Online ISSN : 0975-4172
Print ISSN : 0975-4350
DOI : 10.17406/GJCST

Global Journal

of Computer Science and Technology: C

Software & Data Engineering

Agile and Traditional Software

Machine Technique to Predict Stress

Highlights

Monitoring Social Distancing

Phone App in the Effect of COVID-19

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 2 VERSION 1.0

Global Journal of Computer Science and Technology: C
Software & Data Engineering

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Volume 20 Issue 2 (Ver. 1.0)

Open Association of Research Society

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License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

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Contents of the Issue

Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 20 Issue 2 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

A Review of Metrics for Object-Oriented Design

By Neyole Misiko
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Abstract- The ever-evolving body of empirical results do confirmation on the theoretical perspective the validity of OOD metrics whose validity is determined by them demonstrating that [1] they measure what they purport to measure. Quite often OOD metrics have been used as indicators of both the internal and external behaviors in the software development process. Software metrics especially for Object Oriented Systems literature often describe complex models with the focus to help predict various properties of software products and processes by measuring other properties. Usually designers are met with challenges to work with these measures especially when and how to use them. The very process of collecting these measurements leads to a better organization of the software process and a better understanding of what designers do as long as they confine to measurements that are meaningful. To this end therefore, the initiation of these metrics during the initial software development process is important. This paper elicits an understanding of the OOD metrics used in OOS development.

Index Terms: *MOOD, OOD, metrics, software quality.*

GJCST-C Classification: *D.2.2*

Strictly as per the compliance and regulations of:

A Review of Metrics for Object-Oriented Design

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I. Introduction

Software metrics plays a key role in good software engineering. Measurement is used to assess situations, track progress and evaluate effectives of software products. But there exists a huge challenge in the measurement process due to lack of coordinated, comprehensive framework for understanding and using measurement [2]. Object-oriented approach to software development requires some specific set of metrics [3]. Various object-oriented measurements are used to evaluate and predict the quality of software products [4], where the empirical results are used to supports the theoretical validity of the Object-Oriented Software Product metrics [5]. The validity of these metrics needs to facilitate the accuracy that the metric measure what they purport to measure.

II. Software Engineering Metrics and Quality

According to Edward V. Berard [6] Metrics are units of measurement that refer to a set of specific measurements taken on a particular item or process. For software engineering metrics are units of measurement used to characterize software engineering products, processes and the people, hence assessing quality. Ahmad S et.al [7] indicated that Software metrics are measures that facilitate software developers and software analyst to preview into the efficiency of the software process and projects that are conducted using the process as framework. These metrics measures different aspects of software complexity hence play an important role in analysing and improving software quality [8].

Mahfuzul Huda et.al [9] argued that the quality of any object-oriented design is critical as it has a great influence on the overall quality of finally delivered software product. Further he asserts that Software quality is still a vague terminology since it has different meaning to different people, the way one measure quality depends on the viewpoint he/she takes [10]. Acceptable object-oriented design properties and associated metrics are helpful when utilized in the early stage of software development process, since the metrics determination is an important phase in testability estimation process [11].

Quality in the use of Object-Oriented Software Engineering metrics are available when the final product is in use in real conditions. Here the internal quality determines the external quality, while the external quality determines quality in use [12]. According to the GE model for describing software quality, presented by McCall et al. (1977), software quality is organized around three main types of quality characteristic:- factors which describe the external view of the software, as viewed by the users, criteria which describe the internal view of the software, as seen by the developer and the metrics which control and are defined and used to provide a scale and method for measurement.

With the help of software metric software designers are able to deeper understand the software product in an effective way as they use diverse measurements of computer software in development. Thus, though software metric we are able to measure some property of software's including their components considering that software quality metrics to be subset of software metrics they are helpful [7]. To this end, with the aid of OOD metric therefore, software professionals can then use object oriented metric suite to predict and enhance the maintainability of software with least error and best precision in an object-oriented paradigm [13].

III. Issues in Software Engineering Metrics

Berard E argued that if used properly, software engineering metrics enables us among others to qualitatively and quantitatively define success and failure by establishing the degree of success or failure and identify and quantify improvement [6]. The objective of the ISO/IEC 9126 standards is to address the human

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limitations that canadversely affect the final software engineering development project. Some of the issues addressed include the change of focus after the start of a project. The standards provide clarity through agreeing on the project priorities and converting the compliance to measurable output values that can be validated against schema with total zero interventions, the standards therefore facilitate a common understanding of software engineering project's objectives and goals [14] These ISO/IEC 9126 standard further classified into four main parts: - the quality model, external metrics, internal metrics and quality in use metrics. However, the use of these design metrics is limited in practice due to the difficulty of measuring and using a large number of metrics.

Fenton and Neil [15] journal indicated that the major problem is in using such metrics in isolation. They argued that it was possible to provide a genuine improved management decision support system based on suchsimplistic metrics, but only by adopting a less isolationist approach. Much as software metrics play an important role in developing high quality software as well as to improve the developer's productivity [16] there comes the problem of identifying the right metrics to be used at a given stage of the OOD process.

Emphasis of introducing the metrics during the intimal software development is vital. OO designs are highly involved, often ill-defined, complex and iterative process. Their needs and specifications get more refined only as the design process moves toward its final stages. This therefore calls for effective metric tools that will help the designer make better-informed decisions with proven efficient knowledge representation schemes.

IV. Object-Oriented Design Metrics

Aggarwal et.al (2013) indicated that metrics for OO design entails measurements that are applied to the class and design characteristics [17], as they aim achieve quality in software process and product, This OO metrics measurement tools have yet to achieve the needed degree of maturity [18] they therefore need standardization [19]. Chidamber et.al [20] indicated that while metrics for the traditional functional decomposition and data analysis design approach measure the design structure and data structure independently, the object-oriented metrics need to focus on the combination of both the function and data as an integrated object. Despite the metric being traditional or new, it should be able effective to measure at least one or mere OOSD attributes of a software engineering product [21].

There exist various metrics for object Oriented designs otherwise called MOOD (Metrics for Object Oriented Designs). According to F.B. Abreu et al [22] metrics for Object Oriented Designs define the structural models of a software engineering design where they facilitate measurements of OO paradigms such as encapsulation, inheritance, polymorphism and message passing. These metrics are usually expressed to measure where the numerator defines the actual use of a feature for a design namely the method and attributes. The attributes represent the status of object in the system while method is used to maintain or modify the several kinds of status of the object [23].

Sahar et.al [24] stated that the most important measures that need to be considered in any software product is in the design quality. He established that design phase takes only 5–10 % of the total effort but a large part up to 80% of total effort goes into correcting bad design decisions [25]. The MOOD metrics include: - Method Hiding Factor (MHF), the Attribute Hiding Factor (AHF), the Method Inheritance Factor (MIF), the Coupling Factor (COF), the Attribute Inheritance Factor (AIF) and the Polymorphism Factor (PF) [17]. Each MOOD metric is associated with basic structural mechanisms of the object-oriented paradigm [26]. The MOOD metric set enables expression of some recommendations for designers [27].

Malhotra et.al [28] indicated that design of a system plays an essential role in ascertaining the system's reaction to incoming changes, and well-chosen OO design metrics can function as an indicator of changeability. Gupta & Saxena [29] stated thatthe prediction of software defect is possible on the basis of historical data accumulated during implementation of similar or same software projects or it can be developed using design metrics collected during design phase of software development.

Chidamber and Kemerer [30] theoretical presentation on OO design metrics for software development life cycle are based upon OOD measurement theories that are used by OO software developers. The key requirements of metric measurements by Chidamber and Kemerer [20] focused on improving the quality of software with the help of a new metrics suite that consists of six design level metrics named WMC, DIT, NOC, CBO, RFC and LCOM [29]. According to Shyam Chidamber and Chris Kemerer [31] on the role of metrics for OOD indicated that the important components of process improvement is the ability to measure the process. Their paper provided the appreciation of development and empirical validation of sets of theoretically-grounded metrics of OO designs.

V. Oodmetrics for Analysis

Object Oriented Software Engineering product code is analyzed through object-oriented metrics, two suites of metrics are used, the Chidamber-Kemerer (CK) [20] and MOOD [1] [32] suites. Many of the OOD software's usually fail due to poor quality especially when the estimation of software quality is not prioritized

during the software development. Mago et.al [33] indicated that design metrics play an important role in helping developers to appreciate design aspects of software especially to the improvement of software quality. Thus, through the analysis of the OOD metric data one can forecast the quality of the object-oriented system. Boehm et.al [34] stated that to produce high-quality Object-Oriented applications a strong emphasis on design aspects is highly necessary. To this end therefore OOD software metrics among other metrics should make it possible for software engineers to measure and predict software processes, necessary resources for a project and products relevant for a software development effort. Software quality for OOD is the degree to which OO software possesses required combinations of attributes such as reliability, maintainability, efficiency, portability, usability and reusability.

Object oriented design are intended to capture the fundamental structure of an object-oriented program. The, set of components which can evaluate, represent and implement an object-oriented design include attributes, methods, objects/ classes, relationships and class hierarchies and must be addressed during the whole process of OOSD process. Measuring software quality in the early stages of software development is the key to develop high quality software [33]. During the OOD process analysis of model captures the logical information about the system, while the design model adds details to support efficient information access. This is important; however, the optimizing process must also be considered so as to make the implementation more efficient.

Despite this, design optimization should not be extreme since the ease of implementation, maintainability, and extensibility need to be considered. Often a perfectly optimized design is usually more efficient but less readable and reusable. Designers must strike a balance between the two. Factor to be considered in the analysis include: - addition of redundant associations [35], omission of non-usable associations [36], optimization of algorithms [37] and storage of derived attributes to avoid re-computation of complex expressions.

VI. Internal Metrics

Internal events are those that pass from one object to another object within a system. Dubey et.al [38] stated that metrics provide insight necessary to create and design model through the test. It also provides a quantative way to access the quality of internal attributes of the product, thereby it enables the software engineer to access quality before the product is build [39]. OOD metrics are thus crucial source of information through which a software developer takes a decision for design good software. For instance, through the Reliability metrics, the quality of internal product can be measured by the number of bugs in the software and by the duration of software metrics crash. The Class Method Complexity (CMC) metric defined as the summation of the internal structural complexity of all local methods is a theoretical basis and viewpoints. The metrics greatly affect the effort required to design, implement, test and maintain a class [40].

VII. External Metrics

Punia et.al [40] indicated that the external metrics are used to examine and reuse of an OO system. External events are those events that pass from a user of the system to the objects within the system. For example, mouse click or key–press by the user are external events. For instance, the MPC (Message Pass Coupling) metric addresses the external methods which are the number of send statements defined in a particular OOS class. When a message invokes numerous methods as a response, the class becomes more complicated and more testing and debugging is required [41].

Bidve and Khare [42] indicated that coupling in software has been associated with the maintainability and is used as predictors of external software quality attributes such as fault-proneness, impact analysis, ripple effects of changes, changeability. Shaik et.al [43] stated that external validation involves empirically demonstrating that the product metric is associated with some important external metric. Shaik et.al further states that high cognitive complexity leads to a component exhibiting undesirable external qualities, such as increased fault proneness and reduced maintainability. Accordingly, object-oriented product metrics that affect cognitive complexity will be related with fault-proneness. From the above, the underlying assumption is that such measures can be used as objective measure to predict various external quality aspects of the code or design artifacts [44].

VIII. Conclusion

Dubey et.al [38] indicated that the popularity of object-oriented design metrics is essential in software engineering for measuring the software complexity, estimating size, quality and project efforts. Object-oriented metrics assures to provide OOD that are reliable, maintainable and reusable software products. The initiation of various OOD metrics during the software initial development process in vital as this will enable designers eliminate bugs and limitations making the software product be of good quality. Increasingly, object-oriented design measurements are being used to evaluate and predict the quality of software [4] through prediction SE are able to improve the software product performance as well as enhance more user requirements during and after the OOS design.

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Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 20 Issue 2 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

A Comparison between Agile and Traditional Software Development Methodologies

By A.K.M Zahidul Islam & Dr. Alex Ferworn
Ryerson University

Abstract- Agile and Traditional software development methodologies, both are being used in different projects of software development industry. Agile software development technology is an incremental software development process. On the other hand, Traditional software development methodologies or plan-driven software can be explained as a more formal approach to software development. These methodologies come with a fully completed set of systems requirements followed by an architectural and high leveldesign development and inspiration.

This research focuses on the software development life cycle, role and responsibilities of agile and traditional software development methodologies and their technical practices. It performs a comparison between both the software development methodologies. Here a questionnaire is used to collect data from the various experts of different IT related organizations of Bangladesh. In the questionnaire, there are three sections to bring out the individual knowledge from different organization, methodology knowledge of the respondents and software development experience of the respondents. The respondents are mainly software engineer, system analyst, software developer etc. A comparison is also performed between this survey result and a survey done by Ambler.

GJCST-C Classification: K.6.3

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A Comparison between Agile and Traditional Software Development Methodologies

A.K.M Zahidul Islam [α] & Dr. Alex Ferworn [σ]

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The analysis demonstrates the effect on software quality and cost from agile methodology and compares it with ambler (2007) survey and tries to find out correlation between the cost and quality of both the surveys. According to the respondents of the survey (Questionnaire) it is clear that what are the facilities and drawbacks of the traditional and agile software development methodologies for different size of the projects of an organization. At the end of the analysis part of this research it shows that for small scale projects more than 90% respondent response for agile methodologies and less than 10% responds for the mix software development technologies which are specific for a organization. For medium scales projects about 50% responds for agile software developments methodologies, more than 40% responds for the traditional software development methodologies and less than 10% responds for the other mix technologies for an organization. For the large scale project less than 10% responds for agile methodologies, more than 80% responds for traditional methodologies and slightly more than 10% responds for the other mix technologies for a specific organization.

