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Development of Web Based Application for Supply Chain Management

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Development of Web Based Application for Supply Chain Management

by

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Abstract

As a firm staying competitive in the market is never easy. It faces a lot competition from each and every competitor. The firms have to always come up with a better strategy to satisfy their customers, incorporate latest technologies to provide better service to their customers. The web based application for the supply chain management is a solution that supports collaboration in Supply Chain as the foundation for gaining competitive advantage and maintain market share. There are some other ways to obtain the collaboration but this is a better solution. There are several technologies that are needed for the design and implementation of this web application, some of the include technologies like Java, HTML, CSS, Java Script, Angular JS, Angular Schema form. There is a high level integration needed to bring this on to a single track and make this work. This web application has used the up to date technologies so this way the application can be the most sophisticated one on the market. This application uses technologies that are completely open source and involves a lot less capital than other tools out there in the world. This way the firm whoever uses this technology will be able to see a growth in the productivity, higher profits and the most important thing would be to make the customers happier. With some minor changes to the application it shall be able to make it available to other companies as well.

This report describes the technologies used and how are they integrated, if this application was really able to manage the supply chain management in the company. This section gives an overview about the design of the application, the

forecasting of the demand. The results showed an improvement in the manufacturing

process of the company, reduction in the transportation costs.

Acknowledgement

I am grateful to my chair Dr. Hiral Shah and the Director of Engineering Management Program Dr. Ben Baliga for the immense guidance provided by them throughout the course of this project. By sharing their thoughts and suggestions they have guided me to complete this project successfully. They have spent their valuable time to read and understand this paper. Their suggestions and the recommendations were very helpful for me to design and implement this project in a more effective manner.

I also convey my sincere thanks to Prof. Gary Nierengarten and Dr. Balsy Kasi for their support and suggestions during the entire period of this project. I am grateful to Engineering Management program and St. Cloud state university for providing me such wonderful resources. And finally I would like to thank Ms. Sue Pope, my family and all my well-wishers who supported me throughout my master's program.

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Chapter 1: Introduction

Introduction

Supply chain management (SCM) is the management of the flow of goods and services. It includes the movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption. The management of the supply chain is really a challenging task, if it had automated software to keep monitoring the supply chain even from the origin of raw materials, transportation, processing, production of the finished goods, quality analysis and delivering it would had been really helpful and make the entire production process really easy.

The java based application that was created has the capability of procurement of data that is, it can all by itself acquire the data like the requirement of the end customers, ordering the amount of the raw materials, manufacturing time line, quality analysis, shipment delivery including tracking, customer feedback.

The project involved some programming languages like Java, HTML, CSS, Java Script, Angular JS, Angular Schema form, Json Schema, and Bootstrap. It needed a server and the project uses Web Sphere from IBM, the webstrom as the IDE (Integrated Development Environment). The individual who needs the products goes onto the website of the supplier and places the order; this order is forwarded to the manager of the supplier via a secured channel which involves a bunch of authentications and security layers. The supplier or the corresponding manager then grants permission to the web based application to go ahead and place an order for the raw materials, then the processes of manufacturing that are applicable for the

production are suggested and they can be selected by the manager, quality analysis is also a capability of the application, delivery of the product to the customer and the process of taking feedback from the customer is all part of the functions of the application.

Problem Statement

The client (a manufacturing firm similar to Snap-On) had the inventory maintenance problem, huge lead times caused due to several reasons, the manufacturing techniques were having devastating effects on the client's quality of the products. So the client was looking into a web based application to find a solution to the problems being faced and to automate the whole processes.

Nature and Significance of the Problem

Each and every manufacturer tries to make the utmost profit from the end product, this cannot be done by increasing the prices alone so the manufacturer has to look for other alternative methods to decrease the price of the goods coming out, this can be done by designing better products with high quality, reducing their lead times (Chen et al., 1999). This was the main reason that the client was looking for a better method or tool to bring better products to the market and stay in the competition without being washed way.

The client had been looking for a solution, so they could overcome all the problems they were facing. The web based application seemed like a best tool that can take into consideration the demand, the availability of resources and order accordingly. The tool is capable of suggesting latest manufacturing process by

filtering the sophisticated processes available all over the world for manufacturing of the end product, with an inbuilt way to analyze the quality.

The tool was able to reduce the burden on the management of the client by suggesting the best route to be taken by the trucks, for this to happen the web based application is using the google services to choose from a variety of routes, it was also able to provides the competing third party logistic provider details if the client wanted to go with TPL. The tool is capable of interacting with the end client (customer) of the client to get the feedback and suggestions to improve the quality and service.

Objective of the Project

The main objective of this web based supply chain management system was to effectively manage the whole supply chain of the client beginning from the order placement until the product reaches the customer (Raju, Rajendran, & Fayad, n.d.).

Project Questions

The following project questions were answered at the end of the project:

1. What was the ability of the application to suggest better manufacturing methods, and were the methods capable of providing better quality and reducing lead times?

2. What was the capability application to suggest where to get the raw materials?

3. What was the way for the engineers to enter the analysis data into the application to deliver the results?

4. What was the correctness of the results given by the application? How far can the results be trusted?

5. Was the application capable of suggesting a better transportation route and help the customer with tracking number?

Definition of Terms

Java: Java is a programming language expressly designed for use in the distributed environment of the Internet. It was designed to have the "look and feel" of the C++ language, but it is simpler to use than C++ and enforces an object-oriented programming model. Java can be used to create complete applications that may run on a single computer or be distributed among servers and clients in a network. It can also be used to build a small application module or applet for use as part of a Web page. Applets make it possible for a Web page user to interact with the page (TechTarget, n.d.).

Spring: The Spring Framework is an application framework and inversion of control container for the Java platform. The framework's core features can be used by any Java application, but there are extensions for building web applications on top of the Java EE platform. Although the framework does not impose any specific programming model, it has become popular in the Java community as an alternative to, replacement for, or even addition to the Enterprise JavaBeans (EJB) model. The Spring Framework is open source (Wikipedia.org., Spring, n.d.).

Hibernate: Hibernate ORM (Hibernate in short) is an object-relational mapping framework for the Java language. It provides a framework for mapping an

object-oriented domain model to a relational database. Hibernate solves object-relational impedance mismatch problems by replacing direct, persistent database accesses with high-level object handling functions. Hibernate's primary feature is mapping from Java classes to database tables; and mapping from Java data types to SQL data types. Hibernate also provides data query and retrieval facilities. It generates SQL calls and relieves the developer from manual handling and object conversion of the result set. Applications using Hibernate are portable to supported SQL databases through an isomorphism based on serializability (Wikipedia.org, Hibernate, n.d.).

JavaScript: JavaScript is a cross-platform, object-oriented scripting language. It is a small and lightweight language. Inside a host environment (for example, a web browser), JavaScript can be connected to the objects of its environment to provide programmatic control over them.

JavaScript contains a standard library of objects, such as Array, Date, and Math, and a core set of language elements such as operators, control structures, and statements. Core JavaScript can be extended for a variety of purposes by supplementing it with additional objects; for example:

Client-side JavaScript extends the core language by supplying objects to control a browser and its Document Object Model (DOM). For example, client-side extensions allow an application to place elements on an HTML form and respond to user events such as mouse clicks, form input, and page navigation.

Server-side JavaScript extends the core language by supplying objects relevant to running JavaScript on a server. For example, server-side extensions allow an application to communicate with a database, provide continuity of information from one invocation to another of the application, or perform file manipulations on a server (Mozilla Developer Network, n.d.)

HTML: HTML is a computer language devised to allow website creation. These websites can then be viewed by anyone else connected to the Internet. It is relatively easy to learn, with the basics being accessible to most people in one sitting; and quite powerful in what it allows you to create. It is constantly undergoing revision and evolution to meet the demands and requirements of the growing Internet audience under the direction of the » W3C, the organization charged with designing and maintaining the language. HyperText is the method by which you move around on the web—by clicking on special text called hyperlinks which bring you to the next page. The fact that it is hyper just means it is not linear—i.e., you can go to any place on the Internet whenever you want by clicking on links—there is no set order to do things in.

Markup is what HTML tags do to the text inside them. They mark it as a certain type of text (italicised text, for example).

HTML is a Language, as it has code-words and syntax like any other language (HTML Source, n.d.).

CSS: CSS is the language for describing the presentation of Web pages, including colors, layout, and fonts. It allows one to adapt the presentation to different

types of devices, such as large screens, small screens, or printers. CSS is independent of HTML and can be used with any XML-based markup language. The separation of HTML from CSS makes it easier to maintain sites, share style sheets across pages, and tailor pages to different environments. This is referred to as the separation of structure (or: content) from presentation (W3C, n.d.).

Angular Js: This is an open-source web application framework mainly maintained by Google and by a community of individuals most notably, Rangle.io as well as group developers and corporations. This is used on top of the HTML to make the html come alive. This is really helpful in making the two-way binding come to life.

