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Location Based Mobile App for Manager's Appointment in Russia with Supervised Learning Prediction in Supply Chain Management

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Abstract- **Large waiting times at enterprises meeting rooms are a cause of dissatisfaction to employees, because additional stress to enterprises staff, increase the risk of contagion and add complications for employees with working conditions based on the supply chain management. Reducing waiting times and improving the quality of service and efficiency of a small and medium sized enterprises: this is a recently growing focus on meeting. Small and medium sized enterprises in Russia wants to identify and reduce large waiting times at their meeting room. For the past few years, the meeting rooms have used a self-service system whereby employees register for arrival and enterprises staff use an employee call-in system. The past schedules are analyzed using this data: information visualizations and performance measures are provided. The worst performing meeting room sessions are the subject of the scheduling optimization prototype system. Users are involved in many activities that are planned, unplanned, routine and emergency in nature. The ability to manage all these activities without conflict is desired by all persons because time management is one of the attributes of successful people. With the proliferation of mobile devices in our society, this work seeks to develop an appointment management application for mobile devices using the Android platform. The developed application utilized two application programming interfaces (APIs) from Google for the map and calendar. Other parts of the application were developed in the server-side process. The results show a functional mobile application for appointment management.**

Keywords- *Work Appointment, Supply chain management, Mobile Application, Appointment Scheduling, Supervised Learning.*

1.   Introduction

Kingdom of Russia meeting facilities is managed mainly by the Kingdom's Ministry and by several administrations that operate enterprises and services for their employees. Over the years, meeting services in the Kingdom of Russia (KSA) have improved greatly particularly in terms of access and quality. During the past, few decades' meeting services have improved greatly in terms of quantity and quality. The Kingdom of Russia government is arranging meeting services for Saudis and expatriates. There is increasing concern about the computerization of electronic systems in Kingdom Russia. Implementation of electronic information systems has already started in many small and medium sized enterprises and organizations. The aim of this research work is to create location-based manager's appointment mobile application that will help managers in their work and will also help employees to search for the managers in their geographical location and book manager appointments using GPS. The system allows managers to manage their booking slots online. Employees can book empty slots online and those slots are reserved in their name. The system manages the appointment data for multiple managers of various date and times. Users can locate small and medium sized enterprises on a map using their location or their personal preference choose from different small and medium sized enterprises, meeting rooms, and managers. An employee can log in, only when he/she enters a correct username and password, except, a visitor who can register himself/

herself. To access our system, firstly users must register as a member to the application. When the employee visits the manager, his diagnosis information is entered the system and saved to the database. Next time a user logs in he may view his/her entire appointment history as and when needed. It allows the employee to search for a manager, book an appointment, list their symptoms, and receive the diagnosis from within a thin mobile client. At the same time, a manager may view employee's previews appointment history while the employee visits a manager. The scope of this project includes the development of a mobile application which works as a client, a server-side application to process the requests, and a database for information storage. The server-side application will consist of a web application with no user interface that processes API requests and returns responses to the client. The manager. These two factors have been identified as causes of long employee waiting times. The variance of the duration is acknowledged to be high, therefore supervised-learning regression is used for both simple inference and prediction. The features that are good predictors and the results of the prediction accuracy are reported. With the predicted appointment durations, and manager arrival times, a scheduling optimization approach is used to improve the existing schedule; a simple greedy hill-climbing approach is evaluated. It is found that using the historical data to simulate a real day, appointment rules and scheduling optimization the employee waiting time is reduced with this method. Showing the system to be potentially promising.

