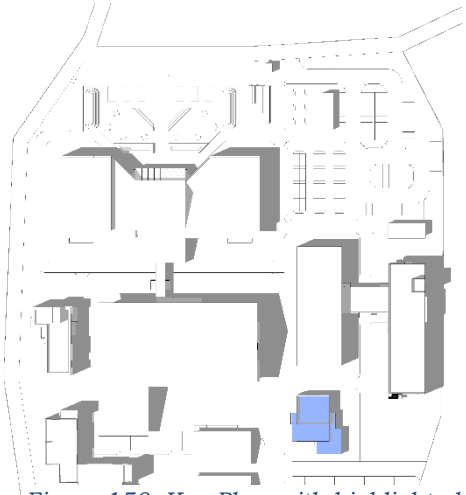


Figure 150: Key Plan with highlighted Staff Canteen Block

15.1.10 Entry Plaza

The front entry commercial space on the front of the building has a wide-open plaza space which is formed as per the place making idea creating a vibrant space which is just at the entry making it easily accessible and can magnets the people inside the complex. This space has seating arrangements, water fountain on the entry leading to the commercial center and food stalls where people can enjoy their quality time on the open green spaces around.

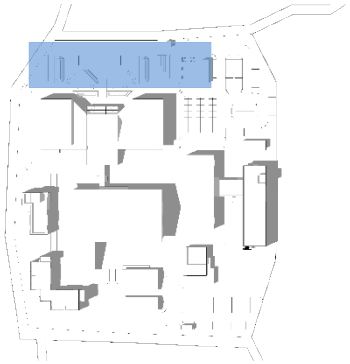


Figure 151: Key plan with highlighted Entry Plaza

16. Services and Utilities

16.1 Water Supply

The sources of water for site are municipal water line and boring. Total volume of water required is stored from source in raw water tank. Water obtained through boring is aerated and sent to the raw water tank. The water to be used in the building is then pumped to treatment plant and then into the treated water tank. Water from treated water tank is pumped to an overhead water tank.

Similarly, the water required for firefighting is pumped directly into firefighting water store tank from raw water tank and rain water storage tanks.

S.NO.	BLOCKS	NO. OF USERS	MIN. REQUIREMENT (lpcd)	TOTAL DEMAND
1.	Commercial	400	45	21600
2.	Administration	120	45	5400
3.	Research & Dev. Center	60	45	2700
4.	Slaughterhouse	130	45	5850
5.	Health Center	20	340	6800
6.	Accommodation	48	100	4800
7.	Review Counter	20	45	900
8.	Staff Canteen	90	50	4500
9.	Other Amenities	10	15	150
		Total		52700

Total water demand = 52.7 cu.m./day
Size of the water tank = 52.7*2 (2-day reservoir) = 105.4 cu.m
Fire Fighting Demand = 50 cu.m
Total Tank Size = 155.4 cu.m
Height of Tank = 3.5 m
Area = Volume/ height
= 155.4/3.5
= 44.4 sq.m = 6.66 m*6.66 m *3.5 m
Therefore, the size of Underground Water Tank = 6.7 m*6.7 m*3.5 m

As per the NBC 208:2003,
40% of 52700 = 21,080 liters' overhead tank
Hence, 11 numbers of 2000 liters' horizontal water tanks are placed at 8 different places on roof without disturbing the building elevations.

16.2 Rain water harvesting

Rain water harvesting is a technique of collection and storage of rain water at surface or in sub-surface before it is lost as surface run off. A system of harvesting rain water from the roof has been proposed to meet the water demands even in dry seasons, for firefighting cleaning and landscaping. The system includes catchments, conveyance system and storage tanks.
The roofs of the bigger buildings can be used as catchment area for rainwater harvesting
Total quantity of rain water (Q)= CIA
Where,
C= runoff coefficient= 0.81 (for flat cement roof)
I= intensity of rainfall= 1.63 (1663 mm average annual precipitation) (World Weather & Climate Information, 2023)
A= catchment area

S.NO.	BLOCKS	CATCHMENT AREA (sq.m.)
1.	Commercial	2360

2.	Administration	1060
3.	Research & Dev. Center	780
4.	Slaughterhouse	2580
5.	Health Center	325
6.	Accommodation	470
7.	Review Counter	260
8.	Staff Canteen	300
9.	Other Amenities	100
	Total	8235

