Distributed Computing

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Name of Organization

"Easy Walk Shoe Corporation".

Mission

Easy Walk aims to become bestselling shoe corporation in Pakistan, they claim to use only the most comfortable material and authentic leather for their products.
Easy Walk, by their online system, want to render their services to their customer at their door steps keeping customers' comfort their higher priority.

Vision

Easy Walk is committed to their mission of becoming Number one shoe corporation in Pakistan, they have recently reached a huge milestone by dominating shoe market of Karachi, Lahore and Faisalabad.

Continuous Development

Since foundation, the company has been following the principle of continuous development. They are 24/7 to maintain and deliver high quality products. They are successfully in shoe market of Karachi, Lahore and Faisalabad. And within a next year their aim is to target Islamabad.

Company Philosophy

Maximum customer service is the goal and philosophy of Easy Walk shoe corporation.

Reasons for Distribution

Data Sharing

Reason for Easy Walk Distributed System is the desire for person-to-person communication facility by sharing information over its branches.

Reliable Data Communication

In a distributed system, if a branch (Lahore, Faisalabad) site fails due to overload of tasks in hand, headquarter(Karachi) site in the distributed system will continue processing the tasks. Thus, failure of a site in the distributed will not cause the whole system to be in a halted state which will result in reliability of the system.

Multiple Application Vendor

Necessity for distributed system of Easy Walk Corporation is to make powerful and highly flexible administration panel to Karachi allowing its branches Lahore and Faisalabad to manage and control their online sales efficiently via a single common storefront.

Transaction and Analytical Processing

Easy Walk as an online system require Transaction and Analytical Processing to work upon diversified systems which may have common data. Distributed database systems aid both these processing by providing synchronized data.

Database Recovery

Karachi as headquarter have its own database along with replication of its branches' which helps in data recovery if database of any branch is damaged. E.g.: if database of Lahore got damaged, its data can be accessed from Karachi Database while the damaged branch database is being reconstructed.

Distributed Nature of Organizational Units

Easy Walk Shoe Corporation is subdivided into multiple units (headquarter and two branches) that are distributed over Pakistan. Each unit requires its own set of local data. Thus, the overall database of the corporation becomes distributed.

Easy Walk's Scenario

As Karachi is Easy Walk's headquarter it maintains its own Database along with the databases of Lahore and Faisalabad and have right to perform manipulation operation (Insertion, Deletion, Modification) on data.

Whereas, Lahore and Faisalabad maintain its individual selling records and can access Inventory (no manipulation of data allowed).

Easy Walk requires a distributed Database System that can full fill all above mentioned needs along with other features.

Karachi

Inventory Table:

Product_ID	Article_NO	Size	Color	Gender	Price	Branch

Primary Key

Selling Record:

Product_ID	CustomerName	Date	Price	Branch

Primary Key

Lahore and Islamabad (each)

Inventory Table for Synchronous and Asynchronous:

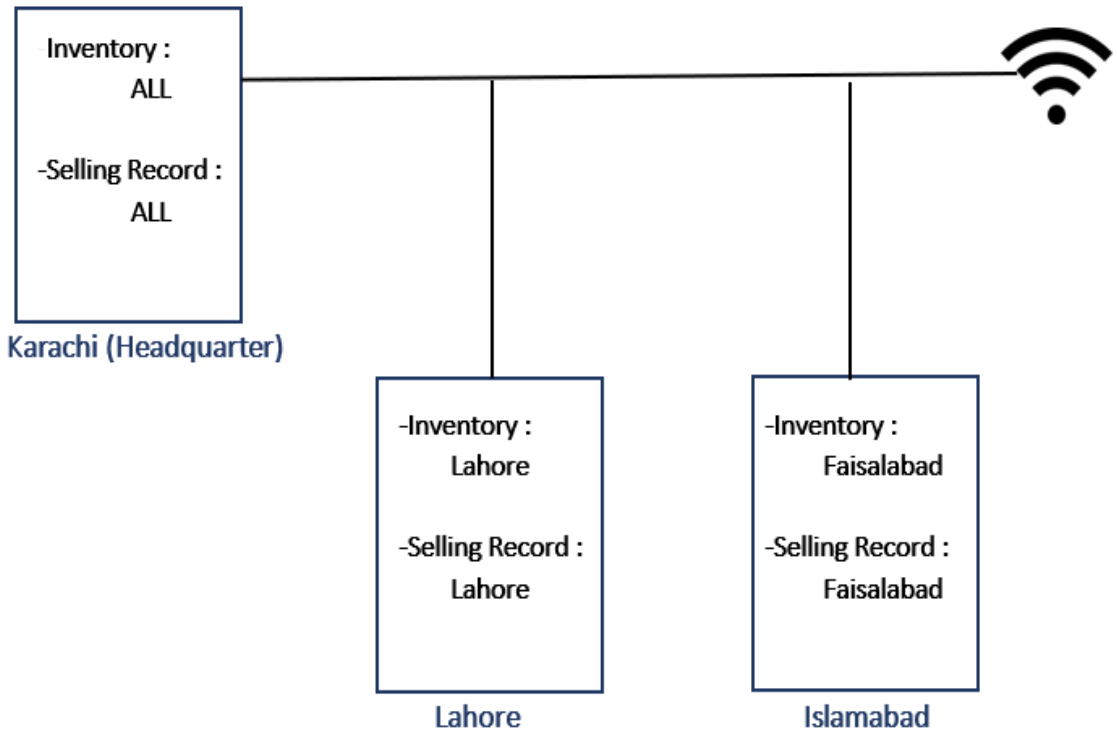
Product_ID	Article_NO	Size	Color	Type	Gender	Status	Price

Primary Key

Selling Record for Synchronous and Asynchronous:

Product_ID	Customer_Name	Date	Price

Primary Key



Site 1: Karachi (Headquarter)

Insertion	Deletion	Modification
Karachi	Karachi	Karachi

Site 2: Lahore

Insertion	Deletion	Modification
Lahore and Karachi	Lahore and Karachi	Lahore and Karachi

Site 3: Islamabad

Insertion	Deletion	Modification
Islamabad and Karachi	Islamabad and Karachi	Islamabad and Karachi