Angular Schema Form: Schema Form is a set of AngularJS directives (and a couple of services). It can do two things to make life easier:

1. Create a form directly from a JSON schema.

2. Validate form fields against that same JSON schema.

Schema Form uses convention over configuration, so it comes packaged with some sensible defaults. But you can always customize it by changing the order and types of form fields.

Json Schema: JSON (Java Script Object Notation) Schema is a JSON media type for defining the structure of JSON data. JSON Schema provides a contract for what JSON data is required for a given application and how to interact with it. JSON Schema is intended to define validation, documentation, hyperlink navigation, and interaction control of JSON data.

Web Storm: It is an editor for JavaScript, HTML, and CSS. It is powerful, light weight and easy to use. It is really helpful in creating interactive user interfaces.

Summary

This chapter gives a basic idea about the problem, objectives of the project, nature and significance of the project at the business, problems that were solved by the project through the development of this web based application. It also explains the technical abbreviations and other terminology used in this document.

Chapter 2: Background and Review of the Literature

Introduction

This section explains about the underlying problem and the literature review. This helps the user to a get better understanding about the problem and the studies made to propose this particular solution.

Background Related to the Problem

A Supply Chain is basically an interconnected network of suppliers, manufacturers, warehouses, distributors and retailers. This incorporates a coordinated plan which in turn has processes to develop products by converting raw materials to finished goods. The client was implementing a semi-automated process of collecting the order and requirements from their customers instead of using a fully automated form of application to deal with the customers, manufacturing processes, quality control, transportation, feedback reception from the customers (Lewis, 2001).

The client was facing a lot of supply chain problems like Inventory maintenance, the lead times, incorporating latest technology into manufacturing and to maintain a global procurement network. So the client needed a better solution that can take care of the problems he was facing by using the semi-automated process and depending on manual processes. The management of Supply Chain assumes to provide the appropriate strategy to deliver products and services to customers in the right quantities, to the right locations and at the right time to meet the required service level with minimal cost. This can be only done by collaboration, information systems and the latest internet technologies like java, java script, angular js, json schema,

spring and lot more. This way companies can create efficient and effective value systems, and get competitive advantage over other companies. The internet has a lot of advanced technologies that can be used for improvement, so thus by using those technologies and incorporating them into Supply Chain Management a better solution to their problems was created (Ganeshan & Harrison, 2002).

Literature Related to the Problem

The Supply Chain is the movement of materials as they flow from their source to the end customer. Supply Chain includes purchasing, manufacturing, warehousing, transportation, customer service, demand planning, supply planning and Supply Chain management. It is made up of the people, activities, information and resources involved in moving a product from its supplier to customer (Ganeshan, 2002).

The basic problem faced here was how to manage the supply chain in a manufacturing firm and overcome the prime issues being faced by the firm in the day to day economy. In order to provide the client with a best solution the development of a web based application is the only way to help the client in solving their prime issues. The web based application works as follows:

1. The customer places the order on the client's website, then the order is processed by the web application and breaks down the requirements, analyses the amount of raw materials required to meet the customer needs. Then it proposes a start and end date, all the methods that can be implemented to produce the end product.

2. This upon approval by the manager is then pushed onto the production, this involves the ordering of raw materials, approval of the project timeline, job breakdown, project assignment to the employees, selecting the best method of manufacturing.

3. Then the products are pushed on the quality testing, the quality engineers test the quality and the readings are entered onto the web based application where the application does all the calculations and finally gives a report of the quality of the products thus based on the report the quality can be adjusted and amended.

4. Now comes the role of transportation, this plays a vital role in supply chain the finished products has to be transported safely without any damage, as fast as possible, cause the customer satisfaction is the most important thing to worry about. The web application can suggest the client with the better routes so that the transportation costs can be reduced to a minimum possible value.

5. The feedback and suggestions for the product can be taken online after the product has been delivered, thus providing a channel for the client and end customer communication.

Figure 1 shows the architecture of the whole project including the point of receiving the order till taking the customer feedback.
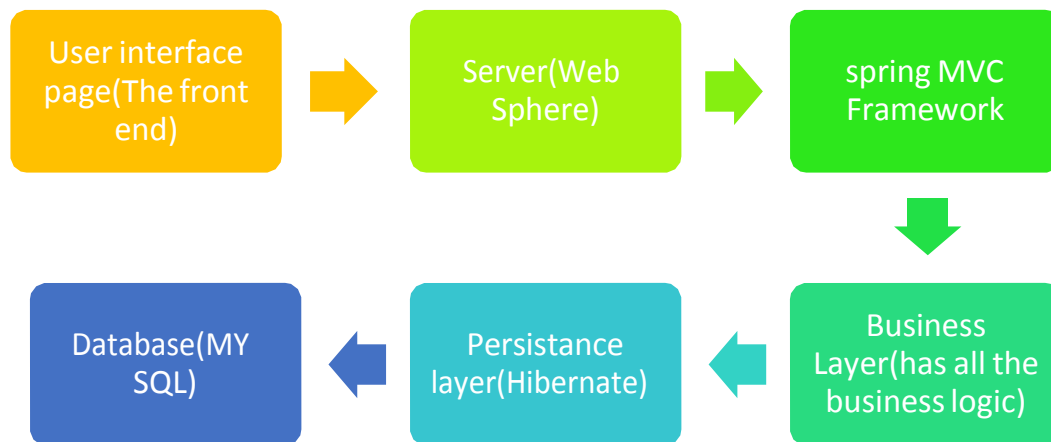
Figure 1: The project architecture.

      This project architecture explains the different components in the project, that integrate together to complete the whole system. There are a total of six individual modules which have their own importance. The whole architecture is explained below.

      The web based application used a high level object oriented programming language to build this web application and the language is Java. It used some frameworks on top of it to enhance the level of programming and make it user friendly. Thus making the language JAVA/J2EE. The project used some advanced frameworks such as Hibernate, Spring, Angular js, JSON Schema.

      User interface: The user interface is the page that is rendered on the web browser and this is the page that the customer would be able to see. This needs a web browser to be expressed, any web browser would work. The application uses HTML5, CSS, Java Script, angular js, json schema and angular schema form to render the form on to the browser (Shneiderman, 1992).

By using Angular js in designing the user interface and MVC pattern the reliability and user experience can be improved. The MVC pattern will be explained in the next module of Spring. Here is a picture that explains the MVC in the front end.
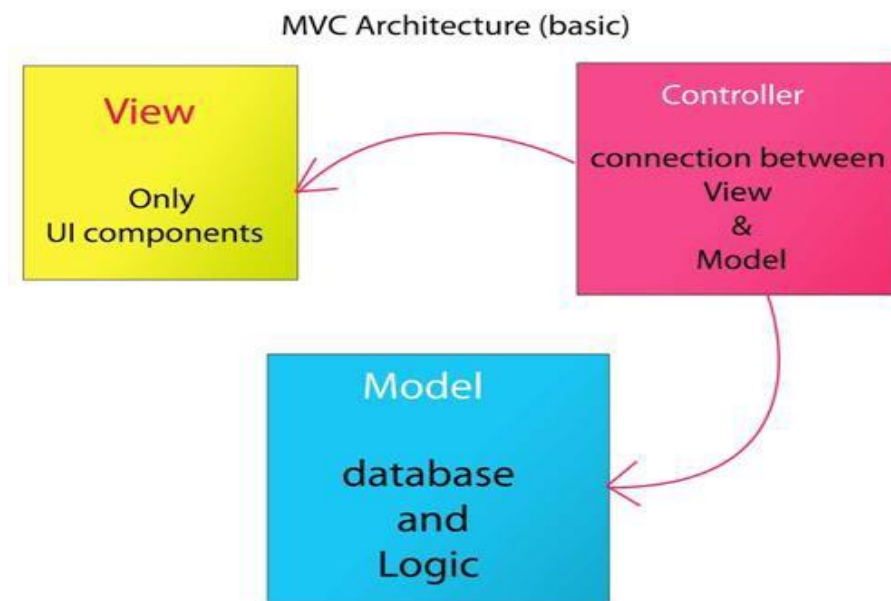
Figure 2: The MVC structure of the Angular js.

Figure 2 explains the MVC Structure of the Angular js framework. The view is the page or the visible content to the user, the Controller is the heart of this pattern, the controller controls the view and the model. The model is data that combines with the view and makes up the big picture.

Server: A server is a computer program or a machine that waits for requests from other machines or software (clients) and responds to them. A server typically processes data. The purpose of a server is to share data or hardware and software resources among clients. This architecture is called the client–server model. The clients may run on the same computer or may connect to the server over a network. Typical computing servers are database servers, file servers, mail servers, print

servers, web servers, game servers, and application servers. The server basically

acts as an interpreter between the code and the machines, the machines cannot

understand the code language, they can only understand zeros and ones. So the bar

files or the zar files after being build into packages that can be understood by the

server are pushed on to the server. Thus the complete working of the applications

takes place on the servers on to which the applications are deployed (Wikipedia,

Server, n.d.).