Catchment area of the roof = 8235 sq.m
Annual rainwater harvesting potential (Q) = 0.81*1.63*8235 = 10872.67 cu.m

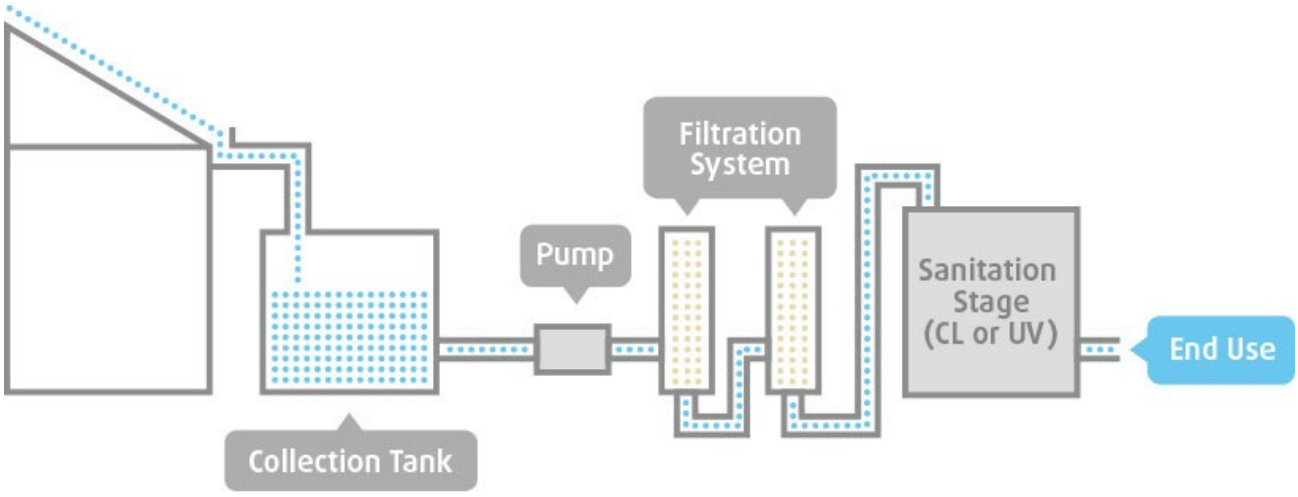


Figure 152: Rainwater collection process diagram

The BS 8515 2009 states that, the capacity of the rainwater harvesting storage tank must be at least of 5% of the annual rainwater yield.
Thus, the tank capacity of the rainwater tank = 0.05 x 10872.67= 543.63 cu.m.
Therefore, 6 rainwater tanks of 90 cu.m. each are required to collect surface runoff. This water will be used for flushing toilets, cleaning of slaughterhouse, gardening and other processes.

16.3 Sanitary

From each building, the solid and waste pipes are arranged for the sewerage. The solid pipe is connected to the septic tank while the waste water is sent to the soak pit.

S.NO.	BLOCKS	CATCHMENT AREA (sq.m.)
1.	Commercial	2360
2.	Administration	1060
3.	Research & Dev. Center	780
4.	Slaughterhouse	2580
5.	Health Center	325

6.	Accommodation	470
7.	Review Counter	260
8.	Staff Canteen	300
9.	Other Amenities	100
	Total	8235

Septic tank:
Quantity of waste water = 75% of water consumed = 39525 liters/day
No of septic tank= 1
Now,
Detention period = 3days
Total quantity of waste water in 3 days (V1) = 118575 liters = 118.575 cu. m
Volume of sludge (V2) = 0.0425 N in m^3 = 0.0425* 800= 34 cu.m
Required size of septic tank = 118.575+34 = 152.575 cu.m
Let height of the septic tank be 3 meters
Area of each septic tank = 152.575/3 = 50.8 sq.m
Tentative size of each septic tank is 7m x 7m x 3m

Soak pit design
Water coming out of septic tank = 39525 liters/day
Percolation rate = 1500 lit/m^3/ day
Volume of filter media = 39525/1500 = 26.35 m^3
Assume depth of pit = 2.5 m
Area of soak pit = 26.35/2.5 = 10.54 m^2 ($A = \pi r^2$)
πr^2= 10.54
r=1.83m
The diameter of soak pit is 3.7m.
So the water leads to municipal drain via soak pit.

16.4 Structural system

The complex uses regular RCC structure is almost all the buildings arranged in rectangular grid layouts for structural safety. The typical grids are shown in the structural drawing on Annex.