The findings of this project research study also confirm the appropriateness of the use of agile methodologies for small scale projects, traditional and agile methodologies for medium scale projects and traditional methodologies for large scale projects of an organization.

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I. Introduction

The software development industry is one of the fastest growing industries in the world. By analyzing previous 20 years history of software development it is evident that a lot of brilliant ideas and methods born repeatedly. However, there was no guarantee whether those methods will last long or not though there are a good number of examples to prove this.

The concept of "Agile" is new. When it was introduced there was no agreement or explanation on what precisely it refers to. Despite this doubt agile methods became very popular among the industry within a very limited period. Agile was born after introducing extreme programming also known as XP. There are different methodologies comes under agile such as Dynamic Systems Development Method, FDD, TDD, SCRUM and etc.

"Agile" has the high reputation and interest in the industry but still there is no clear agreement on how "Agile" can be distinguish from more "Plan-driven" methods which are also known as the traditional methods. So it cannot identify any boundaries or limitations (Boehm and Turner).There is no any systematic check on agile methods. However, there are some studies to identify the suitability of agile methods for different software project natures. Due to that there are no current events or guidelines for practitioners to select the best method to bring the maximum benefits to their projects.

"Agile" is becoming more renowned in the software industry. Agile methods are overtaking tradition methods in projects where requirements are changing frequently. In agile software development there is a series of software behaviors which is conventional as well as controversial. As a result, in the near future the software development industry will find ways to carefully use either the traditional or the agile methods or a hybrid of these two methods.

To get highest result and to achieve the goals, a software development team needs to understand and select the most suitable methodologies and techniques for their project. When acquiring the understanding that they can find answers to these questions:

"What natures of project they have in hand the possibility of changes while the project in progress?"

"What is an appropriate balance of effort between documenting the work and getting the product implemented?" (Lindvall et al., 2002)

"When does it pay to spend major effort on planning in advance and avoid change, and when is it more beneficial to plan less rigorously and embrace change?" (Lindvall et al., 2002)

In order to answer properly to above questions and to make the correct decision proper knowledge should be implemented and should be disseminated within the industry. This research aims to develop a set of guidelines to help an organization in their decision making, when selecting the best software development methodology to a given nature of a project or projects, by doing a review on the different traditional and agile methods.

a) Aims of the Research

The aims of the research project are:

1. Review a number of different software development methods, both traditional and Agile.
2. "Can agile methods be used in any type of software development project?" find out the answer of this question.
3. Come up with a set of guidelines for a software organization to select the most suitable software development methodology for their software projects.

b) Objectives of the Research

The objectives are:

1. Carry out a literature survey on different software development methodologies.
2. Understand the lifecycles, roles and practices of these development methodologies.
3. A comparison for agile and traditional development methodologies to understand the similarities and differences.
4. Carry out a survey in the software industry with practitioners and professional in software engineering.
5. Analyze the gathered data from the survey and summaries them to fulfill the final aim with the help of the knowledge from the literature.

c) Research Question

What are the significant factors for a project to consider the most appropriate type of process model, after comparing agile and traditional software development methods?

d) Structure of this Research

The first chapter introduces what is the aim and objective of this research and what is the research question of this research. The second chapter introduces the literature review of this research to answer the research question. The third chapter introduces the research design and makes a questioner for the target audience of this research. After a survey from the audience the result of this research is discussed in chapter four. Basically this questioner helps to collect data for this research. Chapter five analyzes the research result and tries to bring out proper methodology for specific software. The final chapter tries to bring out limitation of this study and future aspect of this research.

II. Literature Review

a) Outline

The Manifesto for Agile Software Development (MAD) was published in 2001 by a group of seventeen methodologists. This group of experts agreed on a common set of guiding principles and practices around effective software development. The focus was for modeling and documentation of software development projects. The methodologists introduce the guidelines which are: (Fowler and Highsmith, 2001)

- Individuals and interactions over processes and tools

  The main concern in this section is the relationship and communication between the software developers and any other persons involve in the software development process. The dependency on just tools and processes will be minimal.

- Working software over comprehensive documentation

  The main purpose here is to keep the documentation as small as possible and thus concentrating more on building and delivering tested and quality products. Different teams can handle the deliveries differently. Some may deliver hourly or per week while others releases product every two weeks or once a month.

- Customer collaboration over contract negotiation

  The main concern of this section is the relationship between the development team and the client. The relationship has to be very high. However, the importance of having a contract and changing it accordingly is important as well. Agile starts to release functional program modules as soon as the development process starts and thus it effectively minimizes the risk and disappointment of not meeting the actual requirement at the far end of the project.

- Responding to change over following a plan

  The people who are involved in the software development like programmers, clients and any other should be well knowledgeable about the progress and any changes. Any party have the authority to consider possible changes to the product When it is been developed.

The founders of MAD say "while we value the items on the right, we value the items on the left more" (Fowler and Highsmith, 2001), so there are different debates on these values. There are other practitioners including Steven Rakitin (2001) who thinks that items on the left are just an excuse for hackers with no regard for engineering discipline.

Traditional software development methodologies or plan-driven software can be explained as a more formal approach to software development. These methodologies come with a fully completed set of systems requirements followed by an architectural and high level-design development and inspiration. However, during mid 1990's some practitioners found some steps such as full documentation frustrating and unnecessary time wasting (Highsmith, 2002). Due to these heavy aspects, this methodology is known as heavyweight development methods.

Traditional development methodologies all include with the following (Williams & Heckman, 2008):

- Repeatability and predictability
- A defined incremental process
- Extensive documentation
- Up-front system architecture
- Detailed plans, process monitoring
- Controlling and education
- Risk management
- Verification and validation.

The Personal Software Process (PSP), Team Software Process (TSP), and Rational Unified Process (RUP) are the three of the most popular and widely used plan-driven methodologies. Among these plan driven methodologies waterfall model and spiral model are well-known.

According to Davis and Sitaram (1994) waterfall model have the ability to capture the gross state of the project. Using this model therefore a project manager can track the progress through all major phases of development of major intermediate products. On the other hand spiral model captures the iterative nature of software versions and helps the project manager to isolate the key decision points to select a development strategy. They further argue "Neither of these two models, nor any other published model, provides a project manager with a picture of the true state of the project. Project managers who track project status in terms of the major phases have no idea of the status of their projects."

The following table which was published by Abrahamsson et al., (2002) demonstrates the differences of privileged and marginalized methodological information systems development process. These were a collection of views from different authors in the field.

Table 1: Privileged v Marginalized text (source: Abrahamsson, 2002)

Privileged methodological text	Marginalized methodological text
Information systems development is	
A managed controlled process	Random, opportunistic process driven by accident
A linier sequential process	Processes are simultaneous and overlapping and there are gaps in the between
A replicable universal process	Occurs in completely unique and idiographic forms
A rational, determined and goal driven process	Negotiated, compromised and capricious

The marginalized methods have much more things in familiar with the original agile development methods. The privileged method projects use more of a process oriented software development methods. These methods also called plan-driven methods.

McCauley (2001) argues that the underlying philosophy of Traditional methods which is referred to as process-oriented methods in the article, is that the functional requirements of a project is utterly frozen or in other words sealed before move in to the next phases such as the design and development. The article also states that this approach is not feasible for most of the software projects. So the need of a flexible and agile development methods is necessary for developers to make changes or amendments to the specifications while it is been built. Further according to McCauley (2001) there is no software model that suits any nature of software project. It is the project management who should be able to select the best suitable methodology according to the project in hand. There are different other experts in the field who support this argument.

b) Characteristics of Agile Methods

"Battlefields are messy, turbulent, uncertain, and full of change. No battlefield commander would say, 'If we just plan this battle long and hard enough, and put repeatable processes in place, we can eliminate change early in the battle and not have to deal with it later on'."(Highsmith, 2002) In this piece of writing Highsmith (2002) explains that a growing number of software projects which are work the same as a battle and they are called 'extreme projects'. This is where the concept of agility becomes important.

The origin of Agile methods go back a long way even though they were properly introduced and started to gain interest in the software industry during the last few years. As mentioned earlier, as a result of built up frustration within the software developers on structured and planed methods in the mid-1990s, development teams started to use early versions of some of the agile methodologies such as Extreme Programming (XP), SCRUM and Dynamic Systems Development Method (DSDM).

The Agile methodologies describe a number of principles which in summary put the human factor (customers and developers) first over processes and plans. The highest priority principle is to satisfy the customer through early and continuous delivery of software. According to Miller (2001) there are a number of characteristics of agile methods from a fast delivery view, which ultimately shortens the software project life-cycle:

1. Modularity – This is on the process level of development
2. Iterative – Consider short development cycles which enables to clear error faster and more accurate
3. Time bound – iterative cycles ranging from one to six weeks
4. Parsimony – remove all the unnecessary activities in the development
5. Adaptive – Take faster action against possible new emerging risks
6. Incremental – A functioning application software, build up in smaller steps
7. Convergent – Minimizes risks
8. People-oriented – Agile favour people who are involved over the process and technology
9. Collaborative – Active communication.

In Barry Boehm's IEEE computer article (2002) it is mentioned that according to Highsmith and Cockburn (2001) there are several critical people-factors which agile highlights, such as amicability, talent, skill, and communication. Highsmith and Cockburn (2001) further describes, what is new in agile is not the behaviors or practices they use but the recognition of users or any other people involved as the primary sources which drive the project to a success.

Agile does not require highly-capable people to execute its practices in a software project environment. However, it requires tacit knowledge and lot of expertise to function successfully. Due to this reason agile has a minimum use of fully completed documents. Boehm warned that there is a possible risk that this situation may lead to architectural mistakes, which are hard to find and correct by any external party.

c) Definition of Agile

Agile cannot be given with a constant definition. Different practitioners have different wordings according to their experience and understanding. But agile can be explained in few characteristics that are considered as the core characteristics.

- Iterative and incremental process
- Simple and easily adoptable
- Collaboration of all the parties such as users, customers, developers, project managers, etc.
- Produce high quality software within the requirements, budgets and the time scale.

Following are different definitions from different expert practitioners.

"Agile is an iterative and incremental (evolutionary) approach to software development which is performed in a highly collaborative manner by self-organizing teams with 'just enough' ceremony that produces high quality software in a cost effective and timely manner which meets the changing needs of its stakeholders."(Ambler, 2001)

"Agile is a conceptual framework generally centred on iterative and incremental delivery of working software, driven by the customer. The iterative part suggests that we are repeating, or iterating, a complete lifecycle of development over a short, fixed span of time. With each of these iterations, we ship some working subset, or increment, of features." (Langr, 2006)

d) SDLC for Agile

According to Ambler agile SDLC composed of four phases Iteration0, Development, Release and production.

Iteration 0:

1. Initial time of the agile project.
2. Modeling and initial architecture of the project.
3. Setting up the environment of the project.

Development Phase:

Incrementally deliver high quality software which meets the changing needs of the use.

Release Phase:

In this phase agile practitioners transition the system into production.

Production Phase:

The fundamental goal of this phase is to keep the system running and help users to use the software.

e) Agile Methodologies

Agile manifesto provides an ideological environment to modern so called "agile" software development with its defined values and principles. A survey conducted by Cutter Consortium with regard to the methods been used in the software development field revealed that 54% of the users use their own in-house development methods, which can be explained within the agile boundaries. Among the defined methodologies in agile the most popular methods were Extreme programming, Feature Driven Development and Adaptive Software Development. The purpose of this section is to introduce few of the widely used agile methodologies identifying the roles, process, responsibilities and practices. The following methods will be included for discussion: Extreme Programming (XP), Dynamic Systems Development Method (DSDM) and SCRUM.

i. *Extreme Programming*

a. *Outline*

Extreme programming (XP) evolved from the frustrations and the problems caused from traditional plan-driven methods, which were the only development solutions in the software industry for a long time (Beck, 1999). XP was developed and brought in to practice in the mid 1990's by Kent Beck, Ward Cunningham and Ron Jeffries (Paulk, 2001) as a result of a project they been working. The main features which XP emphasizes are those that they identify as the prerequisite for effective software development which are improving communication, getting feedback, simplicity and proceeding with courage (Cockburn, 2001). Even though these practices started as just a better ways of development rather than traditional methods with time they showed success. This was the root for XP. XP has widely influence on the principles in the agile manifesto (Kalermo & Rissanen, 2002).

There are different theories and arguments about XP whether it is actually a method and how extreme this methods is. Paulk (2001) argues that these practices are actually just commonsense practices that any discipline method would have and not something extreme. Beck (1999) who is one of the founders of XP states that XP is a fresh and new methodology and the term "Extreme" comes from taking these commonsense practices to extreme levels.

XP is based on the following five important values.

- Communication - "Problems with projects can invariably be traced back to somebody not talking to somebody else about something important." (Beck, 2000).
  XP focuses lot on face to face or oral communication and its techniques encourages in maximizing interaction. This is valued on the observation that most project difficulties occur because individuals or teams have not spoken with other parties to clarify questions, to collaborate, or to obtain help.
- Simplicity – Rather than try to capture all features and complicate, Design the project in the simplest way to meets the customer's needs. The value highly stresses on the point, only design and code the current requirements obtained rather than to anticipate and plan for unstated requirements.
- Feedback – The development team(s) obtain feedback from the customers at the end of each iteration and release. The next iteration drives with the consideration of this feedback. There are very short design and implementation feedback loops built into the methodology via pair programming and test-driven development (Williams, 2003).
- Courage - The best thing about XP is that the other three values give the team to have courage in their actions and decision making. The team decides which parts will be done at which stages. Further, this encourages the team to avoid any pressure for unrealistic deadlines or requirements.
- Respect - Team members always have to care about each other and about the project.

b. *XP Lifecycle*

The life cycle of XP consists with five phases. There are Exploration, Planning, Iteration to Release, Product ionizing, Maintenance and Death. The following diagram illustrates how these phases work together in the life cycle.

