**Chapter 1**

1. **Introduction**
   1. **Background Overview**

Blockchain is incorruptible digital ledger of immutable transactions, that can be programmed, to record virtually everything of value. Blockchain stores record in a distributed database which spread across all the nodes of the network using peer-to-peer (P2P) network. In P2P network, all nodes are connected to each other and these nodes can directly share data without the need of central server. Blockchain only update the ledger via consensus mechanism. This attribute gives the power of decentralization to the blockchain. It uses cryptography to secure transaction and block. Each block in a blockchain is connected to the next block using hash of previous block. Genesis block is a first block of the blockchain. “Data can only be added in the blockchain with time-sequential order” [1]. Each single transaction is recorded in a block, and on reaching the capacity of block, the block is added to the ledger called blockchain. Each transaction and block have a unique hash code, if someone wants to change the data of a transaction, the hash code of transaction and the block changes which will make the chain invalid.

Growing threats to food security lead, us towards the need for an innovative traceability system. Such systems need to include some mechanism related to food quality control which help us in ensuring the safety of food supply chain product. Food customers/consumers are becoming more health-conscious and want to know more about the food they get. They want to know about the quality of the food and the time when the food was made or brought from the source. “Customers are more likely to switch to a brand that provides more in-depth product information beyond what’s provided on the physical label” [2]. Right now, there is no easy way to check where your food e.g. rice or meat, came from and how fresh they are. The complex chain from raw material to consumer is not known to the consumer.

To address the problem of unsecure food supply chain, a blockchain based solution is proposed which empowers the customers with more data about the food they get .in this system we will use some smart contracts to handle and manage transactions and communication between all the network nodes, system will also be able to verifies all of the transactions stored in a centralized system database. A private blockchain will be introduce which will allow all the network nodes to encrypt their secret information but some major participants will get extra authority like Retailer and manufacturer to handle their customers. Proposed system will collect and manage data against each item included in supply chain process which help us in monitoring and liability for agricultural food quality and safety, can also be prolonged to all food sectors. The main purpose of the proposed system is to enhanced traceability performance, and public health safety also helps to encourage development about the advancement of an advanced business strategies based on blockchain and IoT.

* 1. **Objective**

Our Project objective is to design a secure food tracking system which impose blockchain features and characteristics. Traditional systems for food traceability are used for isolating dirtied products from reaching to the end consumers and preventing consumers from causing risks to their health with the use of these unhealthy products. On the other hand, these systems are much more time consuming, more expensive, can be easily hacked and less secure. In order to overcome the problems of traditional food traceability system, blockchain technology is quite helpful. This system will allow access to the consumer to get the detail information including its quality, making time and other aspect related to the food that they are going to purchase. It will provide us maximum accountability throughout the entire transportation process of food products in the chain. Also provides transparency and traceability throughout the whole transaction process.

* 1. **Problem Description**

With the help of emerging new technologies of internet food traceability systems are improving day by day but nearly all of advanced systems are centralized. These systems result in customer trust problem like falsifying customer information, fraud and corruption. Centralized systems are always controlled by single authority so there is more risk of their collapse as single point of failure can lead us toward crash of the whole system. Food borne diseases rate is increasing with time , there is a need for enhancing the trust of customers on food. Blockchain technology is providing efficient solution for secure food tracing system. Firstly, it will help us in keeping every transaction secure between food source, processing, warehouse, transportation, and retailers. Secondly, it will exchange the traditional system of tracking and manual monitoring system. As the traditional way of tracing food chain is not efficient enough to provide detailed information about food. Customers used to take interest in more detailed information specifically about the food they get.

* 1. **Project Scope**

The proposed shared system with many nodes, such as farmer, manufacturer, transporter, distributer, retailer and customer. Where retailer and customers can negotiate for the best prices for their items, distributors can make payments directly to consumers without brokers and mediators. The aim is to provide the complete traceability of the food from farmer to customer. As the product goes through multiple stages, and at each stage, information about the product is recorded in distributed ledger. A customer scans a code of the product, in which a query is encoded. This query will show a complete traceability of the product.

**Chapter 2**

1. **Literature Review**

With the increase in use of internet of things, many researchers also consider relevant to utilize these IoT technologies for food traceability systems in supply chains. In 2006 Folinas et al. ~\cite{folinas2006traceability} discussed the effectiveness of a traceability system depends on the methodology of tracking and tracing each individual product, in such a way that we will be able to monitor the trace from primary production of product until the final discarding by the consumer.