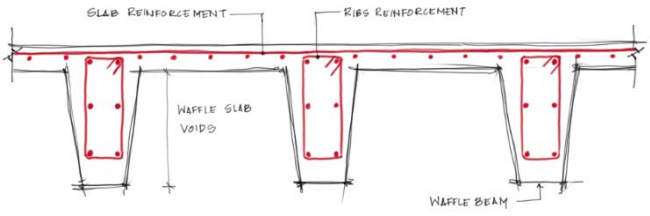


Figure 153: Waffle slab reinforcement

The complex has a large slaughterhouse and meat processing facility which requires large uninterrupted open span for effective functioning. So, in slaughterhouse and two other conference halls waffle slab is being used to avoid internal columns in the structure to maximize free space for machineries and equipment in the industrial section and for programs in those respective halls. The structure is a regular RCC frame structure which uses 750 x 1500 mm columns with a maximum span of 20m.

The industrial section has a **Double-Vaulted Truss** with aluminum metal sheets of top which gives aesthetic beauty to the building. The aluminum sheets are sustainable as it lighter and also can be recycled after the end of its lifespan.

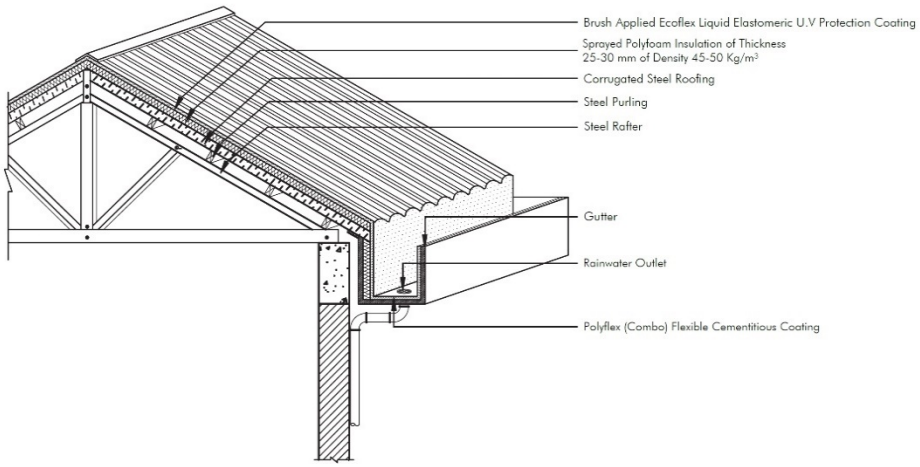


Figure 154: Section detail of aluminum metal roof

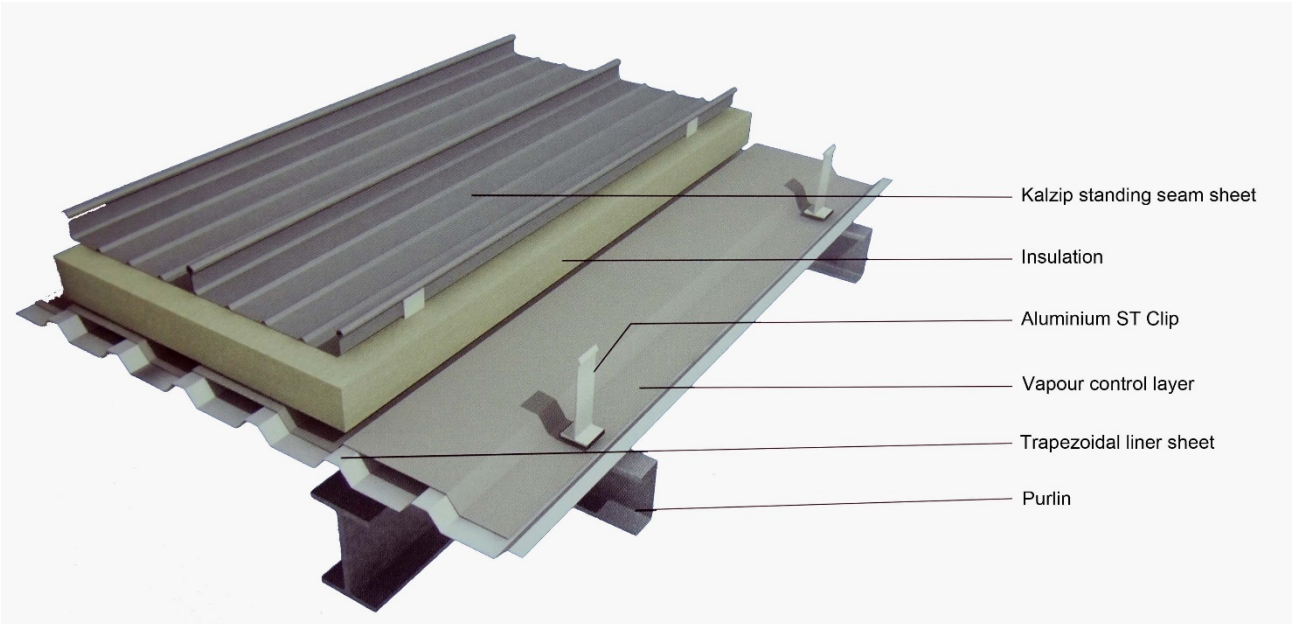


Figure 155: Representive construction detail of aluminum metal roof

11.5 Amenities

The complex is devised in such a way that there are pockets of green spaces and landscapes. Different kinds of amenities have been used to integrate in the design caring about the natural surfaces.

17.1 Tree Grates

Tree grates are designed to endure weathering and heavy foot traffic. They are made from high-quality materials and are made porous to protect the tree allowing rain water to seep through the soil and also prevents the tree roots from becoming obstacles to pedestrians. It has expandable size to allow the tree for future growth.

Figure 156: Tree grates

17.2 Stone Trench Grates

Stone trench or channel grates complements the landscapes along with collection of rainwater along the drain. It is rust and corrosion resistant with green building certified and also invites the viewer eyes along the walkway to open up to the main building design.

Figure 157: Stone Trench Grates

18. Conclusion

In conclusion, modern slaughterhouses are essential for Nepal to ensure that meat production is done in a safe, hygienic, and ethical manner. Traditional slaughterhouses in Nepal often lack proper facilities and equipment to ensure the safety and health of workers and consumers, and they also contribute to environmental pollution. Modern slaughterhouse, on the other hand, utilize modern techniques and equipment to ensure that animals are slaughtered humanely and meat is produced in a sanitary and safe manner.