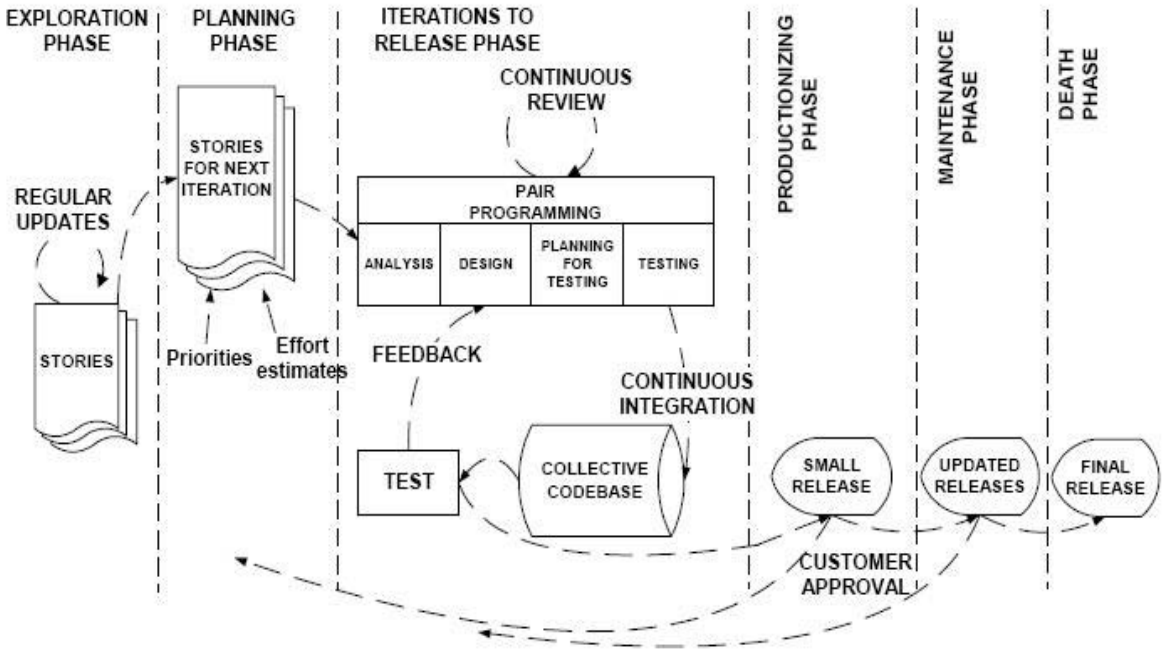

Figure 1: XP Life cycle process (Source: Abrahamsson et al. (2002))

- Exploration phase – Story cards are used by customers to express the features they want in the system. In each story card they have to write a feature they wish to have in the system. Mean while the technical teams focus on the tools and technologies they are going to use in the project. They get familiar with those tools as well. They test the technologies and the proposed architecture possibilities by building a prototype of the system. Depending on the project scope and the teams' familiarity with the technologies this phase spans from few weeks to few months.
- Planning phase – Considering all the stories, prioritize the features to be delivered in the first set of the release of the system. The development teams estimate the time required for different features and then agree upon the deliveries for the first release. The first release of the system can take up to two months and the planning phase may take few days.
- Iteration to release phase – The schedule set up for the first release is divided into small iterations before the actual first release. The first iteration builds system architecture for the whole system by selecting and analyzing the stories which includes the features. The customers decide which story to include in each of the iterations. Further the customers can create functional test for the system. These will be used to check the accuracy of the system and may use in the future. Iteration is around one to four weeks each for implement. Once the iterations are done the system is ready for production.
- Product ionized phase – This phase runs faster than the others, which means that the iterations can be reduced to one week instead of three weeks. The system has to be extra tested for performance before release to the customers. New changes found here has to be decided before start working on them. Postponed ideas will be documented to build later.
- Maintenance phase – After the product is product ionized and released for customer use, teams have to make sure that system in the production running and also produces new iterations. This phase need an effort for customer support tasks In order to maintain these operations. Thus, the maintenance phase may require new people into the team and also changes in the development structure.
- Death phase –The project comes to this phase when there are no more requirements from the customers. But there are other concerns such as reliability and performance before reaching this point. Since there are no more requirements to be added to the system all the documents been written at this stage. On the other hand when the project does meet the requirements and it is expensive for further development, it can reach death phase.

c. *Responsibilities and Roles of XP*

There are specific roles in XP for different tasks. This makes work much easier to handle as they are divided with clear roles. The following describes these

roles according to Beck (2000) and Abrahamsson et al. (2002).

- Manager – Makes all the decisions and is responsible for the team and its issues. He or she has the right to form the team, obtain and allocate resources, manage people and problems. In order to do all above, he or she communicates with the team to understand the present situation. The manager interfaces with external groups as well including the customers.
- Coach – Responsible for the whole process as a whole. Teaches team members about the XP process as necessary, intervene in case of issues. Keep of track of the ongoing process. A sound knowledge of XP is very important to this role. The coach is typically a programmer and not a manager.
- Tracker – Provides feedback. He or she regularly collects user story and acceptance test case progress and other estimates from the developers and gives feedback on how accurate they are to make better future estimates. Further tracker traces the progress of iterations and evaluate if the project goals are reachable within the allocated time with the current resources. The tracker is a programmer, not a manager or customer.
- Programmer – Writes tests, design, and code and try to keep them simple and definite as possible. They refactor code identify and estimates tasks and stories.
- Tester – Helps customers write and develop functional tests. They run functional test often to broadcast results and they maintain the test tools.
- Customer – Writes stories and acceptance tests. Selects stories for a release and for an iteration. One individual from the customer organization or a group of customers can be involved in the sections, or a customer representative can be chosen from within the development organization that is external to the development team.

d. *Technical Practices*

The initial version of XP had defined programmer- centric technical practices. This was published in 2000 by Beck.

- Planning game
- Short releases
- Metaphor
- Simple design
- Testing
- Refactoring
- Pair programming
- Collective ownership
- Continues integration
- 40 hour week
- On-site customer
- Coding standards
- Open workspace
- Just rules

XP practices were changed to include 13 primary practices and 11 corollary practices in 2005 (Beck, 2005). The primary practices are intended to be useful independent of each other and the other practices used, though the interactions between the practices may amplify their effect (Williams, 2007).

ii. *SCRUM*

a. *Outline*

"The relay race approach to product development may conflict with the goals of maximum speed and flexibility. Instead, a holistic or 'rugby' approach – where a team tries to go the distance as a unit, passing the ball back and forth – may better serve today's competitive requirements." (Takeuchi and Nonaka, 1986)

SCRUM is also a member from the agile development processes family. Scrum is a process skeleton that includes a set of practices and predefined roles. It provides you a set of guidelines to develop software from its design stage to its completion. Scrum is best suited for the projects with rapidly changing or highly emergent requirements. It is a Simple and scalable method which means easily combined with other methods and doesn't prescribe engineering practices. According to the article on scrum by Clifton and Dunlap (2003b) there are few software development issues scrum addresses for a better software production.

- Chaos due to changing requirements - The real or perceived requirements of a project usually change drastically from the time the product is designed to when it is released. Under most product development methods, all design is done at the beginning of the project, and then no changes are allowed for or made when the requirements change.
- Unrealistic estimates of time, cost, and quality of the product - The project management and the developers tend to underestimate how much time and resources a project will take, and how much functionality can be produced within those constraints. In actuality, this usually cannot be accurately predicted at the beginning of the development cycle.
- Developers are forced to lie about how the project is progressing - When management underestimates the time and cost needed to reach a certain level of quality, the developers must either lie about how much progress has been made on the product, or face the indignation of the management.

b. *SCRUM Lifecycle*

Scrum has a process which has to be followed by any organization or team that adopt this methodology. As figure 2 illustrates the projects

development happens via a series of month-long iterations called Sprints. Scrum is ideally suited for projects with frequently changing or highly emergent requirements. The Product Backlog lists the work to be done on a Scrum project. It lists all desired changes to the product. A Sprint Planning Meeting is held at the start of each sprint during which the Product Owner prioritizes the Product Backlog and the Scrum Team selects the tasks they can complete during the coming Sprint. These tasks are then moved from the Product Backlog to the Sprint Backlog.

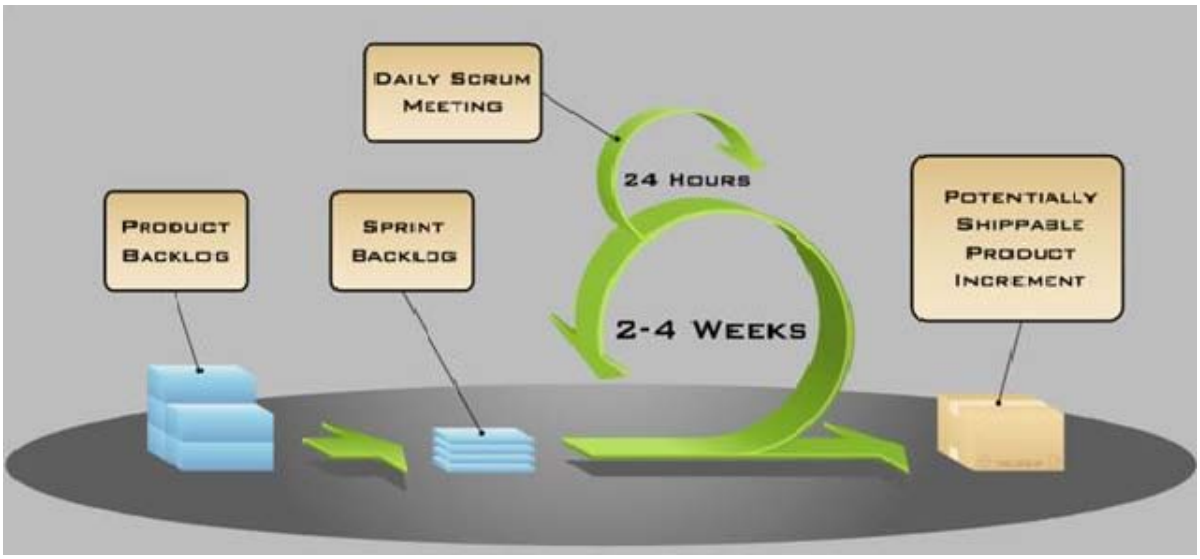

Figure 2: Scrum lifecycle (Source: www.davenicolette.net)

In order to help the team stay on track, a brief daily meeting, called the Daily Scrum, is conducted each day during the sprint. At the end of each sprint the team demonstrates the completed functionality at a Sprint Review Meeting (Mountain Goat, 2008).

c. *Responsibilities and Roles of SCRUM*

Scrum implements its iterative and incremental process through three roles. All management responsibilities are divided between these three roles (Schwaber, 2007).

- Product Owner – The product owner is responsible for the project, managing, controlling and creating and prioritizing the Product Backlog. He or she is selected from the other parties such as management, customers and the scrum master. Product owner selects what will be included in the next iteration/Sprint, and reviewing the system (with other stakeholders) at the end of the Sprint and makes the final decisions related to the product backlog (Abrahamsson et al., 2002).
- Scrum Master – Scrum master makes sure that the project runs according to the plan. He also makes sure that the team follows the practices and rules in scrum. It is his responsibility to reinforce the product iteration and goals and the Scrum values and to conducts the daily Scrum Meeting. Scrum master interacts with the management and the customers during the project and also responsible in the iteration demonstration (the Sprint Review), listens to progress, removes impediments (blocks), and provides resources. The Scrum Master is also a Developer. He takes part in product development as well (Schwaber, 2007).
- Developer – Member of the Scrum team. The Scrum Team is committed to achieving a Sprint Goal and has full authority to do whatever it takes to achieve the goal. The team may consist of developers between 5 and 10.
- Customer – Involves in the tasks of creating the product backlog. They provide ideas and other information for feature to be developed in the system.

d. *Technical Practices*

SCRUM does not mention any particular practices like other methodologies. Instead Scrum focus on some management practices and tools to avoid chaos in different stages of the process. Following are the practices used in scrum development (Schwaber and Beedle, 2002, cited by Abrahamsson et al. (2002)).

- Product backlog
- Effort estimations
- Sprint
- Sprint planning meeting
- Sprint backlog
- Daily Scrum meeting
- Sprint review meeting

Throughout the life cycle of SCRUM these practices are been carried out. Each and every role has their duties towards the success of the project during these practices.

iii. *Dynamic Systems Development Method*

a. *Outline*

The Dynamic Systems Development Method (DSDM) was first developed in the United Kingdom around the mid to late 1990s by a group of people from a business background. It was totally not related with technical perspective. This can be said as one of the heavier Agile approaches available (Coffin and Lane, 2007). It was initially developed as an addition to Rapid Application Development (RAD), incorporating best practices from the business-oriented environments.

DSDM is a well ordered, commonsensical process focused on delivering business solutions quickly and efficiently. It has similarities to SCRUM and XP in many ways, but it has its best uses where the time requirement is fixed (CliftonandDunlap, 2003a). DSDM focuses on delivery of the business solution, rather than just team activity. It ensures the feasibility and business sense of a project before it is created. The cooperation and collaboration between all interested parties is an important fact in DSDM. This method makes heavy use of prototyping to ensure all the involved parties have a clear picture of all aspects of the system.