Spring: The Spring is an architectural framework that helps the java developer

or programmer in simplifying the code and increasing its performance. Figure 3

explains the Spring framework's architecture and the same was explained in this

section. It has the ability to create objects where and when needed, this job is done

by the spring container. The spring has an MVC frame work, where M= Model (data);
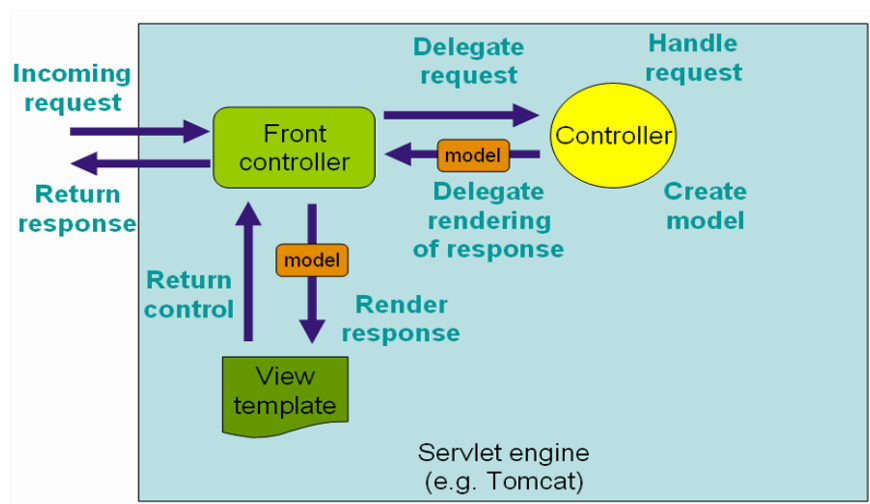
V= View (page display); C= Controller

Figure 3: Spring MVC framework architecture.

- **Model** is the object which has the properties, methods and encapsulates the data (basically coming from the database) for the specific object which generally consists of properties or states and some functionalities that can work on the properties.

- **View** is where all the data gets presented in whatever forms required (depends on the front end technology used). Basic output will be in the format of HTML where the client's browser can interpret. This is the only readable format that can be understood by the user or the customer.

- The **Controller** is like a bridge or an interpreter between model and view. This is responsible for processing user requests and building appropriate model and passes it to the view for rendering on the web browser.

Business Layer: This is the layer where the programmer writes all his business logic like calculating lead times, inventory maintenance, forecasting techniques and much more. Business logic is the programming that manages communication between an end user interface and a database. The main components of business logic are business rules and workflows. This business layer involved the code that had the capability to calculate the amount of raw materials required for the manufacturing of the finished products, this piece of code was written based on the data that was provided by the client. This code also included the calls that were made to the third party logistic service provider, if the client wants to go with them.

Persistence Layer (Hibernate): Hibernate ORM (Hibernate in short) is an object-relational mapping framework for the Java language. It provides a framework for mapping an object-oriented domain model to a relational database. Hibernate solves object-relational impedance mismatch problems by replacing direct, persistent database accesses with high-level object handling functions.

Hibernate's primary feature is mapping from Java classes to database tables; and mapping from Java data types to SQL data types. Hibernate also provides data query and retrieval facilities. It generates SQL calls and relieves the developer from manual handling and object conversion of the result set. Applications using Hibernate are portable to supported SQL databases through an isomorphism based on serializability. This can be illustrated by the below picture (Figure 4) (Wikipedia, Hibernate, n.d.).
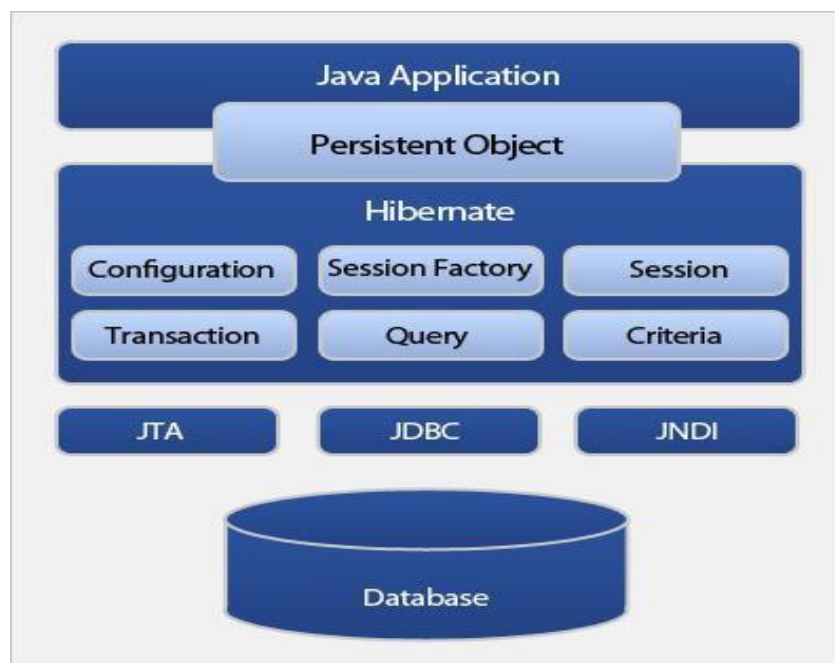

Figure 4: Hibernate ORM framework

Data Base (MySQL): MySQL is a freely available open source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL).

SQL is the most popular language for adding, accessing and managing content in a database. It is most noted for its quick processing, proven reliability, ease and flexibility of use. MySQL is an essential part of almost every open source PHP application. Good examples for PHP/MySQL-based scripts are phpBB, osCommerce and Joomla. This can be integrated with Java on any platform like Windows, Linux, and Unix etc. [https://www.siteground.com/tutorials/php-mysql/mysql.htm]

Figure 5 depicts the integration of Java, Hibernate and MySQL database interface.
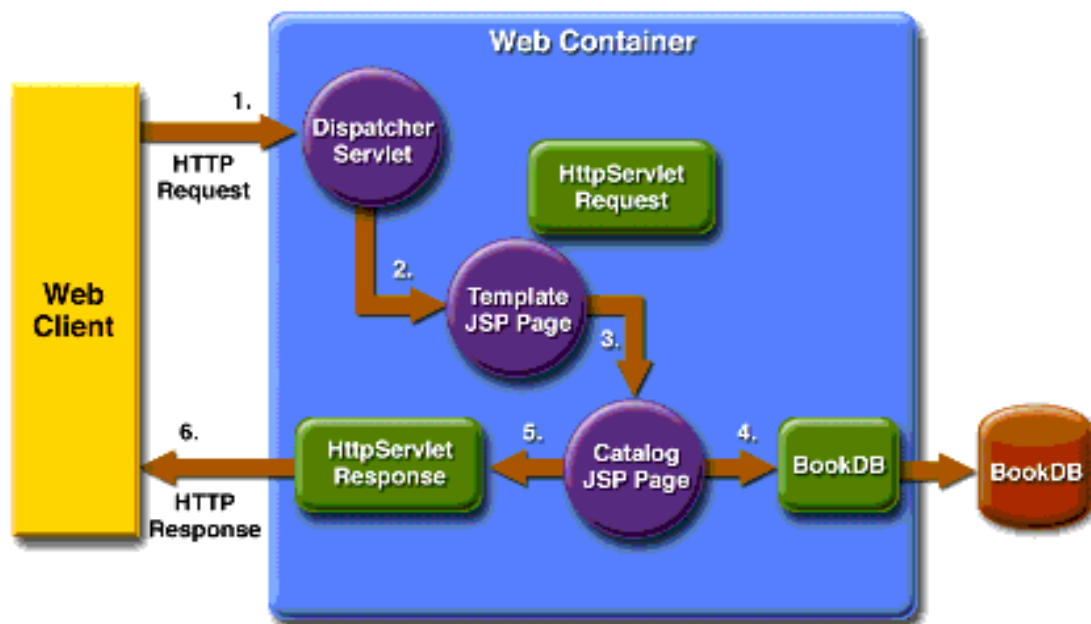

Figure 5: Spring database integration.

Figure 5 shows a picture of integration of Java, Hibernate and MySQL database interface. The Web Client sends in an http request to the controller or the dispatcher servlet which decides which java class to invoke and which data to be collected from the database and then sends it back to the Web Client as an http response.

Literature Related to the Methodology

The project implemented agile, test driven development, Pair Programming and extreme programming.

Extreme Programming is undoubtedly the hottest Agile Method to emerge in recent years. XP owes much of its popularity to developers disenchanted with traditional methods and looking for something new, something extreme. The 12-rules of Extreme Programming, true to the nature of the method itself, are concise and to the point.