Moreover, modern slaughterhouses also offer employment opportunities and can contribute to the country's economy. With the demand for meat products increasing in Nepal, modern slaughterhouse can help to meet this demand while also creating job opportunities for local communities.

So, thinking about solving these prevalent issues, this complex is designed with all the required facilities helping in quality processed meat production. And, as per the place making ideology, various vibrant green spaces have been formulated inside this complex which provides quality time spend not only to the customers coming in but also to the staffs and workers inside from their hectic works schedule.

19. References

Acharya, K. P., Acharya, N., & Wilson, R. (2018). Animal Welfare in Nepal. *Journal of Applied Animal Welfare Science*.

Ahmad, J., & Ansari, T. A. (2012). Biogas from Slaughterhouse Waste: Towards an Energy Self-Sufficient Industry with Economical Analysis In India. *Microbial & Biochemical Technology*.

Bajagai, Y. S. (2012). *Food and Environment*. Retrieved from https://www.foodandenvironment.com/: https://www.foodandenvironment.com/2012/12/major-issues-about-safety-of-meat-in.html

Bajracharya, P. M. (2009). *Survey of Buffalo Slaughtering Places and Meat Shops of Kirtipur Municipality for Infrastructure Facilities and Prevalence of Helminth Parasites.* Kirtipur: Zoology Department Tribhuvan University.

Bhasin, H. (2020, February 15). *Market Space – Definition, Meaning, Characteristics, Components*. Retrieved from MARKETING91: https://www.marketing91.com/market-space/

Casandra. (2014). *5 Plants That Clean the Air*. Retrieved from Green Ribbon: http://www.gardinergreenribbon.com/clean-air-plants/

Fitzgerald, A. (2010). A Social History of the Slaughterhouse:From Inception to Contemporary Implications. *Human Ecology Review*, 58-69.

Fortune Business Insights. (2020). *Market Research Report.*

Giedion, S. (1948). Mechanization Takes Command: A Contribution To Anonymous History. *New York: Oxford University Press.*

Guo, M., Buchanan, R. L., Dubey, J. P., Hill, D. E., Lambertini, E., Ying, Y., . . . Pradhan, A. K. (2015). Qualitative Assessment for Toxoplasma gondii Exposure Risk. *ReseachGate*.