Unlike in traditional development methodologies where functionality is fixed, and time and resources are variable, in DSDM, time is fixed, and functionality is variable (CliftonandDunlap, 2003a). The following figure best illustrates this scenario.

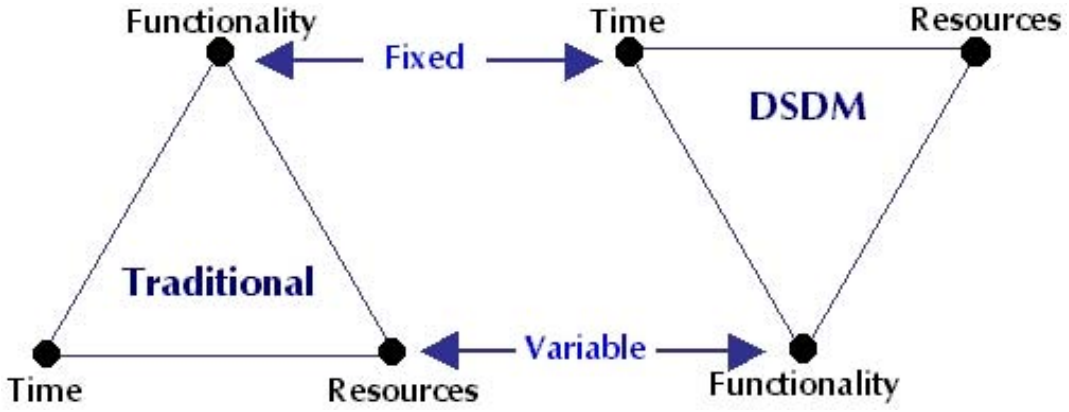

Figure 3: Traditional and DSDM (Source: http://www.codeproject.com)

DSDM respect the needs that larger organisations have to manage portfolios of projects, architectural diversity, resources and to make project decisions on the foundations of a fully considered Return on Investment. DSDM, then, had to, and still does, accommodate these corporate pressures more readily than most other agile approaches by considering a project in a wider context than software delivery alone (DSDM Consortium, 2008). It does this by having a more liberal lifecycle, by presenting and operating the agile development techniques in a way that makes as much sense to the wider organisation as it does to the project teams and by defining responsibilities within key roles to manage the corporate dependencies and preconditions (DSDM Consortium, 2008).

b. *DSDM Lifecycle*

The DSDM lifecycle consists of 4 main phases. The diagram below explains these phases. The phases are Feasibility Study, Business Study, Functional Model Iteration, Design and Build Iteration and Implementation. These phases operate in an iterative manner and have ability to jump to any other phase if required. This is the significant difference made in DSDM compared with the traditional water fall model.

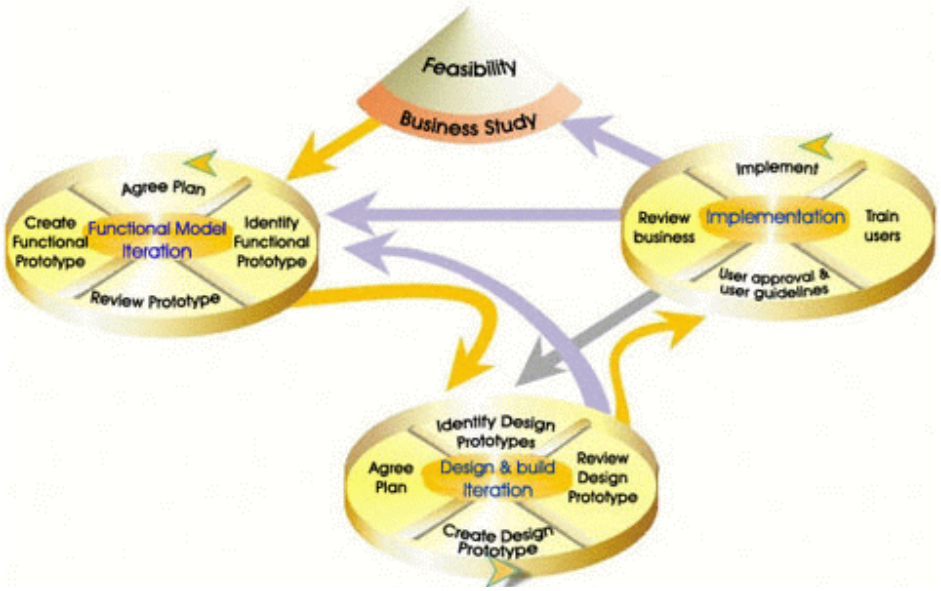

Figure 4: DSDM Lifecycle (source: www.topdownsoftware.com)

There are nine important guiding principles defined for DSDM. These principles describe what DSDM should be and how it should operation when using for a specific project. The following are from Moonzoo (2007)

- Active user involvement is imperative.
- DSDM teams must be empowered to make decisions.
- The focus is on frequent delivery of products.
- Fitness for business purpose is the essential criterion for acceptance of deliverables.
- Iterative and incremental development is necessary to converge on an accurate business solution.
- All changes during development are reversible.
- Requirements are base lined at a high level
- Testing is integrated throughout the life-cycle.
- Collaboration and cooperation between all stakeholders is essential.

c. *Responsibilities and roles of DSDM*

Following are several key roles that should be filled by members of the team as describe in an article by Clifton and Dunlap (2003a).

- Ambassador - The person who acts as intermediate between the users and the development team. He manages the development team, and usually has a good overall understanding of how the system will work.
- Visionary – This role is the driving force behind the project. This role keeps the project steered on course towards the business goals. Often is the person who started/thought of the project.
- Advisers - People who have practical knowledge in areas of the business that need to be automated, and/or in the technologies needed to automate these areas.

d. *Technical Practices*

There are nine principles at the core of the DSDM methodology. Some clearly overlap with XP and similar approaches. However, DSDM's principles are sufficiently robust to minimize damage to schedules and resources when a business process radically changes or a major component's design is faulty—problems that could cripple an XP project (Robinson, 2002).

- Active user involvement is a must.
- Design groups are empowered to make system development decisions.
- Frequent and regular delivery of components is a priority.
- The primary acceptance criterion for a system or component is its fitness for business purposes—the design driver is business benefit.
- The business solution is the goal, and iterative and incremental development is necessary to converge on that solution.
- All changes made during development are reversible.
- Initial requirements are defined very generally.
- Testing is not a specific project phase; it occurs constantly.
- It's essential to have collaboration and cooperation between all project participants.

f) Traditional Software Development

i. *Outline*

"By applying a methodology to the development of software insights are gained into the problems under consideration and thus, they can be addressed more systematically. Software should comply with the important quality requirements of timeliness, relevance, accuracy and cost effectiveness. Software engineering aims to bring to bear the more rigorous

methods used in the engineering world in the software development world." (Georgiadou, 2001).

Traditional software development methodologies are the first methods of software development. They are also known as heavyweight methodologies. They are considered to be the classic way of developing software. These methodologies are mostly based on a series of sequential steps, such as requirements definition, solution building, testing and deployment.

Traditional software development methodologies require defining and documenting a stable set of requirements at the beginning of a project.

ii. *Waterfall Model*

a. *Outline*

The Waterfall model is known as the classic model of software development. The Waterfall model also known as the "top down" approach, was proposed by Royce (1970). Until the mid 80's it was the only model with a level of general acceptance. It was derived from models used in traditional engineering activities with the objective of establishing an order in the development of large software products. It is more rigid and less manageable compared with other software development models.

The Waterfall Model is one of the most important models ever published. It is a reference to others, and serves as the basis for many modern projects as well. Its original version was improved over time and is still frequently used today (Peters and Pedrycz, 2000). A great part of the success of the Waterfall Model is due to the baseline management, which identifies a fixed group of documents produced as a result of each phase of the life cycle (Peters and Pedrycz, 2000). The produced documentation includes more than text files, it has graphical representations of the software and even simulations.

b. *Waterfall Model Life Cycle*

Waterfall model phases are executed systematically in a sequential order. The model usually has the following phases: Analysis, Design, Implementation, Testing, Deployment and Maintenance.

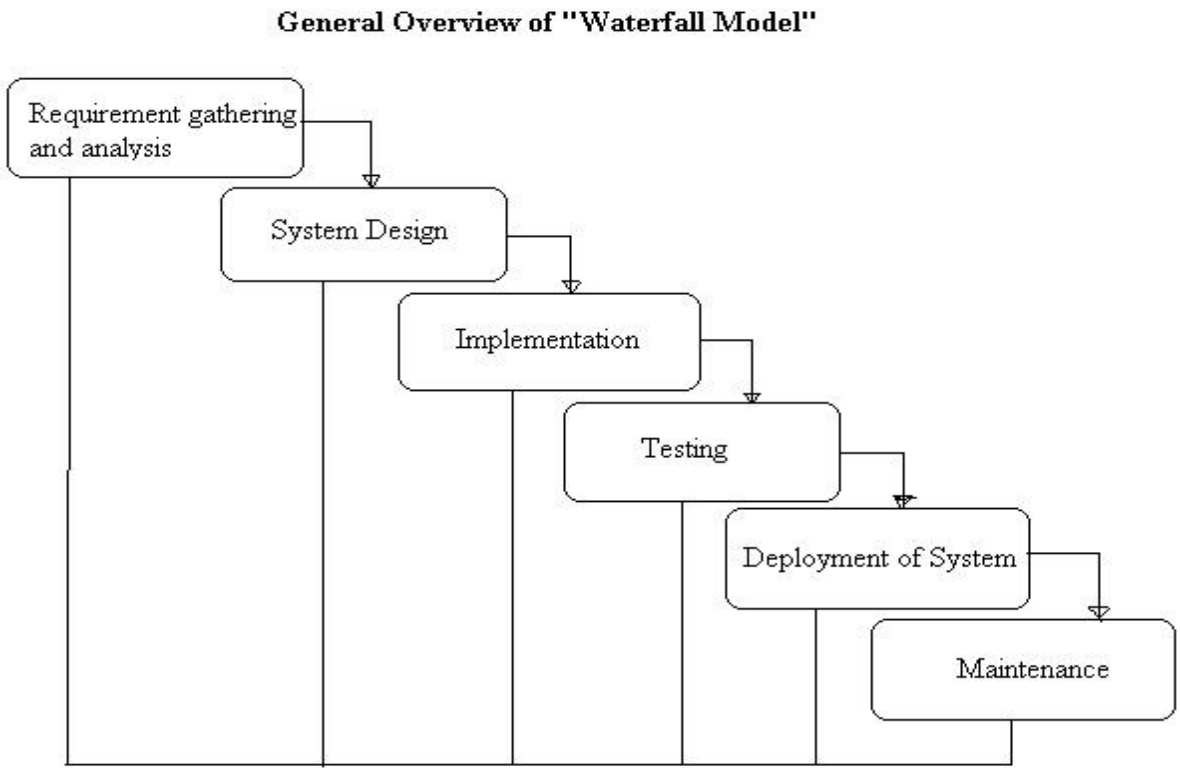

Figure 5: Waterfall model (Source: www.Buzzel.com (2000-2009))

Requirement gathering and Analysis – This is the phase where all the requirements to be developed are captured. This is done by conducting consultations, interviews, observation and so on. A document called requirement specification is created including all the gathered requirements at the end of this phase (Parekh, 2005a).

System design – Looks at the overall system in a design and architectural level before starting actual coding. This is to get an idea how the system look like at the end of the project. All hardware, software and resource requirements are considered here and finally create the system design specification to start the next phase.

Implementation and unit testing – The actual coding begins in this phase. According to the system design spec system is built in small units. Each of these units are tested to ensure that it servers the purpose that unit is built (Parekh, 2005a).

Integration and system testing - In the previous phase the system is built in units. This phase focuses on getting these units together. The system is build by putting the units together. Units are tested with each other to ensure that they work and communicate with each other and give the final outputs which are expected from the whole system (Parekh, 2005a).

Operations and maintenance – This phase is normally considered the longest of all. Issues and errors of the system which were not found during the development stages come alive once the system starts to operate in a live environment. This will normally happen time to time. So this phase is called maintenance (Parekh, 2005a).

iii. *Spiral Model*

a. *Outline*

The spiral model was introduced by Barry Boehm in 1980s, based on experience with various refinements of the waterfall model as applied to large software projects. This method combines elements of both design and prototyping-in-stages, in an effort to combine advantages of top-down and bottom-up concepts (Boehm, 1988). There are four main phases of the spiral model (Boehm, 1988):

- Objective setting – Specific objectives for the project phase are identified.
- Risk assessment and reduction – Key risks are identified, analyzed and to reduce these risks information is obtained.
- Development and Validation –For the next phase of development an appropriate model is chosen.
- Planning – For the next round of spiral the project is reviewed and plans are drawn up.

b. *Spiral Model Lifecycle*

As shown in figure 6 there are four main phases in spiral model. They are Planning, Evaluation, Risk Analysis and Engineering. These phases follow one after another in an iterative manner. The objective is to eliminate the problems occurred in the waterfall model. In an article by Parekh (2005b) mentions that even though the iterative approach became a solution to waterfall model issues, spiral model requires people with high skills in the area of planning, evaluation, risk and customer relations. The project becomes more costly than planned due to the demand for more than one iteration cycle. Following describes the main phase in spiral model.