In 2017 a food traceability system was proposed by Tian and Feng.~\cite{tian2017supply}based on blockchain and LoRa IoT technology, in which they talked about the integration of reliable blockchain verification mechanism into the low-power wide-area network (LPWAN) IoT system, for example smart agriculture system based on LoRa/NB-IoT technologies. They believe that this incorporation will help people to advance the food safety standards.

In 2017 lightweight blockchain based architecture was proposed for smart greenhouse farms in order to enhance the security and privacy in smart farms. The paper was named as A framework for blockchain based secure smart Greenhouse farming~\cite{patil2017framework} The system also provides some framework of security based on the combination of blockchain technology and IoT devices which result in secure communication platform in Smart Greenhouse farming . IoT devices in greenhouse have the benefits of private ledger these devices act as blockchain by managing the energy consumption within the Greenhouse farms.

A new approach was proposed in 2018 that enhance the agricultural food chains and lead us towards trusted applications and services within these chains. This approach helps us in allowing better interactions of farmers and other supply chain participants more specifically consumer, where blockchain is used for enhancing the transparency in the data flow between participants and the capacity of data management. The authors think the research will provide better result in chains performance by proposing new food-on-demand business model. The proposed model can help in decreasing the gap of subjective and objective food metrices based on quality standards.~\cite{davcev2018blockchain}

Atlams have discussed that leading the IoT systems toward the decentralized approach is a wise decision and also highlighted the benefits and challenges that we face while the integration of IoT devices and blockchain.~\cite{atlam2018blockchain} He also describes that blockchain is incorruptible power full technology of this era which is able to handle all management processes and decentralized computation overcome the IoT issues more specifically security issues

In 2018 ,a decentralized, blockchain-based traceability system was proposed for Agricultural Food supply chain, which was named AgriBlockIoT.~\cite{lin2018blockchain} The system is able to flawlessly integrate IoT devices dealing with digital data along the chain. The author has -define, develop and deployed some use cases such as from-farm-to-fork for achieving traceability, he has used Ethereum and Hyperledger Sawtooth, two different blockchains approaches for checking the results. At the end the author has compared the result of both blockchain approaches with respect to network usage ,CPU and latency ,and also explain the drawbacks and benefits of both approaches.

Chapter 3

Requirement Specifications

3.1 Existing System

The existing systems for food traceability in Pakistan are centralized. These systems are used to track and trace the products at various stages of distribution chain and supply chain In Pakistan there is traceability solution named as Meat Trax introduces by ZAUQ group ,its purpose is to trace and track the life cycle of meat from cattle till the end customer. Where they are providing information related to the health, immunization records, growth and ownership information. The main drawback of these centralized system is that they can be easily hacked, there is a single point of failure if the centralized server crashes the whole system will fail. Due to the centralized characteristic of existing system they are losing their customer trust as customer are keener about the food they get ,its quality and safety. Existing systems of food traceability in Pakistan are more time consuming ,much expensive, can be easily hacked and less secure.

3.2 Proposed System

The proposed system is a blockchain based system where users will be able to trace complete rice supply chain and distribution chain within just minutes. In this system a decentralized approach will be used to store data and information related to all network attributes on the blockchain once it will be stored on blockchain, it cannot be altered because this new technology provides transparency and immutability to the data stored on it. Hence the blockchain based traceability system which cannot be tempered will be much faster and more secure because when we query the system and get the information about rice traceability without going through the traditional centralized system and also manual monitoring system we get information without delay. The proposed system will be able to provide us a secure traceable rice supply chain from farm till the end customer with the help of blockchain security methods

3.3 Requirement Specifications

3.3.1 Functional Requirements

* The system needs to be available for the user by the low-cost design
* Brands can retain their customers trust.
* Anyone can check the secure rice supply chain .
* User requirement of the system is to provide traceability for the product they purchased

3.3.2 Non-Functional Requirements

* The system must be secure enough to prevent the leakage of sensitive information and provide confidentiality.
* The system should have controlled the maintenance cost.
* The system should be able to maintain the data integrity
* The system should must be scalable to manage large amount of data
* The system should be more adaptable to the changing needs of users.
* The system should be secure to store sensitive data.
* The system should be able to handle spa attacks.