Hightop Poultry Equipment. (2021). *Professional Poultry Slaughtering Line Equipment Machine For Slaughterhouse Abattoir Project*. Retrieved from Hightop Poultry Equipment: https://www.hightoppoultry.com/large-scale-slaughterhouse/

Hui, S. C. (2003, February 7). *Sheung Shui Slaughterhouse*. Retrieved from ArchSD: http://ibse.hk/sbe/case_study/case/hk/sheungsh/sheungsh.html#1.1

Irshad, A., & Sharma, B. D. (2015). Slaughter House by-Product Utilization for Sustainable Meat Industry: A Review. *Journal of Animal Production Advances 5(6):1*.

ISI. (1979). *Indian Standard Basic Requirements For An Abattoir.*

Khanal, P. (2020). *Food that divides us*. Retrieved from The Kathmandu Post: https://kathmandupost.com/food/2020/06/19/food-that-divides-us

Kumar, R. (2021, July 27). *Nepali Times*. Retrieved from https://www.nepalitimes.com/: https://www.nepalitimes.com/latest/meat-money-and-the-middle-class/#:~:text=Nepalis%20consumed%20552%2C000%20tonnes%20of,requirement%20for%20a%20balanced%20diet.

López, P. G., Resconi, V. C., Campo, M. d., Guerrero, A., María, G. A., & Olleta, J. L. (2022). Slaughtering of heifers in a local or an industrial abattoir: Animal

welfare. *Livestock Science*. doi:https://doi.org/10.1016/j.livsci.2022.104904

MeaTech. (2022, April 14). *What are the most consumed meats in the world?* Retrieved from MeaTech: https://meatech3d.com/what-are-the-most-consumed-meats-in-the-world/

Morgan, K. D. (2022, June 26). *About Mechanics*. Retrieved from https://www.aboutmechanics.com/: https://www.aboutmechanics.com/what-is-a-rendering-plant.htm

myAyan. (2022). *Advantages and disadvantages of wet market*. Retrieved from myAyan: https://www.myayan.com/advantages-and-disadvantages-of-wet-market

Nastasijević, I., Lakićević, B., & Petrović, Z. (2017). Cold chain management in meat storage, distribution and retail: A review. *IOP Conference Series: Earth and Environmental Science*.

North American Meat Institute. (2012). *12 Good Reasons Meat and Poultry Should be Part of Your Balanced diet.* Retrieved from Meat & Poultry: https://www.meatpoultrynutrition.org/content/great-taste-alone-shouldnt-dictate-your-dietary-choices-here-are-12-good-reasons-meat-and

Pollution Prevention Services InfoHouse. (2018). Retrieved from Iowa Outdoors Magazine: https://p2infohouse.org/ref/24/23296/m_chp2.pdf

Poudel, U., Dahal, U., Upadhyaya, N., Chaudhari, S., & Dhakal, S. (2020). Livestock and Poultry Production in Nepal and Current Status of Vaccine Development. *MDPI*.

Prasain, S. (2021, March 26). *Nepal becomes self-sufficient in egg and meat production*. Retrieved from https://kathmandupost.com/: https://kathmandupost.com/money/2021/03/25/nepal-becomes-self-sufficient-in-egg-and-meat-production

Ranabhat, C. L. (2021). Meat Borne Diseases. In *Meat and Nutrition.*

Ritchie, H., & Roser, M. (2017). *Meat and Dairy Production*. Retrieved from Our World In Data: https://ourworldindata.org/meat-production

Shuangyu, H. (2019, July 22). *T-HAM PABP Factory / WZWX Architecture Group*. Retrieved from Archdaily: https://www.archdaily.com/921310/t-ham-pabp-factory-wzwx-architecture-group?fbclid=IwAR29MO8ApiSkQ86ogKElNRC07unsWT-YU8w7IjIfYhuWZu9NxK38RLgxuPk

T. Editors of Encyclopaedia. (2022, April 3). *meat*. Retrieved from Britannica: https://www.britannica.com/topic/meat

The BC Cook Articulation Committee. (2013). *Meat Cutting And Processing For Food Service*. Retrieved from Bccampus: https://opentextbc.ca/meatcutting/chapter/composition-of-meat/

Wikipedia. (2022). *Processed meat*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Processed_meat