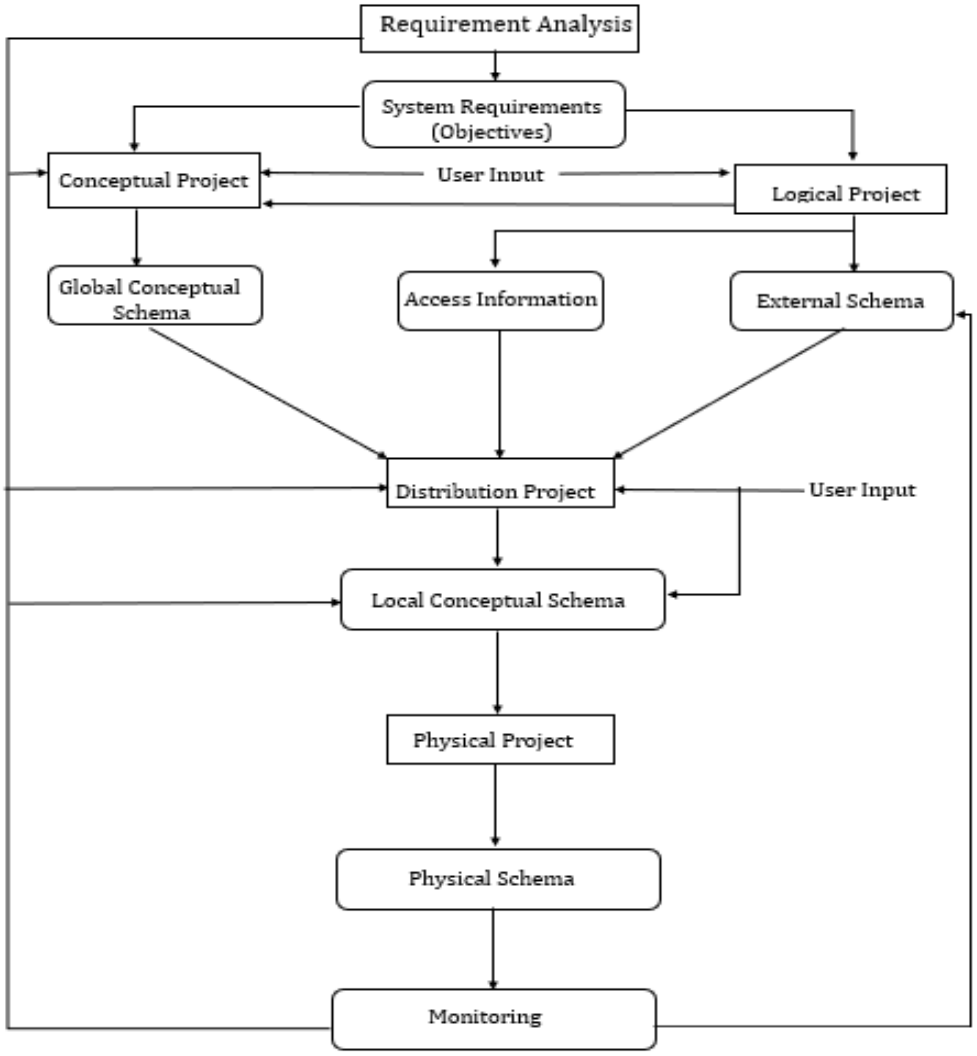
Design Strategy of Easy Walk

"TOP-DOWN APPROACH"

Easy walk has not any distributed database already implemented, we are constructing distributed databases of Easy Walk beginning from the ground which we will implement in homogenous systems.

The top-down design strategy fits in the situation of Easy Walk because they have not any database already implemented.

As can be seen, in yellow are the traditional stages of the top-down model: requirements analysis, conceptual project, logical e physical project. In red is the distribution project stage that is specific in distributed databases.



Stages of Top-Down Approach in Distributed Database

- Requirement Analysis

In first stage of constructing distributed databases, we collect information about the articles of Easy Walk, and its restrictions and relationships within the corporation. The requirements analysis is realized through meetings with the owner, customers and salespersons where we observed how the Easy Walk operates. In the end of our analysis a document according to the requirements of Easy Walk corporation is generated.

- Conceptual project

In this stage takes place the modeling of the data and its relationships independently of the structure of representation regarding the distributed database system DDS (conceptual modeling). The conceptual project is realized through the analysis of the requirements specification. In the end of the conceptual project a conceptual schema (diagram) with the correct data integrity restrictions is obtained.

- Logical Project

In this stage takes place the conversion of the conceptual project to the representing schema of a DDS (logical schema). The logical project is realized through the application of conversion rules, translation to the relational model of the distributed database. In the end of the logical project a logical schema with tables, stored procedures, views, access authorizations, etc. is obtained.

- Distribution project

In this stage is taken the decision of how the data and records must be allocated, fragmented through the nodes of distributed network This stage is considered the most critical in the project of a distributed database.

- Physical project

In this stage the logical schema is defined in a DDS suitable to the data model. The physical project is realized by means of SQL instructions. The result is a physical schema in concordance with the established in the distribution project. After finishing the physical project of each node of the computer network the distributed database is ready for use. A monitoring process is initialized and aims to discover possible errors. Such errors are the system feedback and are sent to the people responsible for the construction of the distributed database.

- Conclusion

At the beginning of a distributed database project it's extremely important to assess the organizational environment of the company that holds the data. Easy Walk doesn't have any distributed database at back-end and legacy systems, the top-down construction approach will be necessarily employed.