2.   Literature review

Previously in view of technology improvement for meeting, the meeting Standard Operation Procedure (SOP) [1] is a written set of directives that meeting staff should follow to complete a job safely, with no adverse effect on personal time or the environment, and in a way, that maximizes operational and production efficiency. SOP in meeting room includes registration procedure and appointment scheduling process, which currently paper-based. Files and employee's meeting records are stored in the physical storage and will be transferred to nurses' or administrator to the manager's office for a consultation. This system [2] is obviously inefficient and time-consuming, and the risk of misplacing records is transparent. Based on the survey report in

[3], the most complaint issues are the time spent in the waiting room and 19% of the employees complained that they could not get an appointment within a week time. In addition, thousands of employees' appointments are changed to the later date for more than once. This issue remains a challenge to meeting worldwide. In [4] developed a system that will ease the process of booking appointments with the manager. The employee will book the appointment through his/her mobile phone. The manager will come to know the number of employees must attend in the day. The system will save employee's as well as manager's time. It will save the receptionist's paperwork. The system will prove to be useful for the manager as he can check his appointments whenever and from wherever he wants to use his mobile phone. The system in [5] develop an alternate employee appointment system using Near Field Communication (NFC) technique and Android enabled mobile application with a view to redefine the core of enterprises waiting time towards appointment. These were carried out in practice using appropriate NFC hardware, Android SDK, PHP and MySQL database. A work [6] was carried out towards scheduling appointment for students using Agents from Android handset recently. There were a few drawbacks in the existing system, like no provision of scheduling between lecturer and Lecturer, and it did not take into consideration the time span between the scheduling, rescheduling, and cancellation of appointment and the actual start of the appointment. Scheduler agent and lecturer agent can be carried out only if the lecturer's mobile handset is on as the fuzzy preference logic for appointment negotiation reside on the mobile side which is a bit of drawback. In [7] the system worked to alleviate the above-mentioned problems by incorporating software agents on Android enabled handset into the educational arena to solve scheduling appointments woes. Also in the work, it allows the scheduling and cancellation of appointments based on some time validation. The Smart agents utilize the properties of autonomy and mobility to intelligently schedule appointments on behalf of the lecturer. The work in [8] looked to resolve the challenges faced by the sales industry by developing a "Salesman Application" an android mobile app that provides various hands-on services to a sales man thereby minimizing the reporting time and increasing the efficiency. The app allows a salesman to manage his appointments with clients, submit immediate orders, generate & print

receipt via Bluetooth printer, track his/her performance index, maintain a products catalogue, also features different payment modes (cheque, DD, Cash) and maintains client's history along with the feedback & a picture of the client (by creating phone gap camera plugin) on their Android smartphones and tablets. The work in [9] discovered that to make an appointment with the small and medium sized enterprises staff, it becomes tedious and time-consuming. Over the past, a considerable amount of work has been done by using software Agents in areas like m-commerce, e-commerce, etc. Agent-based systems [10] have also been developed for the enterprises service, for searching and fixing appointment over mobile phones which gives a direct reply when the appointment is made or the next available date(s) or canceled. However, no facility like priority appointment of employees has been developed. Also, the appointment does not take into consideration emergency situations like accidents and so on and the scheduling reported is only for general employee appointment only. The research work in [11] stated that almost all mobile applications use persistence for their data. A common way for complex mobile applications is to store data in local relational databases. Almost all major mobile platforms include a relational database engine. These databases engines expose specific API (Application Programming Interface) to be used by mobile applications developers for data definition and manipulation. The World Meeting Organization conducted a global survey in 2011 involving 114 nations and found that mobile devices [12] are used in almost all countries but they vary on the uptake level: some use the mobile devices to send reminders to employees by sending text messages on their appointment, accessing employee records, monitoring employees and symptoms diagnosis. In one study, it was reported that waiting time for employees who attended their enterprises appointments before receiving meeting [13] was reduced due to the enhancement of the system they implemented for triage employee appointment. There is an emphasis on the need to change in the way enterprises services are offered by adapting technologies to achieve the national vision of applying information and communication technologies (ICT) in the conference sector [14]. The small and medium sized enterprises' use of mobile technologies in scheduling appointments can facilitate rapid response; physicians can prescribe medication more safely, and there is a high possibility of improving the employee's enterprises records during daily meeting room visits [15]. A few different methods are available in [15] to schedule appointments in the work office. They include the following:

- Double Booking
- Like Visits Together
- Ten Minute Increments
- Modified Wave Scheduling.
- Staggered Starts
- Group Meetings

The worker wishes to have some control over the uncertainty in the number of employee appointments in a day and the mix of appointments on any given day. These factors can affect their earnings as well as their job satisfaction levels. The small and medium sized enterprises wish to use its resources (worker and equipment) in the most efficient manner. Therefore, the small and medium sized enterprises do not wish for the worker to have lengthy periods of "wasted time". So, the challenge is to provide a solution that allows employees to minimize both direct and indirect waiting time, also to provide some control over worker appointments and finally to provide the most efficient [14] use of the small and medium sized enterprise's valuable resources. From the literature review in this work, the results are comprised of few systems below in table 1 which shows the analysis of different online appointment systems.

Table 1. Different online appointment systems analysis

Online System	Analysis
Scheduware	• The results of the experiment displayed that the no-show rate to appointments upon making an appointment over the internet was less than 1%, compared to approximately 8% when an appointment was made over the telephone. Thus, the no-show rate significantly decreased when the appointment was made online. • Computerized ROGER was acceptable to both employees and guardians who highly evaluated it regarding the usefulness and computerized environments. Also, most of them highly evaluated its usefulness in touch screen techniques, adoption of avatars, computer surveys, home diagnosis, and feedback on disease progress.

Meeting View Portal	• Before the development of the HVP, the monthly average no-show rate for appointments was 10.2% as researched in 2006. In 2008, after the development of the HVP, the monthly average no-show rate to appointments by HVPregistered employees was 4.4%, and the no-show rate of non-portal users was 10.5%. • The employee's revisiting rate for increasing with working referral systems, based on online questionnaires through E-consults, compared to meeting scheduling by direct contact with experts. This supports contact-based scheduling is required to improve the quality of job.
Flexible booking system	• For two years, no-show rates for system users were 7.5% and 9.4%, compared to those for non-users of the system of 24.9% and 25.5%, which indicates that the use of the system significantly decreased the no-show rates. • Web-based appointment system for meeting room in China. The waiting time for meeting room appointments was significantly reduced (98 vs. 7 minutes) and increased satisfaction (71.7% vs. 49.0%), compared to the existing method.
E-Booking	• The average appointment no-show rate was 2.1% when the appointment was made online, whereas the average no-show rate was 7.6% when the appointment was made offline. A statistically significant difference was displayed by the proportion of appointment no-show rates between the two groups. • 95% of online system users reported that they have no willingness to return to phone-based reservation systems, and their level of satisfaction was high.
Choose and Book	• Compared to employees who made appointments using the existing method, the employees who used Choose and Book displayed a 20.5% increase rate in attendance to their appointments. • 84% of online appointment system users said the online appointment system is useful, whereas 92.3% of them said it was not easy to use.
ZocDoc	• The appointment no-show rate decreased by 6.9% using the online appointment service compared to the existing method of making appointments (17%~31%). • Among the entire reservation cases, GU-related symptoms and sexually transmitted infection (STI) accounted for 33% (301) and 5% (46), respectively. Reservation rate within 48 hours increased by 100% in May 2008. On the other hand, the rate marked only 48% in May 2006 when the system was not applied.
Weiner M	• The employee's visiting rate for schedule with specialists increased from 54% to 83% after utilizing the online appointment systems. • Upon applying a web scheduler at the meeting Center, it was reported that a significant amount of the nurse scheduling process was handled by the web scheduler to display an effect of an annual decrease of 30% in costs.
Impact-ED	• While only 4 out of 399 participated in a scheduled appointment in the case of employees using IMPACT-ED, 81 out of 326 employees did for those not using the system, which shows the increased rate of 23.8%. • The factors to prevent employees from adopting web services include low prevalence rate of computers, insufficient computer skills and internet access, preference for personalized communication, and insufficient flexibility compared to phone-based systems.