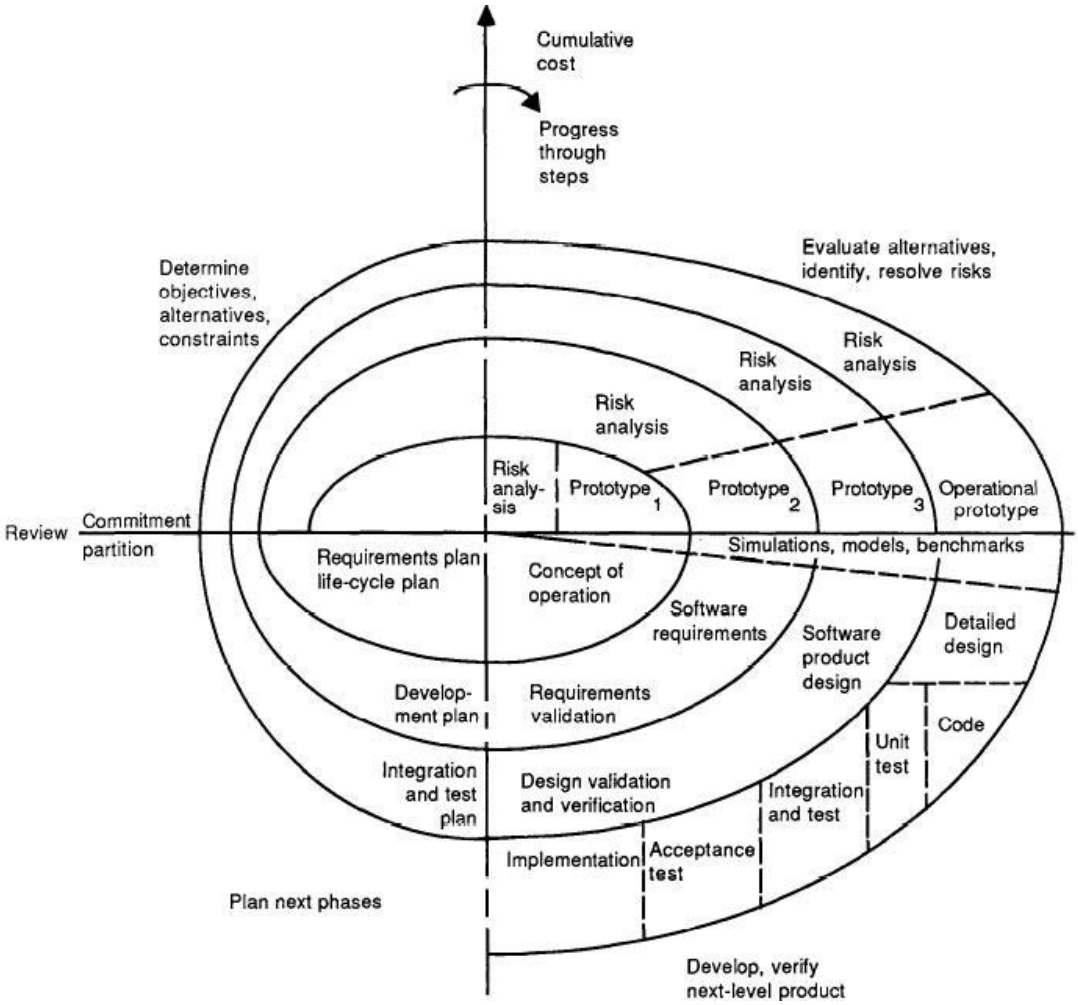

Figure 6: Spiral model (Source: Boehm (1988))

Plan phase – This phase gather and finalize the objectives and constraints of the project and documented. These are kept locked in order to decide on the approaches and strategies of the project.

Risk analysis – This is considered as the most important phase of the model. All the approaches and strategies are analyzed for risk factors. Prototyping is used to find solutions and to develop a low cost and quality system if there are any indications of risk.

Engineering – This is the development phase. Development outputs are carried through all the phases iteratively for improvements.

Customer evaluation – The built product is passed on to the customer in order to receive feedback. This phase is expected to come across possible errors and/ or changes. This is similar to system testing.

iv. *Unified Process*

a. *Outline*

Unified process is actually not a process rather it can be called as an extensible process which can be customized according to the nature of different projects or organisations. Every approach such as modeling is organized into workflows in the Unified Process (UP). UP is performed in an iterative and incremental manner and some of the key features of the UP are described below (Booch, 1994):

- UP consists with an architecture based on components which creates a system that is easily extensible, supports software reuse and intuitively understandable. The component commonly being used to coordinate object oriented programming projects.
- It uses modeling software such as UML to represent its code graphically as a diagrammatic notation to allow less technically capable individuals, but with a better understanding of the problem to come up with a greater input.
- The use of use-cases and scenarios to manage requirements seems to be very effective at both capturing functional requirements and help in keeping sight of the anticipated behaviors of the system.
- Since the design is done in an iterative and incremental manner it helps reduce project risk profile. Further it allows greater customer feedback and help developers stay focused.

- Verifying software quality is very important in a software project. UP assists in planning quality control and assessment built into the entire process involving all member of the team.

b. *UP Lifecycle*

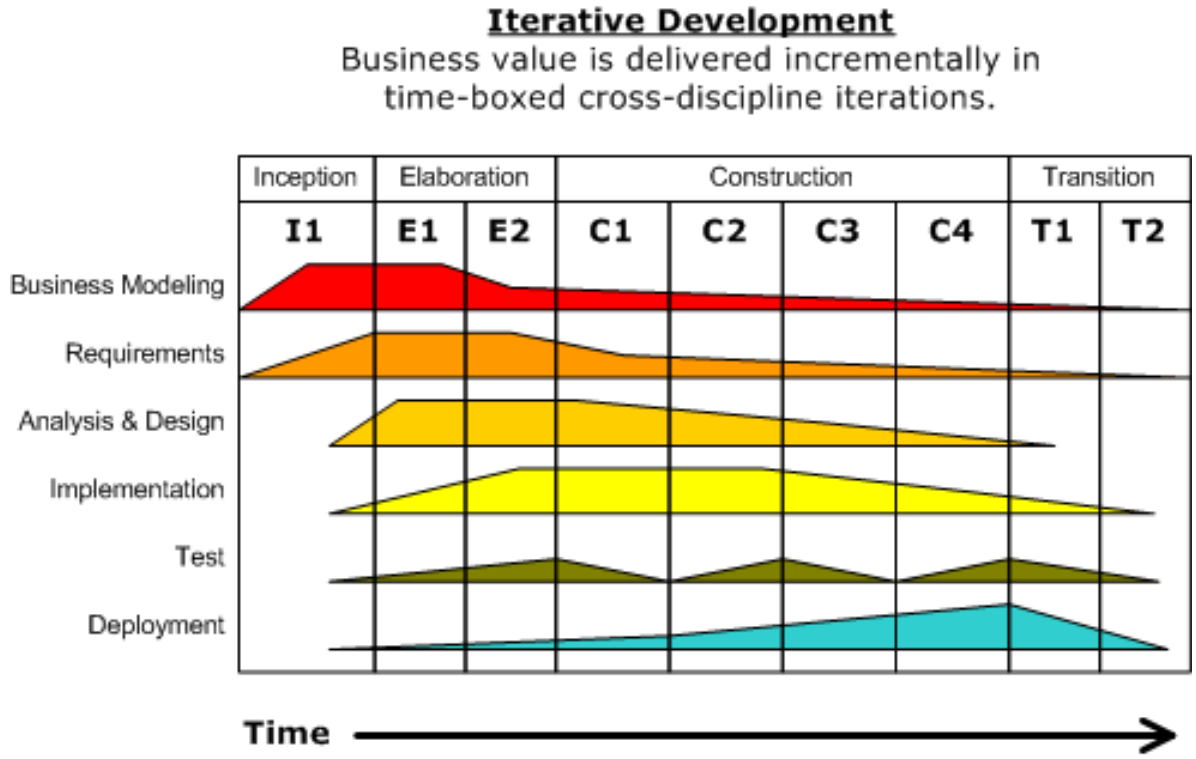

Figure 7: UP lifecycle (Source: Wikipedia at http://en.wikipedia.org/wiki/Unified_Process)

The above diagram indicates the four phases in UP lifecycle. These four phases are described below (devdaily).

- Inception – This phase creates a business case at the end of the process. The feasibility of the system is measured and the scope of the system is defined.
- Elaboration – The basic architecture of the system have been produced and a construction plan is agreed. Furthermore a risk analysis takes place and major risks are addressed.
- Construction – The system is produced and released for testing. This is not a full functioning system. A working system should be available and sufficient enough for testing under realistic conditions.
- Transition – The system is finally up to the standard to go in a live environment. So it is introduced to the stakeholders and intended users. Once the customers and the project team agreed that the intended target is met and the user is satisfied the system is completed.

There are approximately 50 work steps that has to be completed in UP during the process (Larman, 2004). All this documentation and this rigid approach add a lot of complexity to UP. UP has predefined roles to the project team making it less flexible in working.

g) Comparison of Agile and Traditional Methods.

In the previous section some discussions were there on both agile and traditional methods to identify the characteristics of these methods. It is important to do a comparison on these two methods in order to understand the differences that will affect different projects.

Table 2: Comparison of Agile and Traditional (Source: Khan and Balbo, 2004)

	Agile Methods	Heavy Methods
Approach	Adaptive	Predictive
Success Measurement	Business Value	Conformation to plan
Project Size	Small	Large
Management Style	Decentralized	Autocratic
Perspective to Change	Change Adaptability	Change Sustainability
Culture	Leadership-Collaboration	Command-Control
Documentation	Low	Heavy
Emphasis	People-Oriented	Process-Oriented
Cycles	Numerous	Limited
Domain	Unpredictable/Exploratory	Predictable
Team Size	Small/Creative	Large
Upfront Planning	Minimal	Comprehensive
Return on Investment	Early in the project	End of the project

It is mentioned in the early sections that traditional methodologies were ruling the software industry for a long time until practitioners begin to understand some of the drawbacks largely affecting the software projects. Extreme programming became popular in the industry when it was introduced in late 90's by Kent Beck. Then agile was introduced based on the concepts used in XP. Agile handle projects mostly in a volatile and uncertain environments. But with the passage of time practitioners came to realize that agile cannot handle all types of software projects as it has some limitations as well. Both of these methodologies have their strengths and weakness. Now the organizations tend to use the strengths of both together in their projects. There are three main factors which need to be considered when selecting a methodology. They are people, project size and risk.

i. *People*

This is one of the main important factors considered in software development. Especially agile methodologies strongly believe in human factor. Bohem and Turner (2003) believe that "In essence, software engineering is done 'of the people, by the people, and for the people.'" The agile manifesto stresses about the importance of the human interactions and customer collaboration in their basic values of agile methodologies (Fowler and Highsmith, 2001).

Developers and customers are the most important categories in people needed for software development. When using agile methodologies the people factors for developers were identified as skill, talent, communication and amicability (Bohem and Turner, 2003). Agile unlike traditional methodologies encourage working closely with the customers. This is important for a successful development environment.

The organization's culture has an impact on the people factor. If the developers are under the tight rules of the organization, it is hard to adopt agile since the developers will not get the maximum out of agile methodologies.

ii. *Project Size*

Project size of software is another major factor and considered as a challenging factor. In the early stages of project size estimation it was measured by predicting the number of lines of code the project may need (Dekkers, 2005). This is one of the limitations agile is facing today. For most of the large scale projects which involve more than 50 software developers agile seems to be working in a negative manner. This was shown in a study conducted by ambler (2008). Cockburn (2008) states that "A larger methodology is needed when more people are involved. Larger means containing more control elements." This statement is further supported by the following figure.

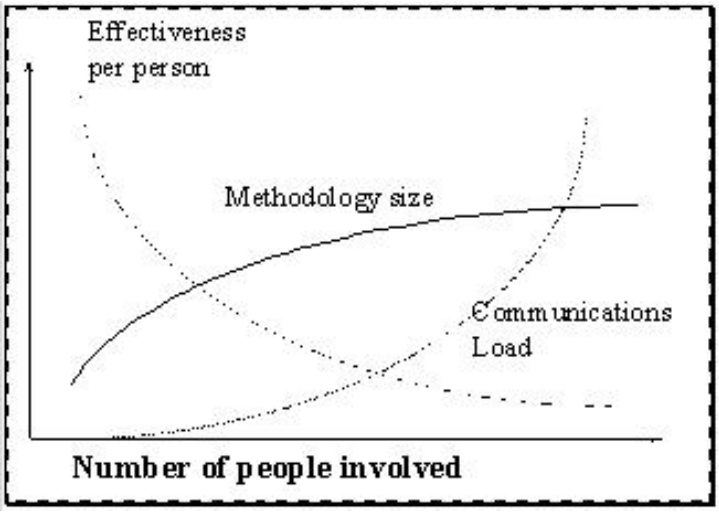

Figure 8: The effect on communication with people

The communication load rises when the number of people is increasing. Then the need of a bigger methodology occurs since that is a media of managing the people and therefore the communication. With this graph Cockburn further explains that "one should not expect a small-team methodology to work properly for a big team, and one need not use a big-team methodology for a small team." However Vaihansky et al (2006) argues that agile methods such as XP and SCRUM can be used successfully for large projects. "Best current Scrum practice is for local Scrum teams at all sites to synchronize once a day via a Scrum of Scrums meeting." The organization should decide on which type of methodologies they are going to use depending on the time and project size.

iii. *Software Risk*

Software project risk may result in lots of problems. Budget and plan overruns and unable to meet the expectations of the uses and many more (Renhui and Fengyong, 2007). There are few categories of risk according to Renhui and Fengyong (2007), and there are;

- Team risk
- Environmental risk of organization
- Demand risk
- Plan and control risk
- User risk
- Complexity risk

An organization should be careful when handling these risks. Traditional methodologies are used for large critical systems with security and reliability such as military systems. However, for the systems that can be made quickly and have lots of uncertainty, Agile is the most appropriate methodology. For example a system expected lots of change of requirement during the development phase through customer involvement agile is the best methodology as it can respond to changes faster.