The planning game: Each iteration began with customers, managers, and developers fleshing out, estimating, and prioritizing requirements or 'user stories' for the next release, capturing it in a language that everyone can understand.

Small releases: An initial version of the system was put into production after the first few iterations. Subsequently, working versions were put into production anywhere from every few days to every few weeks.

Metaphor: Customers, managers, and developers constructed a metaphor, or set of metaphors after which to model the system.

Simple design: Developers were urged to keep design as simple as possible, say everything once and only once.

Tests: Developers wrote acceptance tests for their code before they wrote the code itself, while customers wrote functional tests for each iteration, with tests being ran at the end of each iteration.

Re-factoring: As developers worked, the design evolved and was kept as simple as possible.

Pair programming: Two developers sit together at the same machine to write the code.

Continuous integration: Developers integrated new code into the system, as often as possible and all functional tests must be passed code integration, or else the new code was discarded.

Collective ownership: The code was owned by all developers, and they may have made changes anywhere in the code at anytime they feel necessary.

On-site customer: A customer worked with the development team at all times to answer questions, perform acceptance tests, and ensure that development was progressing as expected (Agile introduction for dummies, n.d.).
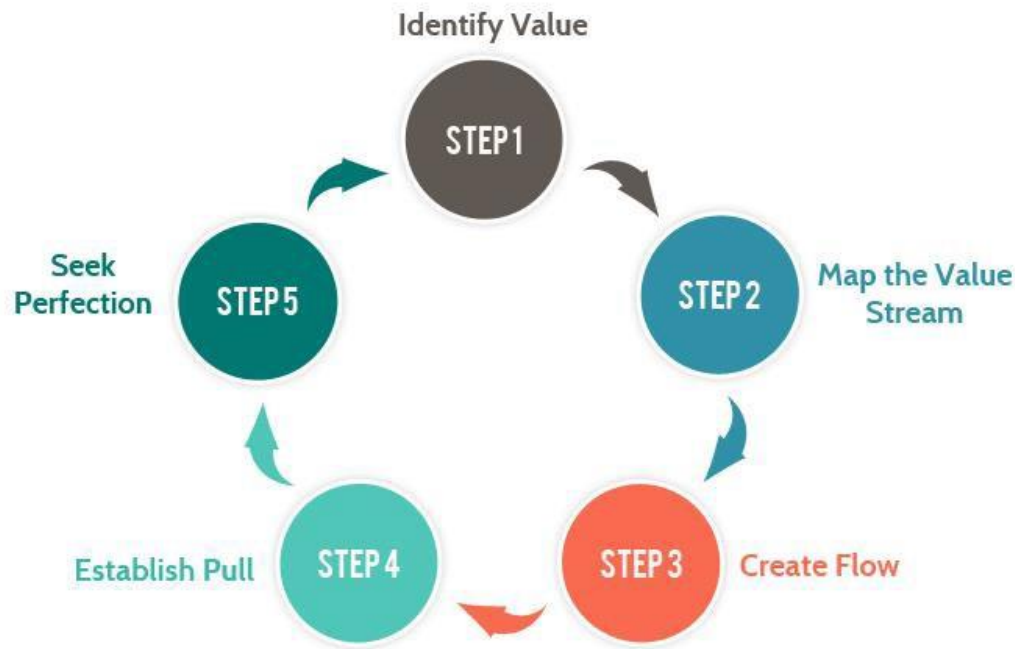
Figure 6: Lean project flow.

Figure 6 explains the lean flow, the lean flow is a latest version for legacy traditional-business process reengineering. It helps in planning, improving the work flow, reduce waste and to attain perfection.

Common principles Lean Development follows are:

1. *Eliminate Waste*: In the software development industry the most commonly identified wastages are unnecessary code or functionality, starting more than can be completed, delay in the software development process, unclear or constantly changing requirements, bureaucracy, slow or ineffective communication, partially done work defects and quality issues, task switching (Waters, 2010).

2. *Build Quality*: One of the techniques used in this is **Pair Programming** which helps to avoid issues by combining the minds of two developers to

each specified task. So collective, combined experience of two developers can be used to yield better productivity and better solutions. Second technique is **Test Driven Development** which avoids most of the quality issues by writing tests before writing code. So basically it is nothing but Test QA writing the test cases before the code is developed (Waters, 2010).

3. *Create Knowledge:* In software development one developer that works on everything and does the work productively creates a knowledge that no one can beat.

4. *Defer Commitment*: Decide as late as possible, is the key for this principle. This particularly applies for decisions that are irreversible, or at least will be impractical to reverse

5. *Deliver Fast*

6. *Respect people*

7. *Optimize the whole work flow*

Summary

This section gives the detailed knowledge about the problem background information and literature information about the software being used to develop the application and also the literature information related to the methodology of the project.

Chapter 3: Methodology

Introduction

A web application was developed with the capability to help the client in supply chain management. The development of the project involved a lot of phases, in which the project is developed step by step. The steps involved in the project development are:

Design of Study and Procedure

The main aim of this project was to design an application that will be capable of controlling and monitoring the supply chain management of the client. So this project dealt with new programming interfaces, backend data collection and also storage of the data. The data had to be collected about the manufacturing processes available in the market, the data about the third party logistics, their type of transportation available, the rate at which they transfer, the prices and all the other constraints that make a TPL worth considering. The selection of the latest technologies and if they are of compatible types, considering their cost of maintenance if applicable. The availability of raw materials, the place of their origin was taken in to consideration and were added into the database. So thus with a design solution the project construction initialized (Martin & Roth, 2000).
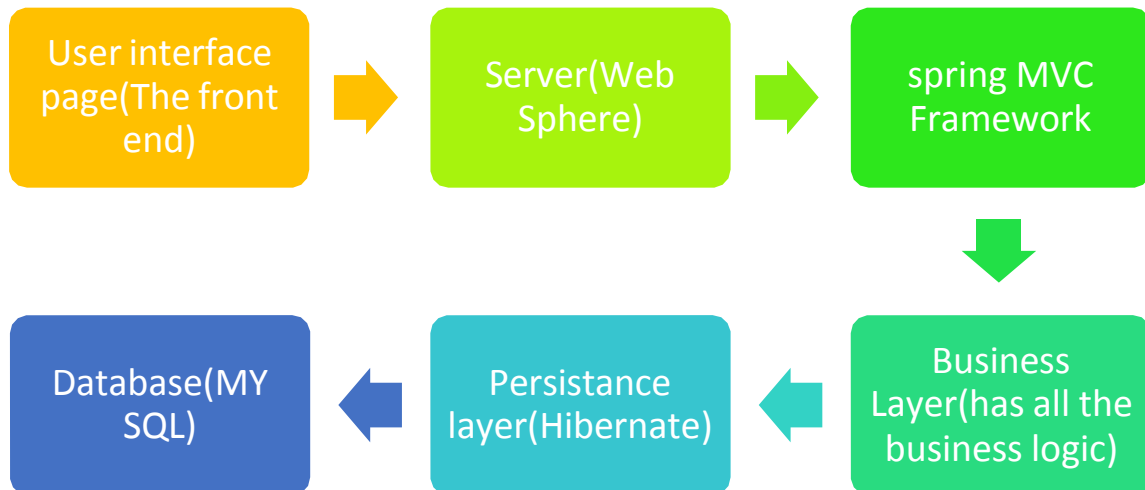
a) **Project Assignment and Roles Identification:** The project requirements were received by the high level management and were passed on to the project manager who was responsible for the project. The project management divided the whole project into tasks and assigned it to

different resources; the resources included Business Analysts, Team Lead, Developer, Testing engineer. The team included business analysts and requirements analyst, four developers which included a team lead, two testers, one iteration manager who kept track of the whole project and had the ability to escalate any issue to the higher level. Agile methodology was followed because of the project requirements were always changing which is the basic advantage of agile. The project had two sprints and a daily stand-up to report the amount of work done and to fasten any backlogs.

b) **Project planning and Sprints:** The initial project meeting had included the selection of the server, project structure, selection of the team members, databases to be used, type of exchange channel to be used for the exchange of the program files. All of these were decided by the chief architect and the tech lead. There were daily stand-up meetings that involved the discussion of the issues that an individual faced during programming and the advancement in the project till date.

c) **Code Design:** Code design was purely team lead's and the architect's decision, team lead and the architect decided which architecture to be used in building the web application, what are the techniques, frameworks, API's (Application Program Interface), Integrated Development Environment (IDE's), etc. The scripting languages were chosen here and then the design structure is developed, each team member was given a particular task, some of them worked on the front end, that is the web page

development and the rest worked on the service logic and database. The techniques used were Spring, Hibernate, Java, HTML, CSS, Java Script, angular js, etc. The basic architecture looked as below and was explained in the earlier chapters.

```
┌──────────────────┐      ┌──────────────────┐      ┌──────────────────┐
│  User interface  │ ──▶  │   Server(Web     │ ──▶  │   spring MVC     │
│  page(The front  │      │     Sphere)      │      │    Framework     │
│       end)       │      │                  │      │                  │
└──────────────────┘      └──────────────────┘      └──────────────────┘
                                                              │
                                                              ▼
┌──────────────────┐      ┌──────────────────┐      ┌──────────────────┐
│   Database(MY    │ ◀──  │   Persistance    │ ◀──  │    Business      │
│      SQL)        │      │ layer(Hibernate) │      │ Layer(has all the│
│                  │      │                  │      │  business logic) │
└──────────────────┘      └──────────────────┘      └──────────────────┘
```

Figure 7: The project architecture.