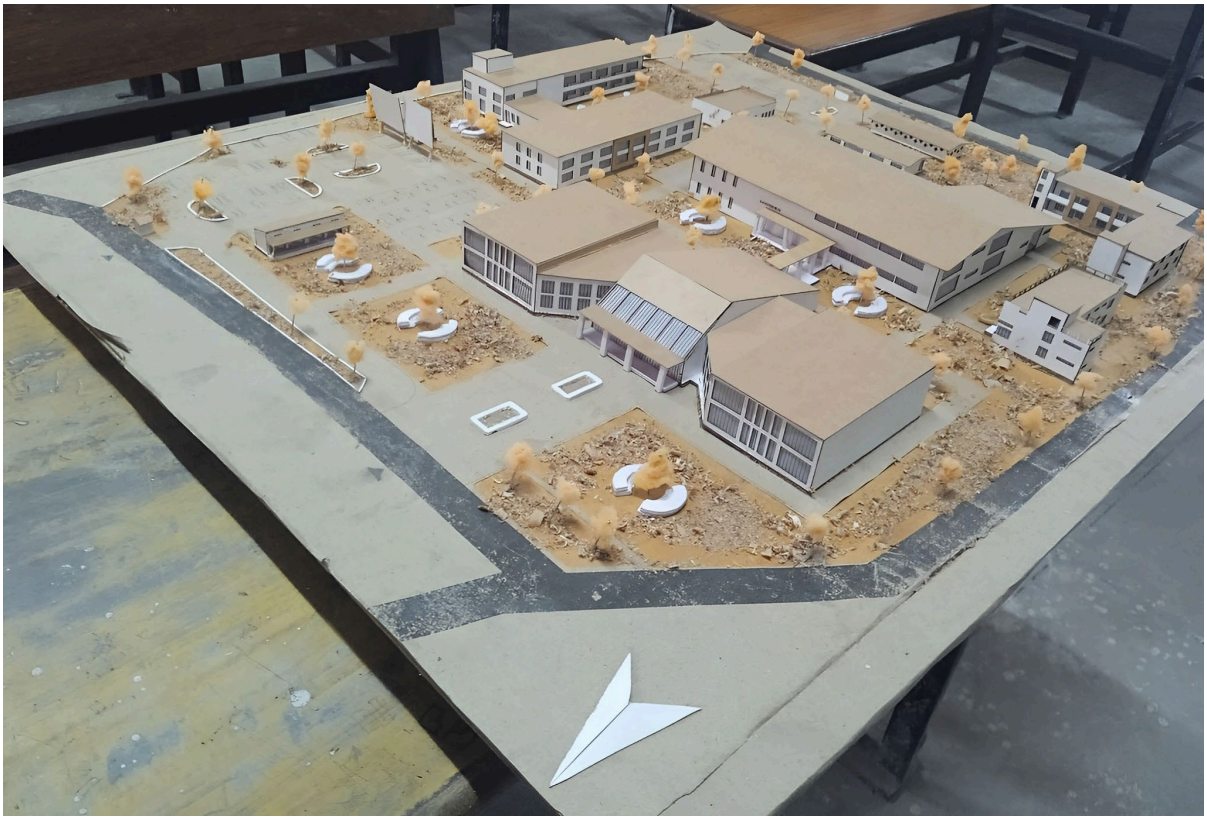
Wiles, W. (2014, September 29). *Slaughterhouses: Meat is modernism*. Retrieved from ICON: https://www.iconeye.com/architecture/features/slaughterhouses-meat-is-modernism

Wong, E. (2021, February 7). *Introduction to Meat*. Retrieved from 3than Wong: https://www.3thanwong.com/introduction-to-meat/

World Weather & Climate Information. (2023). *Average monthly snow and rainfall in Kathmandu in millimeter*. Retrieved from Average monthly snow and rainfall in Kathmandu in millimeter: https://weather-and-climate.com/average-monthly-precipitation-Rainfall,kathmandu,Nepal

20. PHOTOGRAPHS OF MODEL

AERIAL VIEW OF THE MODEL



BIRD'S EYE VIEW SHOWING THE COMMERCIAL PLAZA SPACE

SOUTH VIEW OF THE MODEL SHOWING SERVICE ENTRY

VIEW OF THE MODEL SHOWING SLAUGHTERHOUSE AND OTHER ANCILLARIES

NORTH VIEW OF THE MODEL SHOWING MAIN ENTRANCE

VIEW OF THE MODEL SHOWING PUBLIC PARKING SPACE

VIEW OF THE MODEL SHOWING SERVICE FUNCTIONS

ANNEX