III. Research Methods

a) Introduction

This chapter discuss about the methodology used by the researcher to present a research into the statement of aim. The main purpose of this section is to evidently define the specific guidelines which will make possible the researcher to substantiate the achieved hypothesis. In brief, this section discusses about the ideas, which are used in the course of primary and secondary.

b) Research Philosophy

Research philosophy depends on the way a researcher thinks about his/ her development of knowledge (Saunders et. al., 2003). The major research philosophy theories are Positive, Phenomenology and Realism (Maylor & Blackmon, 2005).

Positive or scientific method affirms that there is just one truth about the world. It is understood that such truth is objective and does not entail any value judgments. Finding this truth requires a process based on a deductive method for which data must be collected. In this sense positivist researchers stand that the data is not affected by the researcher opinion and that the more objective the data collection the better. (McNeill, 1985)

Usually the data is collected, interpreted and analyzed following the quantitative method and according to a statistical approach. Data collection might be achieved through surveys. The survey aim is to test the original hypothesis and therefore, to establish the truth of a specific phenomenon. The relevance of this kind of approach resides in its objectivity, since the results obtained are independent of the subjectivity of those involved in that process.(McNeill, 1985)

Phenomenology (ethno methodology), has as main principle that there is not a unique truth. According, the explanation of a phenomenon emerges

from different points of view people affected and involved have in relation to the phenomena analyzed. This is an action- reaction process. Every single person has his own interpretation of the world and phenomenon. In this sense, there are different truths and realities, and sharing meanings and interpretations vary depending on the context. (McNeill, 1985)

Realism shares some philosophical views with positivism, since it is based on the impression that there is an intention reality, which is self-governing of human beings' thoughts and beliefs. However, realism also recognizes that humans are not substance to be considered in the style of natural science. On the other hand it takes social influences into account. Realism recognizes the importance of the fact that those social influences, although are independent of individuals, affect the way people make sense of their world, whether they are conscious of these forces or not. (Saunders et. al., 2003)

The comparison between the characteristics of each research philosophy is summarized in the following Table 3.

Table 3: Characteristics of Positivism, Phenomenology and Realism research philosophy (Source: Adapted from Saunders et. al., 2003)

Positivism	Phenomenology	Realism
Objective truth analysis Value-free data collection Law-like generalization Quantitative approach	Subjective truth analysis People's account, motives and intentions Complex and dynamic Qualitative approach	Socially constructed environment analysis Independent reality Social influences recognized Qualitative approach

In this research, researcher uses realism philosophy because it helps to find out the research questions more efficiently.

c) Research Design

According to Kerlinger (1994) "A research design is the plan, strategy and structure of exploration conceived so as to achieve answers to research questions and to control variance."

Sekaran (1992) states, research has been defined as:

"An organized, data based critical, systematic, scientific enquiry and exploration into a particular difficulty, undertaken with the intention of finding answers or solutions to it."

According to Saunders et. al.(2003), there are three different types of research design, which are; 1) Exploratory 2) Descriptive 3) Explanatory.

The concept of each is discussed below.

i. *Exploratory*

Exploratory research is a kind of investigate conducted because a problem has not been evidently defined. Exploratory research helps decide the best research design, data collection process and variety of subjects. Investigative research relies on Secondary research. Though, research that is conducted with a desire to discover are called an exploratory research.

ii. *Descriptive*

Descriptive analysis describes data and characteristics about the society or phenomenon being studied. If the function of the study is to describe, the study is measured to be descriptive in character. It mainly gives the researcher a choice of aspects, perspective, levels, terms and concepts, as well as to observe, register, systemize, classify and interpret.

iii. *Explanatory*

Explanatory research is useful when the issue is previously known and has a explanation of it. The ambition to know "why" to provide details is the point of explanatory research. It builds on descriptive and exploratory research and goes on to identify the cause for something that occurs. Explanatory research looks for reasons and causes.

The different between exploratory, descriptive and explanatory research design

Table 4: Characteristics of exploratory, descriptive and explanatory research design (Source: Adapted from Saunders et. al., 2003)

Exploratory	Descriptive	Explanatory
A study to find new insights Useful for clarifying the understanding of the problem Qualitative approach	A study to describe an accurate profile of persons, events or situations Useful for giving details of incidence or phenomena and for predictive findings Quantitative approach	A study to find casual relationship between variables Useful for explaining the relationship of two or more incidents in terms of cause and effect Quantitative approach

In this research, the researcher has explored "Marketing strategy in fast food restaurant" in particular through his own literature view. The researcher has tried to explore the relationship between the impacts of marketing strategy in fast food restaurants and consumer intentions of coming back to the restaurant. On the beginning of this correlation the researcher has been capable to explore the various features of the marketing strategy. Consequently, the researcher has coined his research as an exploratory research.

d) Data collection Method

Data collection method is an important stage of a research and must be well planned to ensure that researchers will not face the problem of being overwhelmed by the data, which become a barrier rather than an aid to the research project. In order to be able to plan and organize data collection systematically, an understanding of the various types of data depending on different approaches to, methods of, and techniques of data collection is significantly required.

According to Saunders et. al. (2003), data comes in various shapes and forms, but can be distinguished between two main categories: 1. Secondary data, and 2. Primary data.

i. *Secondary Data*

Secondary data is data which has been composed by agencies or individuals for purposes other than those of our meticulous research study. For example, if a management has carried out a review of, say, expenditures of family food, and then a food producer might apply this information in the organization's assessments of the whole probable market for a fresh product. Similarly, statistics arranged by a ministry on agricultural production will demonstrate useful to whole lots of people and organizations, including those marketing agricultural supplies.

The most frequent exercise of secondary data in marketing research is to achieve familiarity and to create a background in which primary data are composed, reported and analyzed, the problem is defined, and the research is planned. This approach is a literature search – an assessment of exiting material, penetrating for information pertinent to the present marketing research project. Materials are typically scholarly magazines, journals, books, newspapers, and company records (accessed through computer data bases). (Patzer L. Gordon, 1995)

Secondary data can give information about performance and procedures for conducting marketing research. For example, these data can help learn language for communication with the research sample members, questions and topics to avoid, problems likely to be encountered, and statistical techniques to engage. (Patzer L. Gordon, 1995)

Secondary data are potentially misleading term for people not experienced with marketing research. For example, it is misleading to think of secondary data as being of second importance, minor importance, inferior value, or in any way not necessary. Their worth, like that of all data, depends instead on the marketing research project. However, it is reasonable to conclude that secondary data play a significant role in almost all marketing research projects. Another misconception is to think of secondary data as coming second in a sequence. The sequential order is just the opposite: secondary data typically are collected and analyzed first, before primary data. (Patzer L. Gordon, 1995)

ii. *Secondary data sources*

Book reviews: The external research will be carried out through the reading and understanding of published material. This includes books and articles written on online shopping, catalogue shopping and consumer perception and satisfaction. Book and journal reviews are a very good source of collecting data as can get a wide variety of theories and authors references.

Internet Research: Internet research is another source of secondary data. This will be used to gather historical and present information about online shopping, catalogue shopping and consumer perception and satisfaction. This will also help to get contact details about the bottom level consumer as a whole. Helps to gather and analyses articles and journals about catalogue shopping and consumer perception and satisfaction. Collecting data from internet search is widely used now a days and is very quick and also you can get a wide variety of data through internet search.

Documents: Documents can be treated as a source of data in their own rights. In effect it can be an alternative to questionnaires, interviews or observation. This includes published materials of company details, like annual and financial reports of the proposed banks as well as other banks.

iii. *Primary Data*

Primary data means the data that are to be collected by the researchers themselves through a variety of data collection methods and techniques, for example, interviews, questionnaires, experiments, observations etc. Although the process of collecting primary data may have more requirements than secondary data in terms of time , effort and resources, the result is likely more relevant for answering the research question.

Regarding collecting data primarily, we can distinguish the type of data collected into two sub-categories; 1.quantitative data and 2. Qualitative data

Quantitative Data

Quantitative data means data which is number based or can expressed numerically as well as classified by some numerical value. In contrast, qualitative data means data which is in the form of

descriptive accounts of observation or classified by type. (Ghos B.N & Chopra P.K., 2003)

Quantitative data is more objective and scientific than qualitative data. It involves the implication that what is being researched can be quantified, and, therefore, is only applicable to incidence that can be quantified and measured.

Qualitative Data

Qualitative data explained items in terms of some feature or category that possibly informal or may use comparatively imprecise characteristics such as benevolence and flavor. However, qualitative data can contain well-defined aspects such as gender, nationality or object type.

Qualitative research apply individual in detail interviews, focus groups or questionnaires to gather examine and interpret information by observing what people do and say. It reports on the concepts, meanings, definitions, characteristics, symbols metaphors, and descriptions of things. It is more individual than quantitative research and is often investigative and open-ended. A little numbers of people are interviewed in detail or a relatively small numeral of focus groups is performed. Qualitative research engages the deliberate exercise and selection of a variety of practical materials, such as personal experiences, case study, introspection, interview, life story, artifacts, observational, historical, interactional, cultural text and productions, and visual texts that describe typical and controversial moments and meanings in individuals' lives. Saunders et. Al. (2003) suggest the distinctions between quantitative and qualitative data as shown in the Table 5 below

Table 5: Distinctions between quantitative and qualitative data (Source: Saunders et.al., 2003)

Quantitative Data	Qualitative Data
Based on meaning derived from numbers	Based on meanings expressed through words
Collection results in numerical and standardized data	Collection results in non-standardized data requiring classification into categories.
Analysis carry out throughout the use of statistics and diagram	Analysis conducted through the use of conceptualization

iv. *Primary Data Sources*

Interviews: Direct Interview is one of the major sources of primary data today. This method is would be used for the internal research. The internal research will focus on a few semis structured interviews with a few senior and top managers. The intention is to ascertain a true picture of the perceptions and satisfactions that a consumer feels when they eat in a fast food restaurant. These interviews will help to find out the secrets of their success or reasons for failure.

Interviews are a good source of collecting data. Also it is relatively cheap and quick to collect data through conducting interviews. But also there are some disadvantages in conducting an interview: -

1. As the nature of topic suggests it will be highly impossible to contact top level officials of the company and to ask them to give information about their company.
2. The second disadvantage is that the nature of the topic is so complex that there is a chance of getting biased opinion and it will be highly risky to rely on these answers.

Questionnaires: Another methodology that is the questionnaires. In this research, researcher uses seventeen relevant questions to find out the findings of this research which are given in APPENDIX 1. Questionnaires are more economical, easier to arrange, the answers will be standardized. In situations of difficulty to get appointments with the top-level managers this method would be used to. Postal questionnaires will be sendingto top managers of the banks and the responses can be analyses.

Collecting data from questionnaires is often for getting information and also it is relatively cheap. But it also has got some disadvantages like: -

1. Collecting data from questionnaires is a long procedure and takes long time to collect and analyze such data.
2. The second disadvantage is that people generally don't like to spend time in giving answers in writing.

e) Data Analysis

After the data have been composed, the researcher turns to the responsibility of analyzing them. Analysis of this data needs a number of closely connected operations such as creation of category, the importance of these categories to unprocessed data through tabulation, coding and then sketch arithmetical inferences. Scrutiny work after tabulation is mainly based on the calculation of various coefficients, percentages, etc. in brief the researcher can analyse the collected data with the assist of various numerical equipment.

f) Reliability

According to Joppe (2000)

"The extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar

methodology, then the research instrument is considered to be reliable."

In this study, the researcher used the method of qualitative research in order to explore and understand the implementation of marketing strategies in the fast food restaurants, so that the researcher was then able to compare and contrast the findings with the literature, and eventually, was able to give suggestions about the issue. The case to be explored is dynamic and complex, and, therefore, it cannot be ensured that the research can be replicated and will give the consistent result when the time and circumstances have changed.

g) Validity

According to Winter (2000) "The traditional criteria for validity find their roots in a positivist tradition, and to an extent, positivism has been defined by a systematic theory of validity. Within the positivist terminology, validity resided amongst, and was the result and culmination of other empirical conceptions: universal laws, evidence, objectivity, truth, actuality, deduction, reason, fact and mathematical data to name just a few."

Researcher built the validity by establishing correct operational measures for the concepts of study. Researcher used the structured questionnaire as the mean to obtain the data.

The questions were designed and pre-tested in order to minimize as much as possible the misunderstanding and problems for the respondents; meanwhile it also increased the internal validity and reliability of the data.

h) Limitations of the research project

Researcher found some limitation at the time o research work. These are: a) Extent of research will provide a general overview of the entire outsourcing operations rather than complete audit. b) Limited amount of time available for completing the study. c) May not be possible to conduct interview with all of the firm's clients. d) Some of the data gathered may not be totally relevant to the research topic. e) Research needs to be conducted on a very low budget. f) There could also be a problem with translating the questionnaires and interviews as the company is located in a region where English not the main language in use. So there are chances that some data corruption might occur.

i) Methods for this Research

The chapter describes the methodologies used in the research. The project used both qualitative and quantitative methods. Using the following methods, a detailed study of the software development methodologies were carried out. The research is in two sections. Primary research carried out with a questionnaire. It consists of a survey. The Secondary research comprises of Literature survey from various sources.

i. *Completing the Questionnaire*

The questionnaire has been created in a way so that responders can answer quickly and easily. It is divided in to three main sections and contains all close-ended questions. The time taken to complete the questionnaire was approximately 15 minutes to 17 minutes.

Individual and organizational questions – This section contains questions on respondent's position in the industry as well as the position of the organization. It also contains question on the size of the organization including the number of employees, the projects they adopt and the likeness of adopting new technologies.