As a macro overview it's possible to infer that in the first stage a document with the requirements is generated and after that the logical and conceptual projects start. Logical and physical schemas start to be generated. With the logical and physical schemas already defined the distribution project starts and this is the most complex. After the definition of the local schema of each node of the computer network, the implementation of the local physical schema starts. At this point each network node is given the responsibility for determined tasks of the company. This means that some objects (views, stored procedures, etc.) of the database are created specifically according to each physical local schema. In the last level is the distributed database monitoring process, which helps in the discovering of bugs and propitiates at the same time the possibility of correction forwarding the bugs to the superior levels.
The top-down approach aims to structure the creation process of a distributed database. Defining and separating the construction stages in a correct manner, the database architects and other people involved in the construction of a distributed database will have more chances of achieving success in a given project.

Easy Walk's Distributed Database Architecture

Client—Server Architecture

Karachi's branch is the headquarter will serve as a server and the branches in Lahore & Faisalabad will be treated as Client. Client branches only hold their own data while the main server, Karachi's branch will hold all the records of both clients i.e Lahore and Faisalabad branches respectively. Both the server and clients have same application servers, also using same technologies constitute a homogenous system.

Architecture's Alternative

Alternative of the Easy Walk distributed databases will be made by keeping tight integrity(a0), client-server architecture(d1) and homogenous systems(H0).
Scenario of Alternative Architecture: ***(A0, D1, H0)***
This will create an environment where instance of one database is running at different locations within an organization.

Replication in distribution of Easy Walk Database

For reducing the risk of fault tolerance in distributed database of Easy Walk, we will do replication. As replication is the popular fault tolerance technique in which we store instance of database at different locations, so that in case of any failure in component at any site, the whole distributed system will not suffer.
Thus, in this way we achieve our goal of reliability.

Type of Replication

Partial Replication

We did partial replication as Head branch(Karachi) has complete replica of both other branches (Lahore & Faisalabad), but the Lahore and Faisalabad branches will not hold any replica of any branch. They just maintain their own transaction record.

Architecture of Replication

Synchronous Architecture

Karachi's branch has replica of both relational table i.e. Lahore and Faisalabad, any update in the relational table or client branches will be modified immediately in replica, which is head branch Karachi. So, there is no difference between data of Karachi (Replica data) and Lahore, Faisalabad (Original data).