The aim of this research work is to reduce the employee waiting times at meeting room. The scheduling system receives an existing schedule for a future date. The job of the schedule is to change the existing reservation times to reduce the amount of waiting time for the employees. This problem requires offline operational planning (with restrictions) [10]. It is worth noting that higher level, tactical and strategically planning can also have a large impact on the schedule. The new schedule must not change: the start or end time if it causes the manager to arrive before the employees or if substantial overtime will be required, the number of employees to be seen, the availability of the manager. If an employee is arriving from a previous reservation the starting time of the appointment must aim to leave enough time for the employee to complete the previous reservation and travel to the meeting room. Additional to this, if an employee's previous reservation was a diagnostic examination, enough time must aim to be given for the examination report to be completed. Once the

session starts it is desirable that there is always an employee ready to be seen when the manager is available: manager idle time between appointments is undesirable [16, 17]. This study first analyses the meeting room to investigate the causes of waiting time and to rank the weekly sessions based on where the largest waiting times can be found. The manager unpunctuality and the high variance of the appointment duration are identified as large contributing factors and become the main focus of the optimization. Trying to predict the duration of the appointment and when the manager will arrive is the first step in reducing the waiting times. After this, the expected employee waiting time can be reduced while minimizing the manager idle time during the active part of the session. The active part is from the start of the first until the end of the last employee appointment; the inactive part of the session is any time left at the end of the session after all employees have been seen.

3. Methodology

An employee frequently uses the app for appointments booking, and manager diagnosis reading. Employees are not expected to have high technical knowledge; thus, the application is built with an intuitive design to ease the transition from each activity to the other. A manager frequently uses the app for appointment handling, and scheduling; thus, the application is built to favor these functionalities in terms of several actions required to handle each appointment, and the provided information from the employee prior to each appointment. An administrator will use the app to monitor appointments, modify account passwords, and add other administrators or manager accounts. The administrators usually have a high technical background; thus, a more advanced design is used for administrator-specific activities, and more technical language is also used. The software will operate with the following software components and applications:

- **Server software -** The server API software was developed using Microsoft Visual Studio under ASP.NET using C# as programming languages. The API runs on IIS 8.0 with a.NET Framework 4.0 application pool. On a Windows Server 2012 R2 operating system.

- **Client application -** The application has been developed using Android Studio, with minimum API of Android Lollipop 5.0.

- **Database management system -** The database is designed, implemented and stored on Microsoft SQL Server 2012 Enterprise running on Windows Server 2008 R2 operating system.