Methodology knowledge questions – This section focused on the knowledge of the respondent on the methodologies

Software development questions – This section contains questions on the different agile and traditional methodologies used on different projects. This is scaled on the project sizes measured in person months. The scales are selected as small scale, medium scale and large scale projects. There are questions to capture the opinion of the respondents on how effective the used methodologies were with regard to cost and quality of the software. Finally questions were included to capture their opinion on the preferred characteristics of both development methodologies from their point of view. The questionnaire is included in Appendix 1.

ii. *Target Audience*

The questions were distributed among software companies of various sizes and types. The respondents involved were mainly software architects, software engineers, and project managers. However, there were some other roles involved in software development as well.

j) Research Audit

Different resources were used for the research. The resources include various books on software engineering and development methodologies from different authors including Cockburn, journals related with software industry, white papers on agile and traditional methods, and websites from the internet which are related with the subject area.

IV. Research

The following are based on the data that were collected from various companies in the software industry. A questionnaire was prepared and provided in order to collect these data.

a) Data Collection

Most of the respondent was from Bangladeshi 21 different organizations. Among the organization 15 organizations were Information technology related organizations, 3 organizations were from

Telecommunication, 2 organizations were from the Engineering and 1 was other organization.

i. *Organizational Characteristics*

When analyze the results from the sample question it was discovered that about 70% of the respondents were from organizations with an Information Technology background. There were other respondents from telecommunication, engineering and medical organizations as well. There were some cases that projects were outsourced to information technology organizations. It is shown in the table below in a ratio of 100

Table 6: Survey Response from the organizations

Information technology	Telecommunication	Engineering	Others
70%	15%	10%	5%

Figure 9 represent the results

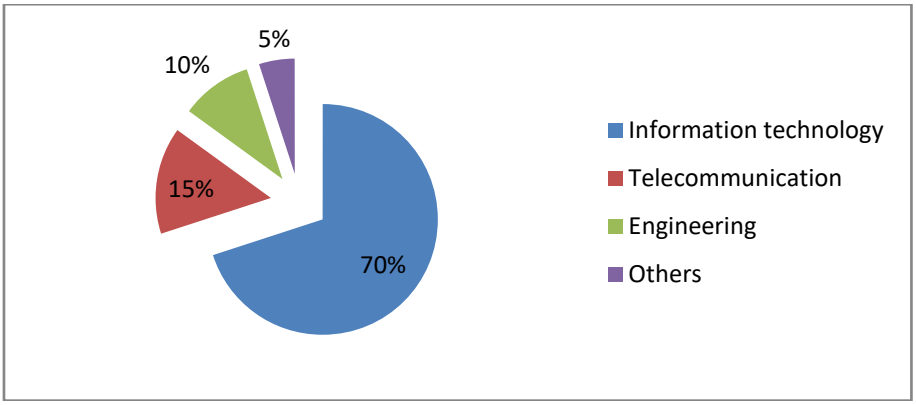

Figure 9: The type of organisations involved in the survey

ii. *Individual Knowledge Gathering from Different Organization*

Among the organization the number of the respondent was 21 and majority of the respondents to the questionnaire were software developers. The other respondent were System Analysts, software engineer and software architects. It is shown in table below in a ratio of 100.

Table 7: Survey response by job position

Developers	Analyst	Software engineer	Project manager	Executive
53%	13%	20%	7%	7%

Figure 10 represent these results.

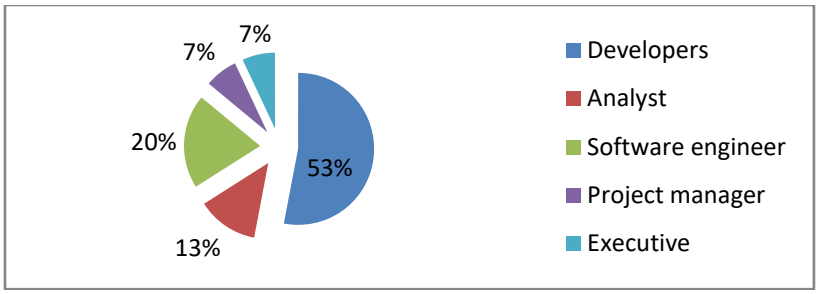

Figure 10: Respondents' job positions

iii. *Organization size based on employee*

The organizations were in different sizes of course. Around 73% of the organizations employed staff between 10 and 100.Most of them is employees who are working in Information Technology .The remaining 27% of the organizations fall under more than 200 employees or less than 10 employees working for the organization. It is shown in the table below in a ratio of 100.

Table 8: Employees' in software development in organizations

Less than 10	Between 10 and 20	Between 21 and 50	Between 51 and 100	More than 100
7%	20%	26%	27%	20%

Figure 11 represent these results

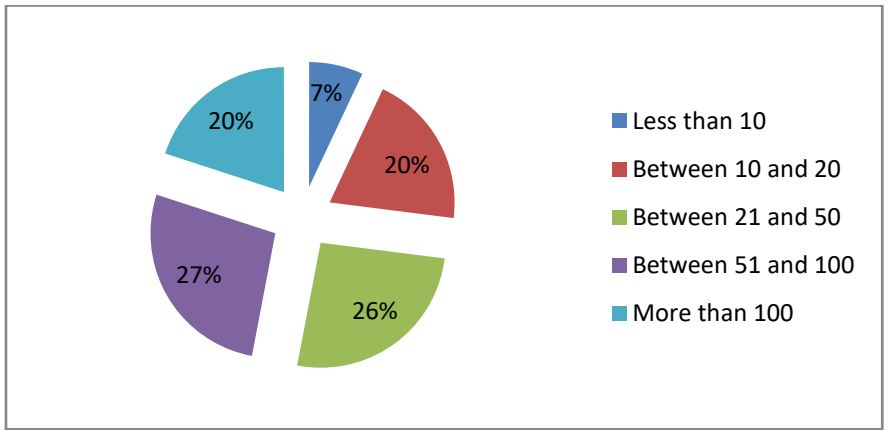

Figure 11: Employees' in software development in organizations

iv. *Agile and Traditional Software methodology Knowledge of the respondents*

When it comes to the knowledge rating for different methodologies more than 90% of the respondents have an understanding about agile and traditional methodologies in an average or higher level. 12 out of the 15 respondents have rated their knowledge of agile methodologies as average or broader, out of that 6 of the respondents rated their knowledge as broad or very broad. For traditional methodologies the rating was broad or very broad for 12 respondents. When compare the experience they have in the software industry it was revealed that with less experience in the field or in other words people who have experience less than four years have less practical knowledge in traditional methodologies. Figure 12 presents the results below.

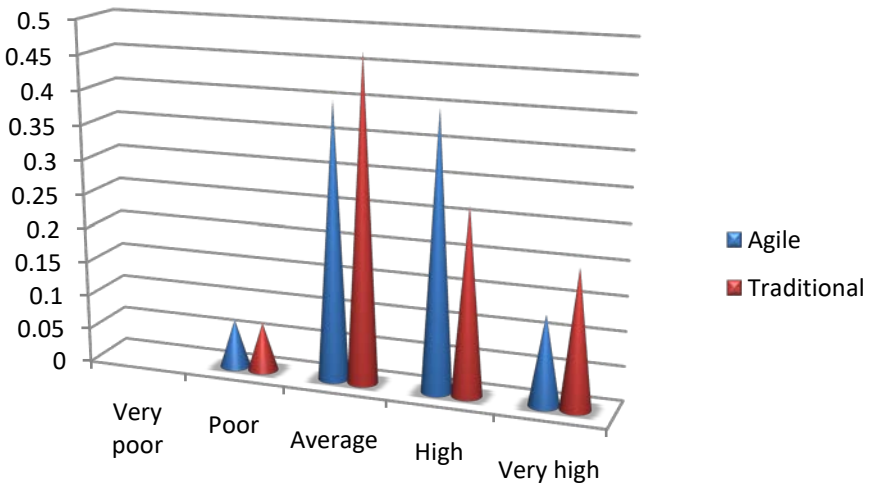

Figure 12: The methodology knowledge of the respondents'

v. *Knowledge of adopting new methodology by the respondents*

According to the respondents, the result found on adopting technologies in different organizations was interesting. More than 75% of the organizations were either Leaders in adopting a methodology or followers. But there are other organizations who describe themselves as conservatives. This means that there are organizations which will hang onto their accepted methods and not willing to experiment something new. It is illustrates in figure 13.

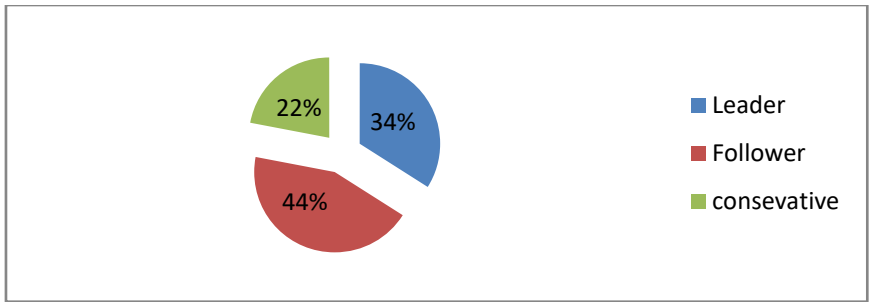

Figure 13: Adopting new methodologies in the industry

According to a survey results published by Ambler in early 2006 he has found that even though more than 60% were fully or partially using agile, there is a considerably a large number of organizations who are still have no idea of adopting agile. In that survey result shown below

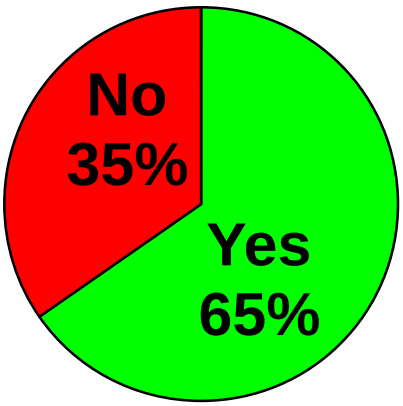

Figure 14: Ambler survey result of Adopting agile methodology (www. ambysoft.com)

In this survey about 75 % of the respondents are either leader or follower to adopt agile methodologies, on the other hand in Ambler survey 65% of the respondent said yes for adopting agile methodology.

So with the result of this survey, it proves that other than the organizations who adopted agile at the beginning, the potential of organizations adopting agile at a later stage without any assurance is minimal. A possible reason could be that these organizations are just waiting to see how agile projects will result in the future.

b) Methodologies used in Organizations

In this section focus on which type of agile and traditional methodology used on different organizations. If the organization is small which types of agile and traditional development methodologies they are using. In similar way it is focused for the medium and large scale organizations.

i. *Use of Agile Methodologies*

According to the respondents of the different types of organization indicate that Extreme programming (XP) is the most popular method used in the industry. But SCRUM also maintains a good position within the industry even though it is not up to XP level. There was a remark about XP stating that it sometimes gives bit of a fear because of the steps it includes and also the "Name itself". There is an interesting point that was found during the analysis. The next most popular was in-house build methods by organizations for their own use. In an article published by Sliwa (2002) mentions that agile methods can be mixed for different organizations purposes. The article further stated that;

"Schwaber, a Scrum co-creator, said it makes sense to combine Scrum and XP because Scrum focuses on management practices and XP centers on engineering practices for building object-oriented software."

The result proves this point as organizations are already using combined methods according to their needs for a better result. Another point was that some organizations tend to mix other new techniques built for specific tasks in software development with their development methodology. For example they use scheduling techniques such as planning porker for estimating time for development tasks. Planning poker is a technique which is used in Scrum in most cases to estimate time for development tasks. It has a deck of cards with different estimates which the developers can use (Cohn, 2005) cited by planningpoker). Figure 14 represent the results of respondent.

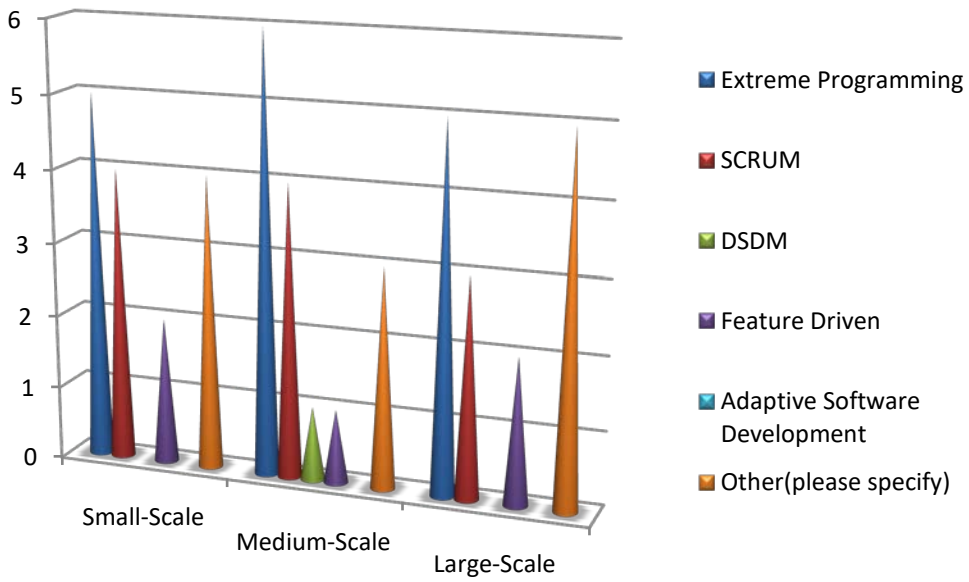

Figure 15: The use of agile methodologies

In figure 15 it is indicate that for small, medium and large scale organizations Extreme programming (XP) is most popular among the agile methodologies and SCRUM is in second position. Other methodologies are using in a very small scale in different organizations.

ii. *Use of Traditional Software development Methodologies*

According to the respondents of the questionnaire, for traditional methodologies more than 50% respondents use the waterfall model, 23% of respondents were interested in unified process and the rest was on in-house build methods for different type and sized projects. Figure 16 represent the results.