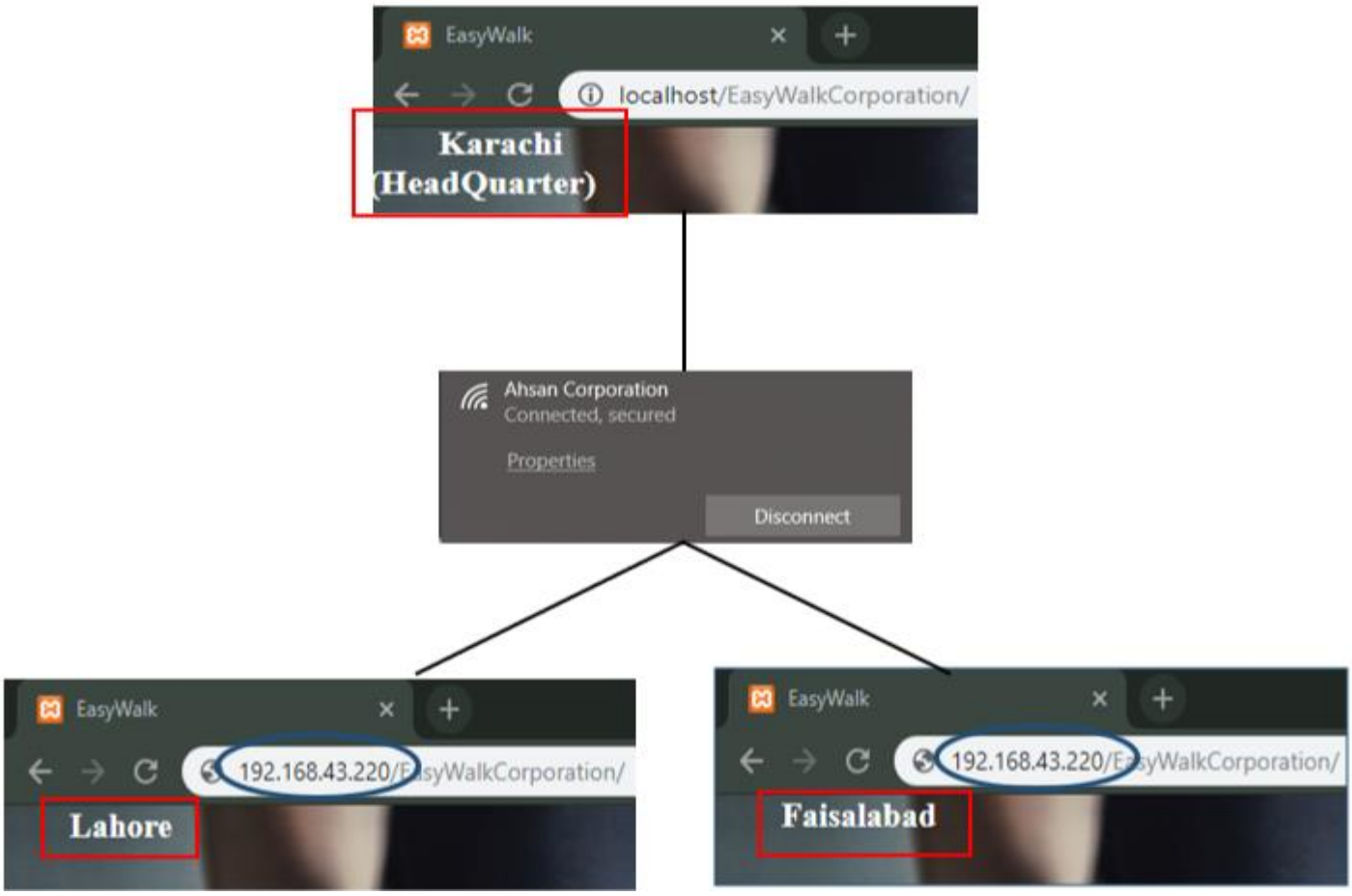
Asynchronous Architecture

Karachi's branch has replica of both relational table i.e. Lahore and Faisalabad, any update in the relational table or client branches will be modified to the primary storage (inventoryasyncho table) first and then copy the data to the replica, depends when Client commits data to be replicated to Head Quarter. So, there is no difference between data of Karachi (Replica data) and Lahore, Faisalabad (Original data).

Implementation

Step No. 1

Distributed system of Easy Walk is established by connecting server (Karachi, Head Quarter) and clients (Lahore and Faisalabad, Branches) to a common data communication link, Ahsan Corporation. Then, IP address of the headquarter is used by branches to access it.