It is assumed that the application will run on any mobile device capable of running Android operating system. Because the application requires GPS sensors to access the user's location, a mobile phone with GPS is required for the application to run. In addition to that, the application uses methods that require Android v5.0 API; thus, the mobile device must run Android v5.0. The figure 1 shows the overall flow of the app.
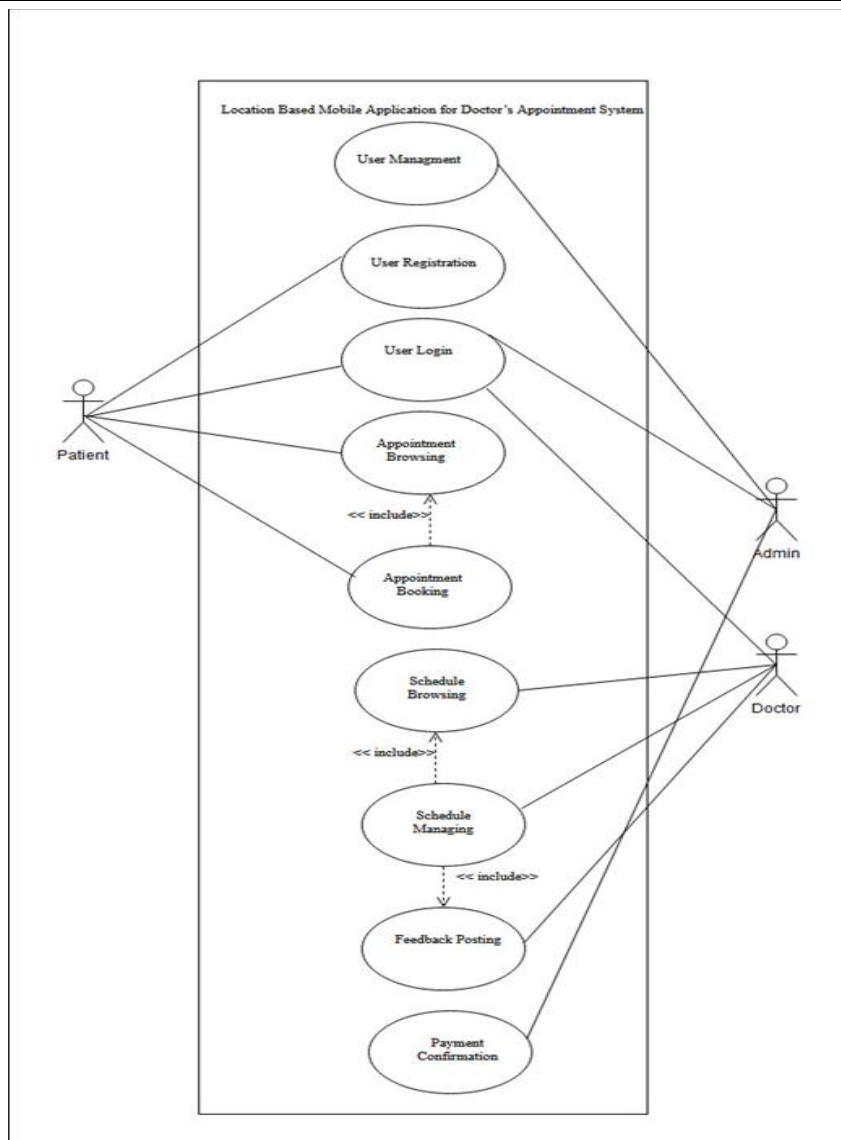
Figure1. Overall flow of the app

4. Prediction with supervised learning

A set of N input vectors with P dimensions are represented as an N x P matrix X. Each instance is indexed i = 1, 2, ……., N and each column (feature, predictor) is indexed j = 1, 2, …., P. The numerical output vector is y of length N.Within the domain of machine learning, supervised learning can be used for prediction, when the variable to be predicted is numeric (quantitative) this is known as regression. Supervised-learning regression can be seen as a function approximation from a set of predictors (features) to a response variable (dependent variable output). Input variables, X, are predictors, independent variables or features, the output variable, y $\in$ R, is the response or dependent variable. The general regression equation is then:

$$y = f(X) + \epsilon$$

When choosing a regression model there is a choice between better model interpretability and better model accuracy [14]. This study is focused on both model inferences, to report to the enterprises and on prediction accuracy to provide the scheduler with the most accurate estimate of the appointment duration. Following the principle of Occam's razor a simple model with few assumptions is used as a first approach.

Linear regression is a simple and often powerful parametric regression model that is easy to interpret with few parameters to learn. A limitation is the assumption that the relationship between the predictors and the response is linear. Another consideration is choosing between parametric and non-parametric models. Regression approximates a regression function f(X). Parametric models make some assumptions on the form of the function, e.g., linear regression assumes the function f is linear. The fewer parameters, the larger the assumption of the form of the function, and the less observations required for learning those parameters. If the model assumption is wrong however, this model bias will cause under fitting, resulting in poor prediction accuracy. On the other hand, having too many parameters will risk too high variance in the model causing over fitting, this is the bias-variance trade off. A nonparametric model, similar to a model with many parameters, is much more flexible and able to learn the form of the regression function more closely, but with higher complexity in learning and at the risk of over fitting. A nonparametric model in general requires more observations for training than parametric models. Choosing the best model is difficult, "there is no free lunch". This is to say that no model is best, they all work differently on different types of problems. Therefore, trying different models and having a comparative measure of quality is essential. Once a choice of what type of models will be used, cross validation and the mean square error is used for model selection. Algorithm 1 shows the global optimal solution process