Figure 7 explains the project architecture, the user interface is what the user or the client was able to see. The server is a physical component that can process the jar files, spring is a java framework. This is a good illustration of how the actual application flow occurs.

d) **Code Development:** In this phase the code was written, there were some strategies that were followed in code development. The strategies followed were TDD (Test Driven Development), Pair Programming.

The Test Driven Development is a strategy in which the code developers write test code even before they write the code and that way they can make sure that the code is correct and free from errors. Whenever
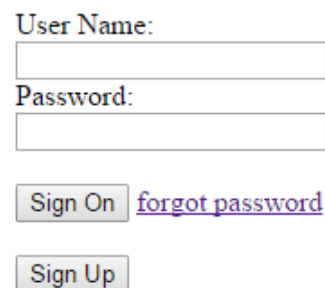
it comes to the part of testing this method makes it easy to test as the test code has the ability to test the code itself and the testers have used automated processes that have the capability to automatically test the code.

Pair programming involves a pair of programmers coding together so the code is effectively better and less prone to have bugs in the project. The productivity has been showed to improve if this technique is followed.

The front end application was developed using the angular js, HTML, CSS, Angular schema form, JSON Schema. The frond end application looks like the one in the following picture.

The initial customer login page is as shown in Figure 8:

Wecome to the User login Page

User Name:

Password:

Sign On forgot password

Sign Up
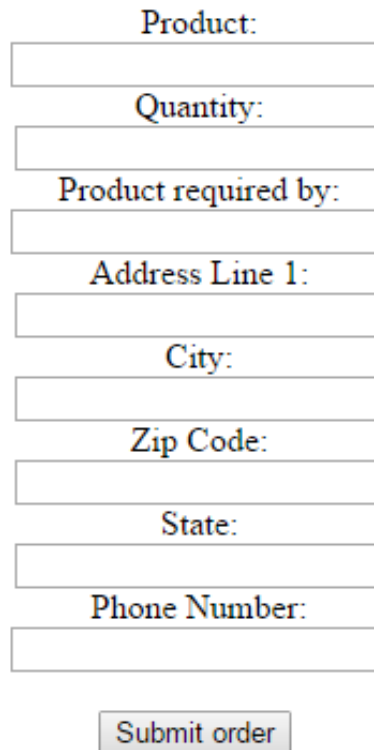
Figure 8: The initial customer login page.

Figure 8 shows how the user can login to the application. As the customer logs into the page with the valid user credentials, the customer is redirected to an order placement form, where the customer has the options to select the type of products needed the number of them needed, date of

requirement. Give the address information if the address is not on the file and lot more details.

Wecome to the Order Placement

Product:

Quantity:

Product required by:

Address Line 1:

City:

Zip Code:

State:

Phone Number:

Submit order

Figure 9: Order placement page, this is where the user places the order.

Figure 9 shows the user order placement page and this was where the client's customer was able to place the order. The client view is completely different and the products requested by the customer is shown to the manager of the corresponding department, the manager will have the access to the product request order page and then can approve the order and the application takes him to a page where he can have the access to select the raw materials based on the order and select the manufacturing

process which further provides options to the employees to manufacture products.

The client's page looks like the image in Figure 10 after the required authentications have passed.

Wecome to the Order managements

The orders received are:

1. Sample Order one

2. Sample Order two

Raw materials required:

Manufacturing process to be followed:

Then there will be brief descriptin or some notes to the employees regarding the manufacturing process
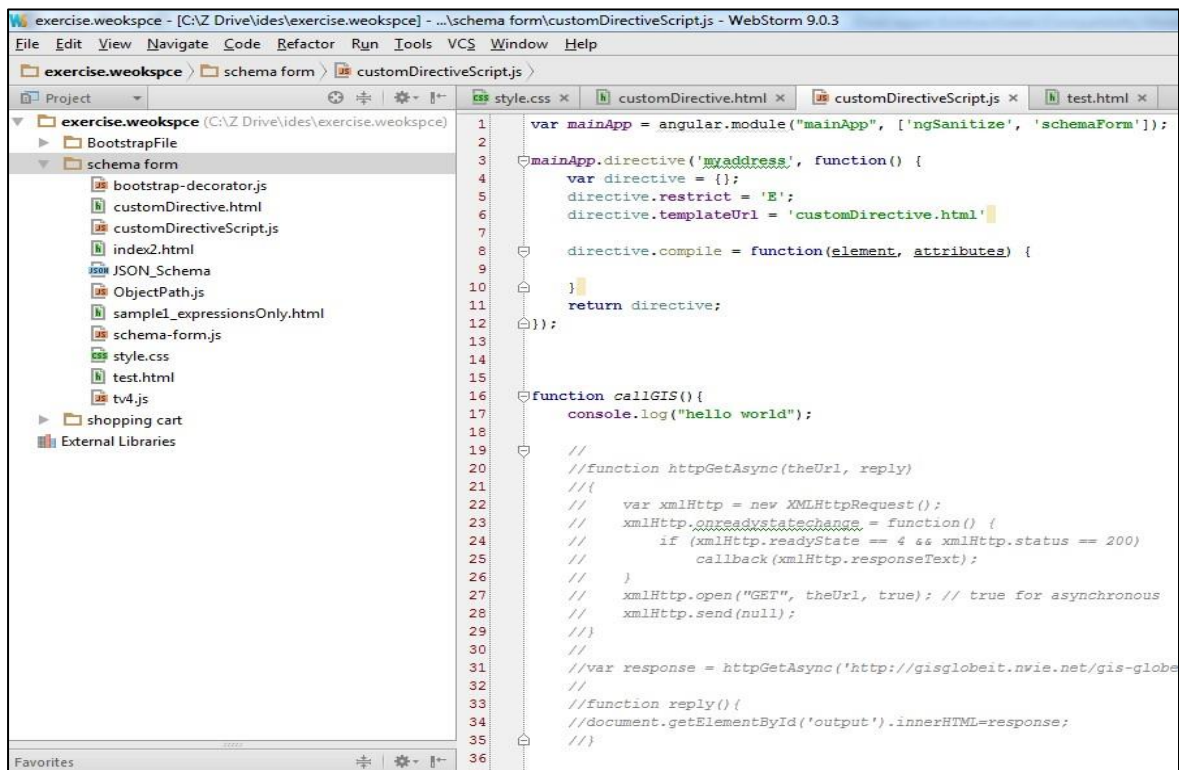
Comments:

Figure 10: Order approval, client side page.

Figure 10 shows the order confirmation and the fields for any special comments. Then a confirmation email will be sent to the customer that the manufacturing process has begun and then the customer can keep a track

of the products based on the automatic updates from the manufacturing company.

After the manufacturing is completed and the packing is all done and then the manager gets to pick a mode of transport, the options could be like their own trucks taking them, the application itself has the capability to propose about the trucks leaving in the similar direction and that can take the package. There is also an option of Third Party Logistics, the application can look for all the available third party logistics for a cheaper price and reliability.

Some of the code samples are as shown in Figure 11.

Figure 11: Code samples using Webstrom as an IDE.