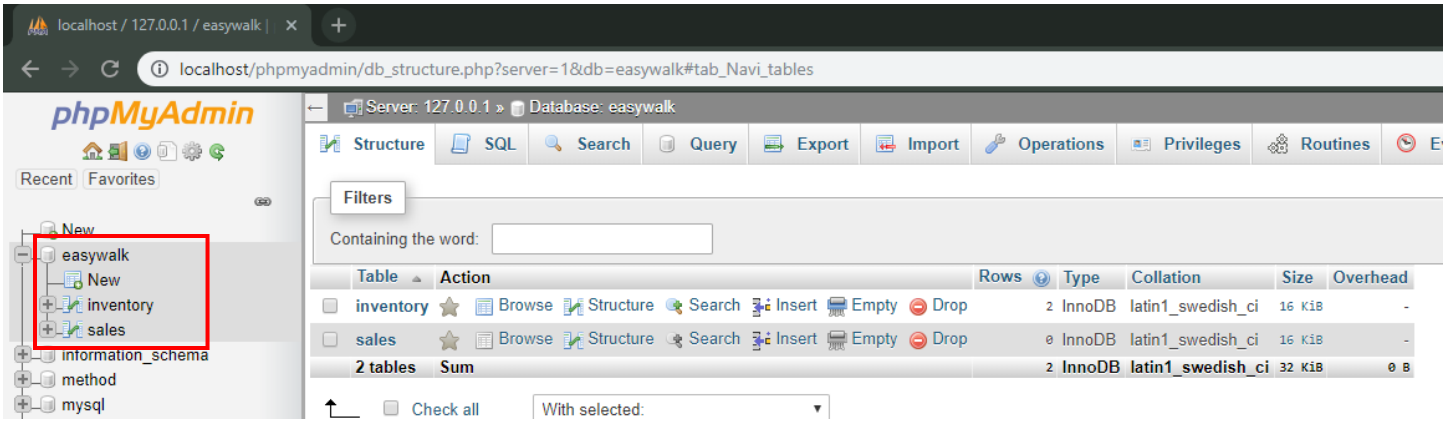


Step No. 2

After connecting them to a common data communication link, database is created on them with the help of phpMyAdmin.

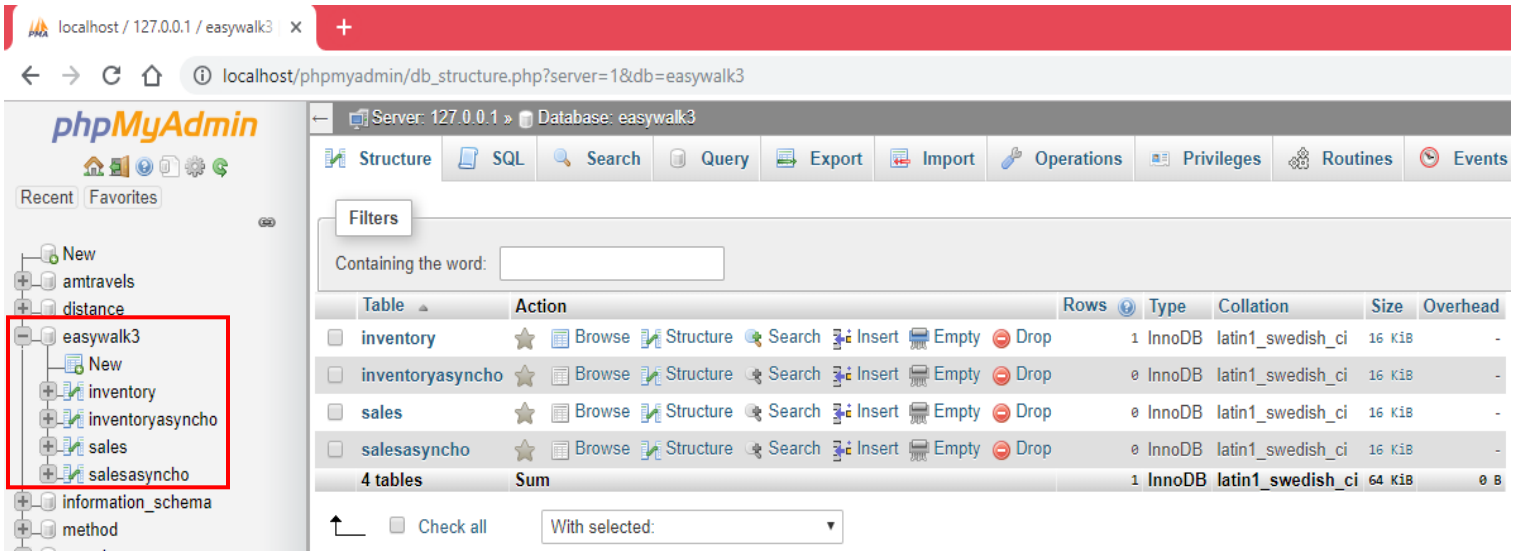
Server (Karachi, Head Quarter)

On IP: 192.168.43.220



Client (Lahore and Faisalabad, Branch)

On IP: 192.168.43.21 and IP: 192.168.43.94



Step No. 3

Then connection is created between them through following SQL Query and PHP Code:

Server (Karachi, Head Quarter)

```
//connect to the database HQ
$db = mysqli_connect('192.168.43.220','EasyWalk','easywalk','easywalk');
```

Client (Lahore, Branch)

```
//connect to the database LAHORE
$db = mysqli_connect('192.168.43.21','EasyWalk2','easywalk2','easywalk2');
```

Client (Faisalabad, Branch)