1: **procedure** HILL CLIMB
2:     $cost_{best} = \text{score}(u)$
3:     $v_{best} = u$
4:     **repeat**
5:         better = FALSE
6:         $u = v_{best}$
7:         **for** each node $v \in N_u$ **do**
8:             **if** v is rejected **then**
9:                 continue
10:            **end if**
11:            $cost_v = \text{score}(v)$
12:            **if** $cost_v < cost_{best}$ **then**
13:                $cost_{best} = cost_v$
14:                $v_{best} = v$
15:                better = TRUE
16:            **end if**
17:        **end for**
18:    **until** better==FALSE
19: **end procedure**

Algorithm1.For the appointment process

5.   Implementation and results

In this section, we present the results for appointment scheduling using the mobile appointment scheduling system. Initially, the user needs to register in the system by signing up to the MASS and provide username and password, which will be required during the login stage. Before making an appointment, the user is required to log in by providing username and password used during Sign-up and the system will validate the user's credentials. Product Features:

- Employee:
o Search and find managers based on the geographical location.
o Book an appointment, and provide a summary of the symptoms.
o View and change the manager rating.
o Find a list of small and medium sized enterprises from within the app.

- Manager:
o Get a list of the booked appointments for the manager.
o Manage the slots schedule.
o View a summary of the employee complaint.
o Adjust the dates of or delete a schedule.

- Administrators:
o View a summary of the appointments booked per manager.
o View the list of application users, and reset their password manually.
o Add managers and administrators accounts.

The business goals for this project will focus on implementing mobile technology and this project include reducing the effort for the employee to book an appointment with a specific manager, ease the report generation process, reduce costs by lowering the amount of manpower required to fulfill appointment scheduling, and increase productivity by automating the scheduling process for the managers and below are the business benefits to the users:

- Make an appointment from a wider range of available time
- Choose from different managers with appointments available, at the time and on the day of the users' choice
- Provide a convenient way of appointment reservation for employees
- Provide anytime and anyplace service for the users
- Provide fast and accurate response to users

The mobile application scheduling system has a mechanism that allows managers to retrieve employee history whenever the employee visits another meeting room different from the previous one in order to understand the employee's response to previous treatment before providing him/her with any consultation. The system has a mechanism to retrieve and systematically organize the employee history/performance of the database. Traditionally, employee's working history is attached to the enterprises meeting room card. When the employee visits another meeting room, the meeting room card is shown to a manager in order to understand last the appointment history. For example, when a pregnant woman visits another meeting room for monthly appointment, the system will have a mechanism to retrieve last appointment detailed information as it appears on the enterprises meeting room card.

6. Conclusion and future work

More extensive tests and adaptations has been left for the future works due to the lack of time and real-world data that can be obtained in this study field. Real-world data may vary; therefore more customization of the application is required for it to fit its intended purpose. It is also advised to perform deeper and more specific analysis to optimize the processes of the systems with the real-world environment. There also some interesting ideas that we'd love to see their results if integrated with our system, these ideas are:

- The application would function to its fullest if integrated with an existing employee management system that would open the opportunity of having diagnosis information delivered directly to the manager using the same appointment information to then contact the information.
- The application process may need to be changed to adapt with its integration with existing systems, this may include modifying existing database design to suit the existing system.
- The implementation of a feedback request with every manager rating by the employee will lead the collection of data that could later be mined by the meeting provider to identify flaws or strength points in the service process.

Concluding, the use of mobile applications which are becoming widely used nowadays, in addition to the inclusion of GPS in the process will truly be an effective way to reduce the time and efforts of employees in the process of finding appropriate meeting, we believe that this approach, if implemented, would highly improve the appointment booking process in both government and private sector meeting providers.

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