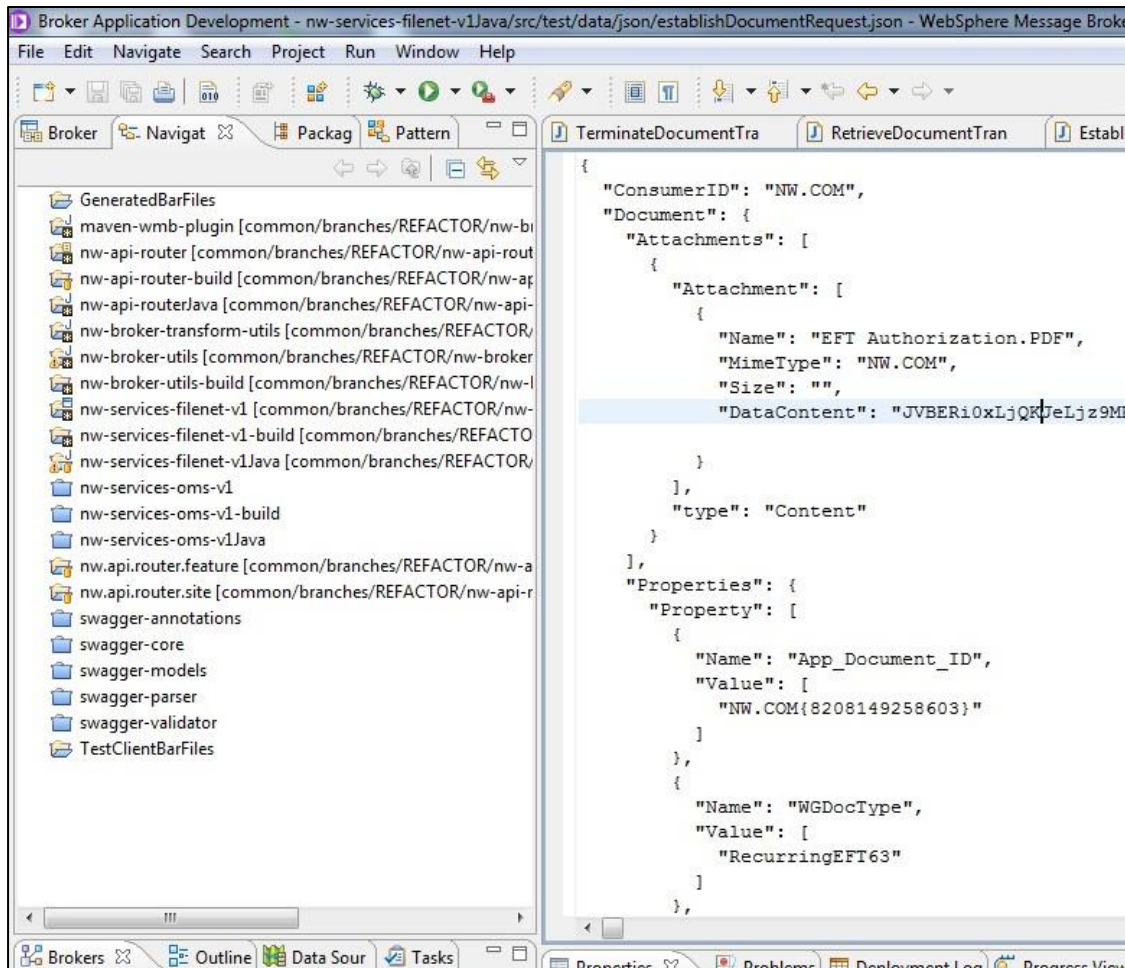The backend editor with code samples looks something like the one in Figure 12.

Figure 12: Code samples using Eclipse as the backend IDE.

e) **Code Testing.** The code written by the programmers was tested by the testing department. These engineers checked the code for every possible bug, error, functionality mismatch. They wrote some automated tests that were capable of testing the code. They have used a variety of tools that have the capability to automatically test the project and the services offered by the project. For User Interface Selenium IDE testing and for code JUnit

testing were employed.

f) **Deployment and Maintenance.** After the testing phase, once the project met all the requirements of the client then the web application was sent to the deployment phase. This is the phase where the whole project is pushed onto the production server, so from here the client can access the web application through his browser. The end client for the client can access the webpage and place orders.

Data Collection

This phase involved the collection of all available data from the client. The project required integrating the data that was required to be shown on to the web based application whenever a customer (for client) comes to the web page to place the order. The data involved the available products from the client, prices, specifications of the product, quality, what it is compatible of etc. All this data was pushed onto the database and was mapped to the corresponding servlets (a java based program). This mainly included the various types of the manufacturing process that were being followed and other processes that were available in the market that can be followed. The TPL logistics data that included the cost, transportation procedures etc. The logic required to calculate the quality of the manufacturing process and of the goods itself. The data about the raw materials is also pushed on to the database to be considered later for the improvisation ad suggestion purposes.

Data Analysis

The collected data from various vendors was stored in a MySQL database. Application which was developed analyses the data using different techniques according to the business requirements and project the data in a user readable format. Data entered into the tables represented a model object and its properties. So Hibernate was the tool used to retrieve the data in the form of an object and display it according to the requirements. To analyze the gathered data, data analysis techniques were performed.

Data collected from the both the sources as mentioned above goes into the same place before going through different validation checks. Data cached here was processed through a nightly batch jobs that run throughout the nights and puts them into the database in the required format. Both these techniques were then used to retrieve the data to transform it into a simply understandable form, habitually with visual graphs, without using any statistical model or a formulated hypothesis. This data was written as rules for the application so the application can go through these rules and then made an output.

Budget

There were a lot of costs that were incurred during the project. All these costs were covered by the client. The costs included the licensing of different products like the IDE's, databases, servers, data analysis system installations, updates and maintenance and other miscellaneous.

Timeline

This is the outline of the project time line. Total duration of this project is 6 months and went live on January 2016 with zero percent defects.

Project Idea Formulation and Research	August, September 2015
Project Proposal Write-up	September 2015
Gathering the requirements	September 2015
Designing the code	October 2015
Developing the code	October 2015
Testing the developed code	December 2016
Deploying the tested code	December 2016
Evaluating the Web Application	January 2016
Project Write-up	January 2016
Final Defense	February 2016

Summary

This chapter explained the project methodology that means the way how the project was planned, executed and implemented. This section clearly explained all the methods followed to get the project from initial beginning stages till the end, this section also included the budget, timeline of the project.

Chapter 4: Data Presentation and Analysis

Introduction

In this chapter we will deal with the data that the application would handle and process. After the data collection, data presentation was a really crucial aspect for this project. The sorting, arranging, processing the data to make it meaningful was a lot was crucial. Then the data had to be modified to be compatible for the databases.

Data Presentation

The data was collected from various vendors, the data included a lot of information which will be used by the application to produce meaningful methodologies and results. The data obtained was all raw data and was in unmodified form that humans can understand, but this cannot be understood by the application. This data had to be modified so that the application can use the data. All the raw data was analyzed, sorted out and put under different tables, which was used by the DBA team and was pushed on to the Databases. The data here was mapped on to the application using a lot of java rules and the Hibernate framework was used for this mapping. Hibernate usage reduced the time taken for the data entry and reduced the chance for the human induced error. Figure 13 shows the usage of Oracle SQL Developer for the data entry in to the data bases.
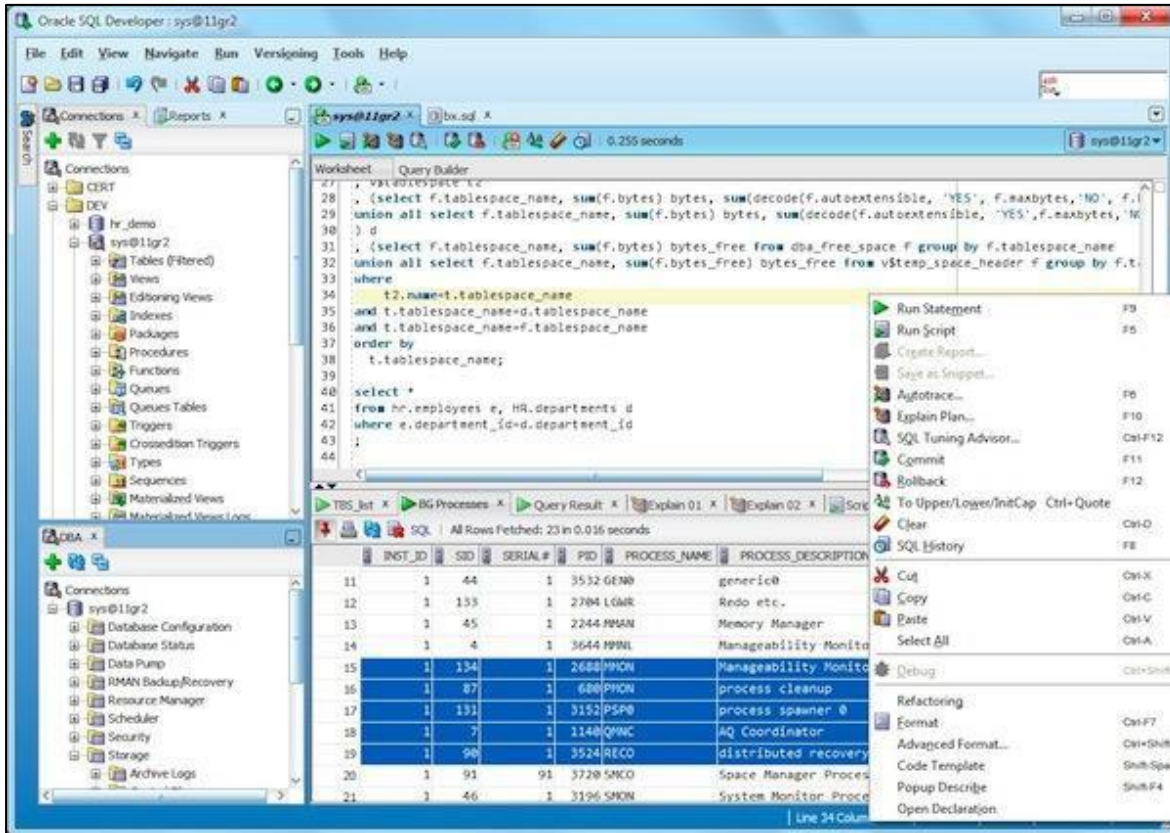
Figure 13: Data entry to the My SQL Database using the oracle sql developer IDE.