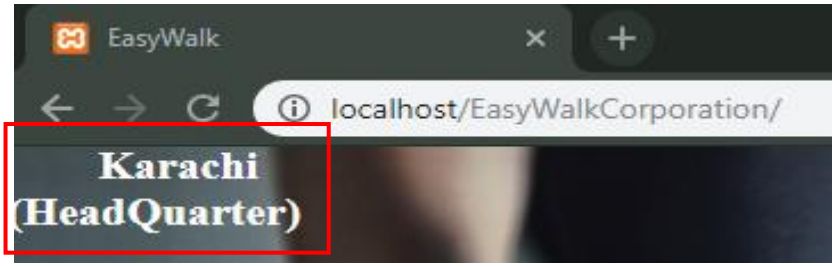
```
//connect to the database Faisalabad
$db = mysqli_connect('192.168.43.94','EasyWalk3','easywalk3','easywalk3');
```

Step No. 4

This is how website show the connection verification:

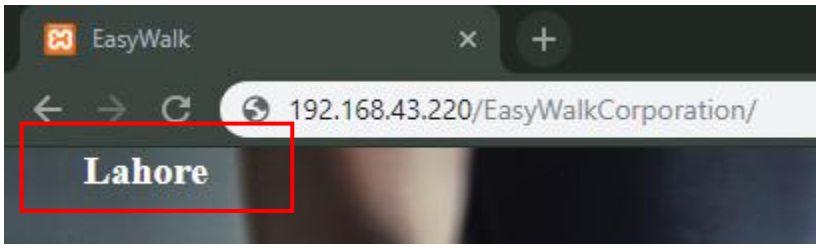
Server (Karachi, Head Quarter)

For IP: 192.168.43.220 (Local Host)



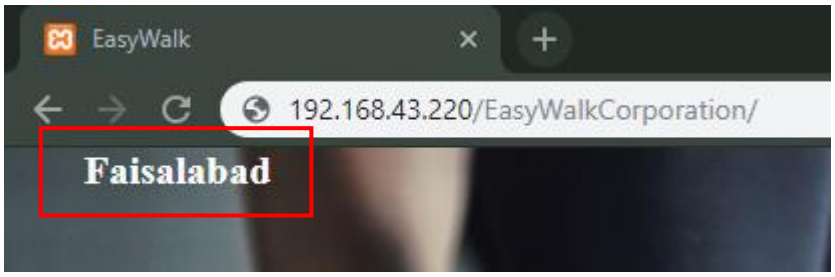
Client (Lahore, Branch)

For IP: 192.168.43.21



Client (Faisalabad, Branch)

For IP: 192.168.43.94

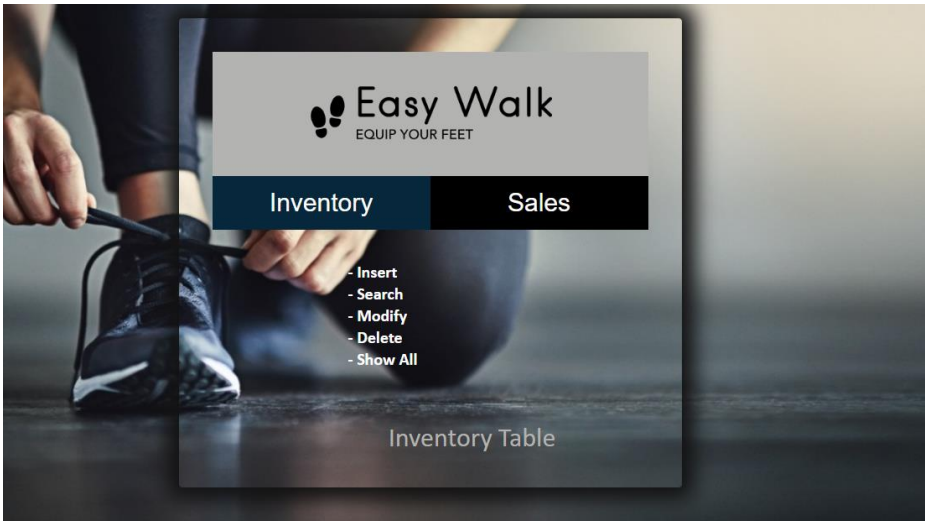


Working

There are two types of main pages of Easy Walk website one is for Headquarter and other is for Branches.