Then this data was mapped on to the java based application using the java

rules. The java rules are just mapping rules. The mapping rules help the application

to read the data from the databases. The java based mapping rules are shown in
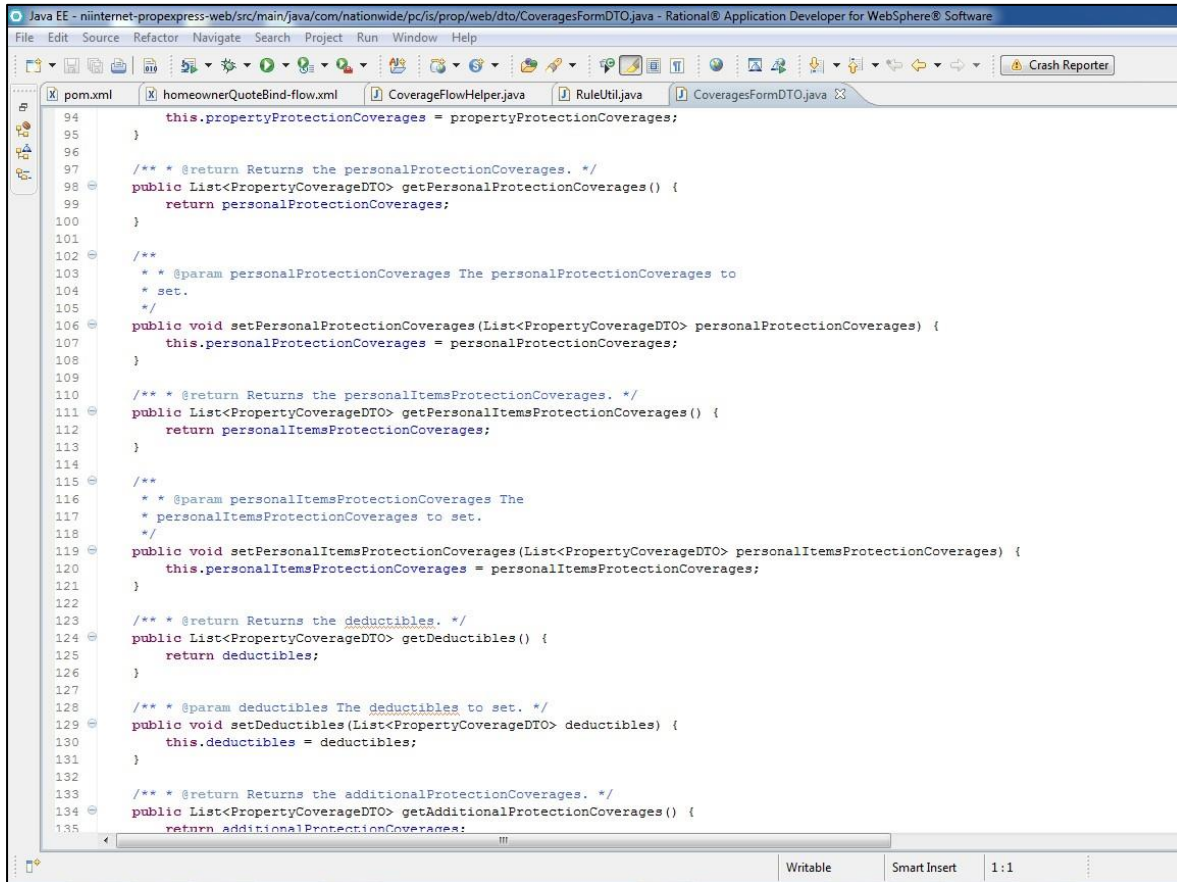
Figure 14.

Figure 14: The java based mapping rules.

Data Analysis

This phase was where the data was divided into small pieces of data and was

used by the application in determining the source of raw materials and the

manufacturing methods, this would be discussed in detail in further chapters. The

business logic was written in this phase to put the data from the database to action.

Whenever a java class was invoked then the associated data would be analyzed by

the application and then processed to make up meaningful results and would be

shown to the client. Data collected from the both the sources as mentioned above

goes into the same place before going through different validation checks. Data

cached here was processed through a nightly batch jobs that run throughout the nights and puts them into the database in the required format. Both these techniques were then used to retrieve the data to transform it into a simply understandable form, habitually with visual graphs, without using any statistical model or a formulated hypothesis. This data was written as rules for the application so the application can go through these rules and then made an output.

Summary

This chapter explains the data flow in the business and how this project can be used to analyze the company's data. This also explains how the raw data was analyzed, presented and entered into the system.

Chapter 5: Results, Conclusion, and Recommendations

Introduction

      This chapter discusses the results obtained at the client's place by implementing this project. This chapter discusses about results from the client, the effectiveness of the web application, the amount of work that could be reduced by using this application, the ease of usage. This also shows if the web application has provided a better solution and has provided an answer to the project questions.

Results

      In the wake of executing this undertaking, association has a strong application which can deal with huge volumes of information all the more rapidly and productively. This application goes about as an interface for different offices in the association by giving them the required data. This application replaces the quantity of legacy frameworks which are being utilized as a part of the association by sparing the old information to the database. Presently this application runs more cost adequately and in less time which requires less number of assets too. Consequently, the application gives numerous advantages under single rooftop as greater part of the work is being done naturally. Greater part of the reports was kept running as occupations at one point of time in every month. Every one of the occupations are kept running at the foundation at a planned time in this manner it can spare additional time. Likewise, these reports can examine the information as appeared in the above parts. Utilizing this examination reports association can keep continually enhance the administrations gave to the end clients. As per the feedback from the client, the

client's customers said this web application based ordering of the products is very easy when compared to the older manual process of placing the order, the order track functionality was one of the latest techniques to know how far the products have taken shape, the position of the products referring the transportation. From the client's point of perspective, they were really happy from the new application because the application made their work a lot easier and faster so they could start focusing on other tasks which did not have enough of their attention before, because they did not have enough time. They were able to order raw materials right from the application itself. Look for transportation, manufacturing methods, pass on comments to the employees about the manufacturing, and maintain inventory and much more.

The web based application was able to perform all the below tasks;

1. It provided a platform for the customer to place order and notify the manager or the similar decision maker in the hierarchy.

2. It was able to process and show all the raw materials needed for the order to be fulfilled and where to get the raw materials at a reasonable price.

3. Provided latest manufacturing methods to improve the quality and reduce the production costs, came up with a better solution so the client could significantly reduce the time and costs involved in manufacturing.

4. It was able to provide the best route of transportation, take feedback and suggestions from the customers.

Project Questions

The project questions were answered in the following manner**:**

1. What was the ability of the application to suggest better manufacturing methods, and are the methods capable of providing better quality and reducing lead times?

The manufacturing methods were taken as a part of data, the data that came from the client had included the advantages and the disadvantages of each and every manufacturing methods. Other than that they have provided the details of which method would be a perfect fit for a particular product. Based on these details the Business Analysts came up with an organized form of data that can be understood by the developers. This whole data was made in to table that can be easily entered into a database. Further going down the database was linked to the business layer through the persistence layer and thus was able to analyze the data whenever there comes an order for a product the web application was capable of identifying the product required and the method that can be used. This way the Java based Web application was able to suggest the manager about all the manufacturing methods available. Based on the results obtained from the client after implementation of this web application the lead times were considerably reduced because the application keeps track of the number of products made and the deadline, showing the manger the amount of work to be done and the amount of work hours needed. The manager had an option of adding more resources or removing resources if there are excess of them.
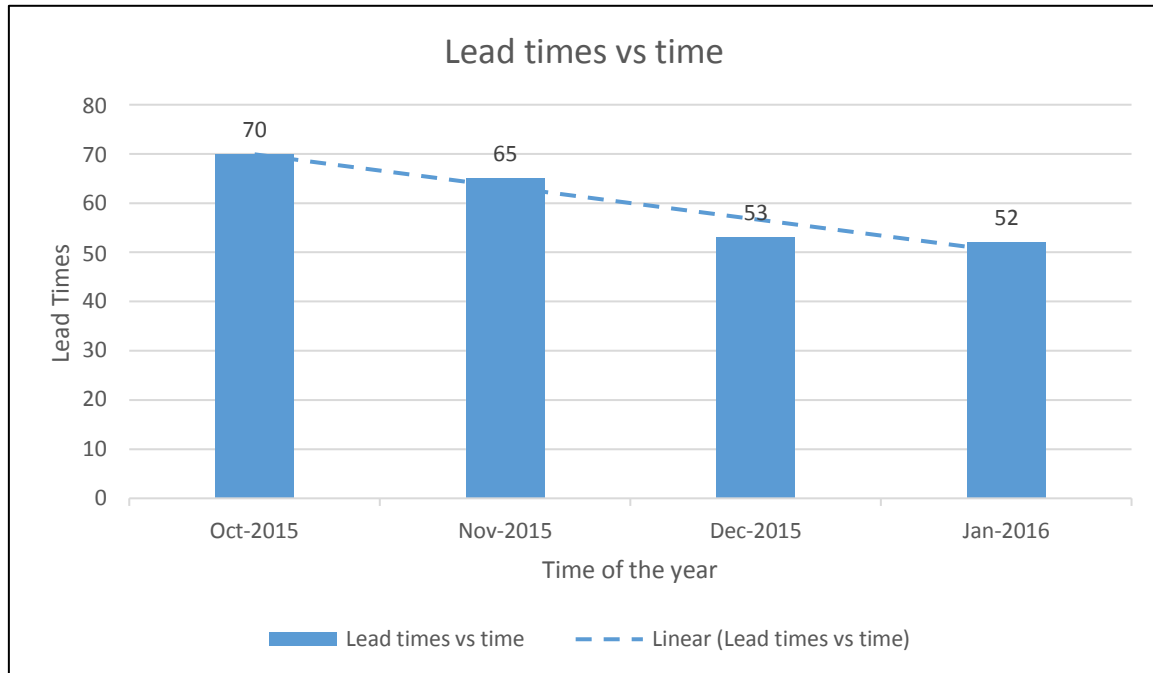
Figure 15: Lead times before and after the implementation of the application.

Figure 15 shows the considerable reduction of the lead times upon implementation of the web based application over time.

2. What was the capability application to suggest where to get the raw materials?

The application was inbuilt with all the data that was taken from the client and the places or vendors where they get the raw materials from. So whenever a customer comes onto the client's website to place an order, based on the order placed and the products requested the web application calculates an index value based on the price and the quality index and thus providing a reference for the raw materials to be ordered. The application also came with an inbuilt search engine plug in so that upon placement of the order, the application makes a quick look up to search for the raw materials. Based on the reliability-cum-quality index the manager

was able to choose from a variety of raw materials provider. The sample search

engine plugin is shown in the figure below. The application used a very similar

approach to look for available raw materials. Figure 16 explains how a simple google

search engine plugin was added to a web based application aiding the client's

customer to do a search for required products.

Figure 16: Google plugin used in the application.

3. What was the way for the engineers to enter the analysis data into the application to deliver the results?

The application had another front end web page that is accessible by the quality engineers to enter all the quality deciding factors, the dimension of the product and all the values that would be required to calculate the quality of the products. This in turn had a feedback to the quality engineers and the managers to control the quality based on the results, reducing the amount of work that will be done by the quality engineers to do all the immense work. The web page that was used to calculate the quality of a product or the production line is something similar to Figure 17.

Please enter the batch number and the employee id

Batch Number [   ]

Employee ID [   ]

Dimensions:

Dimension 1: [   ]

Diemnsion 2: [   ]

The dimensions and other quality deciding factors depends on the product and the type of the process followed

Comments:

[   ]

Figure 17: Quality factors calculation page.

4. What was the correctness of the results given by the application? How far can the results be trusted?

The results given out by the web application were most accurate as they were calculated by a computer based program and not by a manual process, where there is a scope for a lot of human errors. The application calculated the quality based on a process given by the client itself so the results that came out of the web application were absolutely correct and this was confirmed by the client's manager and the quality engineers themselves. The same results were produced by the quality engineers when they calculated the values manually themselves.
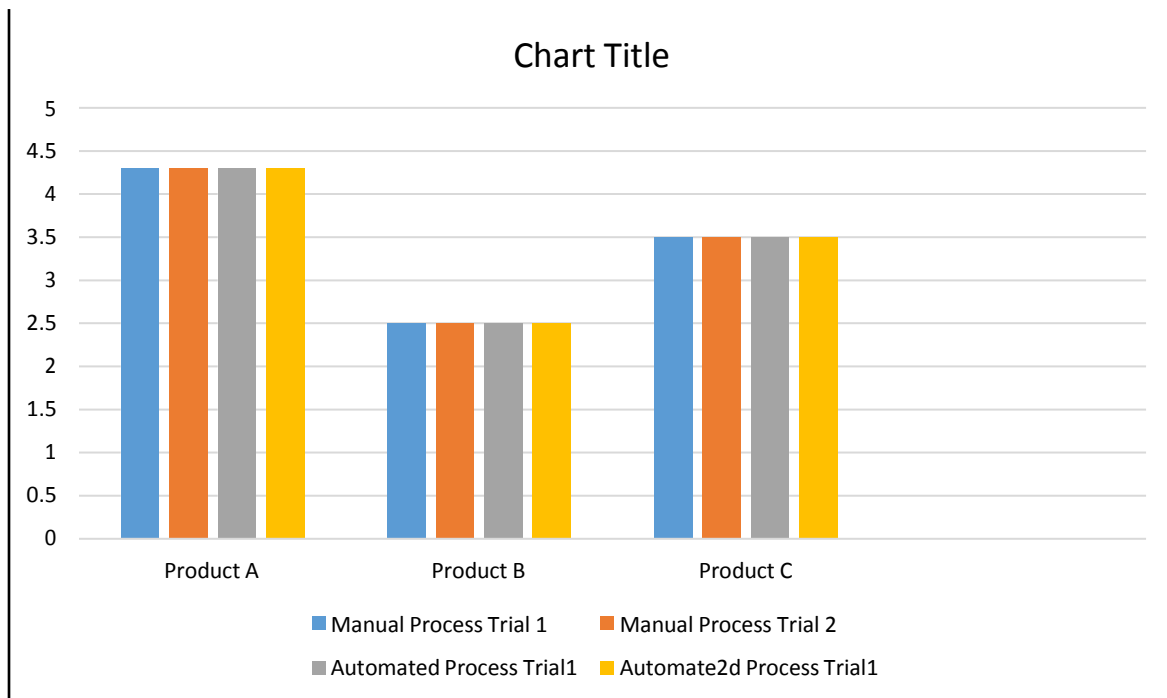

Figure 18: The quality indices without and with the web applications.

So Figure 18 shows that the results that came out shows that the quality results that have come out of the automated web application are same that of as the

manual process and only took seconds of time, this way the time could be saved and there comes a scope for developing a lot more.

5. **Was the application capable of suggesting a better transportation route and help the customer with tracking the shipping?**

The transportation route was chosen based on the cheapest and the fastest route, this was done by using the google api services where the web application will have a module that can make external calls to the google maps api services and then get a best route, there were a lot of factors to be considered for this to work out. There was a lot of logic written to select the best route out of which top three best route possible were selected. The selection of route will also consider the points like multiple stops and pickup as well. Then the manager gets to decide which route to be taken and the route shall be forwarded to the driver. If the transportation was being done by their trucks the tracking was made available based on the gps navigation systems which are inbuilt into the trucks. Each and every truck shall have a unique id based on this id the tracking is possible. If the transportation mode chosen is TPL (Third Party Logistics) the tracking depends on the individual transportation method, in this mode of transportation the tracking might or might not be available.

One sample route provided based on the maps plugin that was built into the web application. Figure 19 shows a sample route that will be taken by the client's truck.

Figure 19: The google plugin in action along with the web application*.*

Conclusion

The organization now has a fancier (or smart), more reliable and strong and healthy system which helps the organization not only the billing department, the system also helps the other departments like (amount or quantity of items stored now) management by providing the current usage details and the described/ explained analysis of the data collected from all the meters. The employee survey that was taken a week ago mentioned that the employees are much happier with this new web application and fell that the application made their work a lot easier. This data can help the organization to maintain the proper amount of (amount or quantity of items stored now) to be maintained according to the usage. This way reports helps

the (amount or quantity of items stored now) team to make key decisions. The lead times were reduced by a considerable amount, customer satisfaction has increased as they get their products on time, and can keep track of their products and plan accordingly for their demand.

Recommendations

This project was designed mostly based on Java, JavaScript and the frameworks that are built on top of them. Here are some recommendations that can be made.

- The application still uses some legacy technologies like the JSP internally, they can be replaced with the latest technologies like HTML 5, CSS 3, angular schema forms.

- No SQL databases would provide better speed and reliability.

- Any changes to one environment should be notified and changes should be done in other two.

- Most calculations done are in the java code. So they should be done at the back end to promote faster responses.

- Java code is used to write the test scripts, instead of using Java code, if Ruby scripts were used that would make it really easy to track and maintain.

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