For Head Quarter:

Actions could be performed shown in action panel



For Branches:

Here choice is given for Replication Method and after choosing one method same page as above opens.

Example

Synchronous Insertion

	Product_ID	Article_NO	Size	Color	Gender	Price	Branch
Edit Copy Delete	1	23A	45	BLACK	MALE	1200	Lahore
Edit Copy Delete	2	2A9	34	FEMALE	RED	4300	Lahore
Edit Copy Delete	3	DA7	12	MAGENTA	MALE	2300	Lahore
Edit Copy Delete	4	GY5	23	WHITE	FEMALE	1233	Lahore

Branch

	Product_ID	Article_NO	Size	Color	Gender	Price	Branch
Edit Copy Delete	1	23A	45	BLACK	MALE	1200	Lahore
Edit Copy Delete	2	2A9	34	FEMALE	RED	4300	Lahore
Edit Copy Delete	3	DA7	12	MAGENTA	MALE	2300	Lahore
Edit Copy Delete	4	GY5	23	WHITE	FEMALE	1233	Lahore
Edit Copy Delete	200	R66	38	RED	Female	1300	Faisalabad
Edit Copy Delete	500	44T	30	YELLOW	Female	1500	Karachi
Edit Copy Delete	999	77K	29	RED	Female	1300	Karachi
Edit Copy Delete	2002	99T	32	BLUE	Male	1000	Faisalabad

HQ

Asynchronous Insertion

TEMPORARAY TABLE in Branch

	Product_ID	Article_NO	Size	Color	Gender	Price	Branch
Edit Copy Delete	9	DE3	34	ORANGE	MALE	900	Lahore

HQ Table after "Replicate in HQ" is clicked

					ider	Price	Branch
Edit Copy Delete	1	23A	45	BLACK	MALE	1200	Lahore
Edit Copy Delete	2	2A9	34	FEMALE	RED	4300	Lahore
Edit Copy Delete	3	DA7	12	MAGENTA	MALE	2300	Lahore
Edit Copy Delete	4	GY5	23	WHITE	FEMALE	1233	Lahore
Edit Copy Delete	9	DE3	34	ORANGE	MALE	900	Lahore
Edit Copy Delete	200	R66	38	RED	Female	1300	Faisalabad
Edit Copy Delete	500	44T	30	YELLOW	Female	1500	Karachi
Edit Copy Delete	999	77K	29	RED	Female	1300	Karachi
Edit Copy Delete	2002	99T	32	BLUE	Male	1000	Faisalabad

FRAGMENTATION

Horizontal Fragmentation

```
SELECT * FROM `inventory` WHERE branch='Lahore';
```

+ Options

	Product_ID	Article_NO	Size	Color	Gender	Price	Branch
Edit Copy Delete	1	23A	45	BLACK	MALE	1200	Lahore
Edit Copy Delete	2	2A9	34	FEMALE	RED	4300	Lahore
Edit Copy Delete	3	DA7	12	MAGENTA	MALE	2300	Lahore
Edit Copy Delete	4	GY5	23	WHITE	FEMALE	1233	Lahore
Edit Copy Delete	9	DE3	34	ORANGE	MALE	900	Lahore

Check all *With selected:* Edit Copy Delete Export

Vertical Fragmentation

```
SELECT Article_NO,Branch,Price,Color FROM `inventory`;
```

+ Options

Article_NO	Branch	Price	Color
23A	Lahore	1200	BLACK
2A9	Lahore	4300	FEMALE
DA7	Lahore	2300	MAGENTA
GY5	Lahore	1233	WHITE
DE3	Lahore	900	ORANGE
R66	Faisalabad	1300	RED
44T	Karachi	1500	YELLOW
77K	Karachi	1300	RED
99T	Faisalabad	1000	BLUE