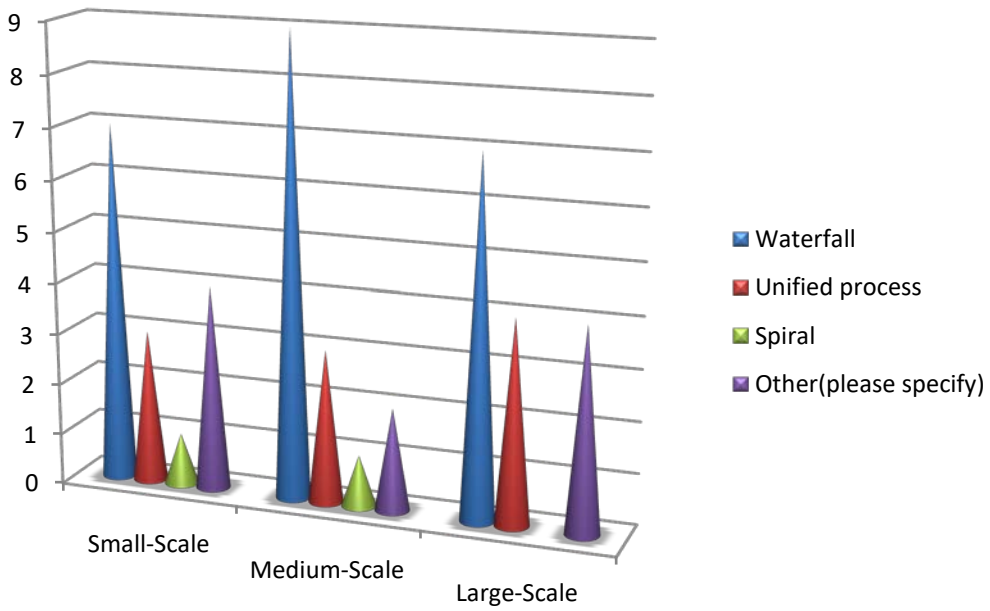

Figure 16: The use of traditional methodologies

V. Analysis

In this chapter the discussion will be focused on analyzing these collected data and find out the responses from the software industry professionals.

a) Most Appealing Agile Values over Traditional Characteristics

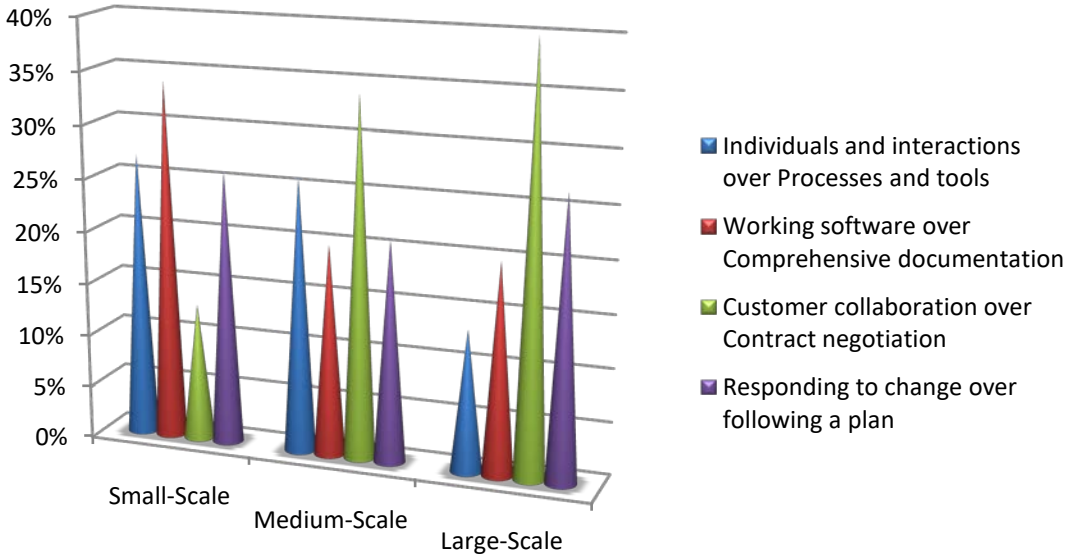

Figure 17: Most appealing agile values

When consider the small scale software projects more than 30% of the respondents think that working software is more important. People interactions and responding to change come after respectively. All the respondents' believe that human interaction is an important fact for better software development regardless of the project size. Cockburn (2001) point out that;

"Core to agile software development is the use of light-but sufficient rules of project behaviour and the use of human and communication-oriented rules" proving the point made out from the survey results.

Respondents' have a different view about Medium and large projects. For both of these project types, customer collaboration have obtain the highest votes. This means that when the system is getting bigger more customer collaboration helps to keep the development on the track. Medium projects have a higher percentage of votes for people interaction than large projects. Even though this is outside the expected result for large projects, it may be due to the reasons that respondents think it is hard to communicate within large projects. Figure 17represents the results obtained.

b) Factors that Influence to use Agile Methods over Traditional Methods

Cost and quality of software products are the main concerns in the industry when it comes to software engineering. It is important for both software organization as well as the customers (Krasner, 1998). Due to this in the questionnaire, it was necessary to include questions regarding the cost and software quality. The reason was to find out how agile methodologies have affected on these two features of a software project compared with traditional methodologies.

The questions were targeted to capture the opinions of the respondents, whether they believe by adopting agile methodologies will affect the software cost and quality of a project than the traditional methodologies. Since agile is making a huge entrance to software industry I was expecting a very higher positive feedback. Even though the result was rather different from what I was expecting.

When it comes to cost of the software project 50% of the respondents agreed that there were no change in cost at all by using agile methodologies but according to Ambler (2007) it was 47 % (in Figure 19). Surprisingly 22% of the respondents have voted as the affect of the cost has slightly decreased than the traditional methodologies but according to Ambler (2007). Only about 18% of the respondents believe that agile methodologies have made a slight increase affect on cost. The rest of the respondents falls both sides to the far end of the ratings.

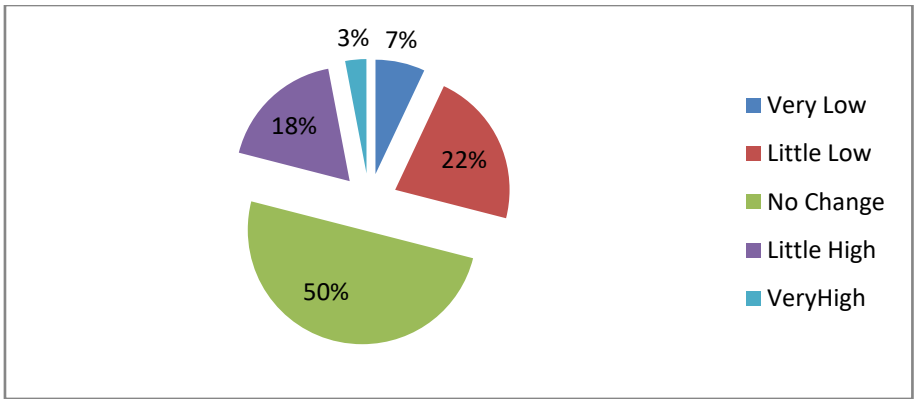

Figure 18: Affect on software cost from agile methodologies

But with regard to software quality the result I obtain was different than the cost. Overly respondents have a positive feedback on the quality. More than 30% of the respondents believe that adopting agile methodologies have slightly increased the affect on quality compared with traditional methodologies. 13% of the votes were even higher. They believed that the affect was in a very higher state. But again there were huge number respondents who really did not believe in agile methodologies as 39% was on the no change state. The rest was in the low side of the rating.

Figure 18 and figure 19 show the results for the software cost and quality I discovered.

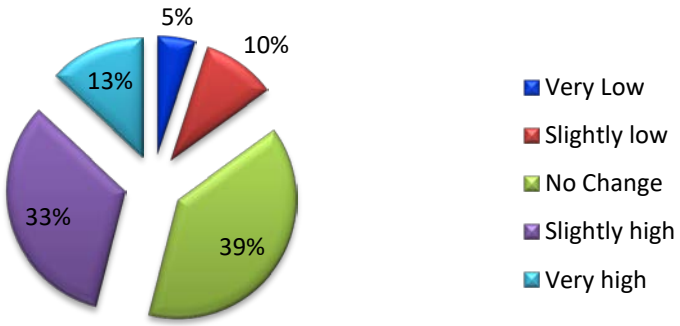

Figure 19: Affect on software Quality from agile methodologies

So comparatively organizations believe that there is a higher effect to quality from agile than the effect to cost. In the survey done by Ambler in early 2008 the results on quality was noticeably different. In his survey 67% of the votes said that they experienced better or significantly better affect on the quality of software projects with the adaptation of agile methodologies.

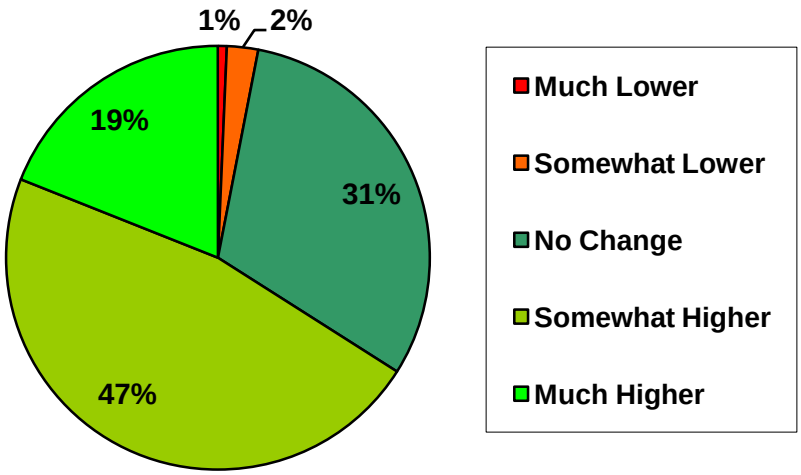

Figure 20: According to Ambler affect on software quality from agile methodologies

The difference to my results is that considerably a large number of respondents voted for no change. Since the results I got mentioned about medium size projects than other two there can be issues occur when practicing agile values such as team communication and customer feedback. Due to these reasons there may be problems when try to capture the quality of the project. The cost affect was slightly tally with the results from the Ambler's survey. Figure 18 and figure 19 show the results for the software cost and quality I discovered.

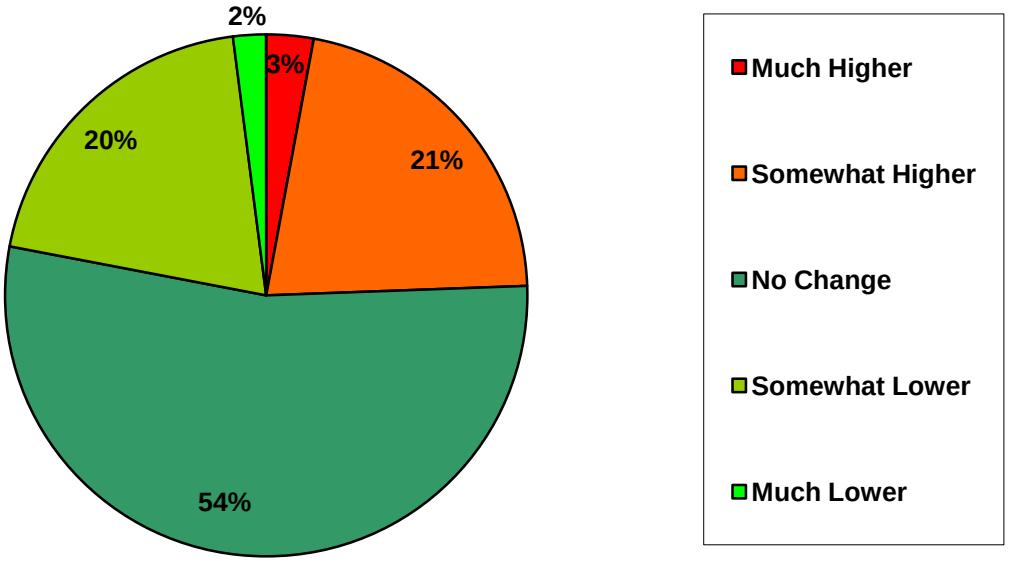

Figure 21: According to Ambler affect on software cost from agile methodologies

i. *Comparison of software cost from agile methodologies between Ambler and this survey*

Table 9: Comparison of software cost from agile methodologies between Ambler and this survey

Cost	This surver	Ambler (2007) survey
Very low	7%	2%
Slight low	22%	20%
No change	50%	54%
Slight High	18%	21%
Very high	3%	3%

This two survey result on software cost are closely similar and their correlation coefficient is 0.991039.

ii. *Comparison of software quality from agile methodologies between Ambler and this survey*

Table 10: Comparison of software quality from agile methodologies between Ambler and this survey

Quality	This Survey	Ambler (2007) survey
Very low	5%	1%
Slight low	10%	2%
No change	39%	31%
Slight High	33%	47%
Very High	13%	19%

This two survey result on software quality are closely similar and their correlation coefficient is 0.87579.

c) Preferences for Agile and Traditional Methodologies

When an organization uses a methodology, there are processes and techniques they have to follow regardless of the type of the methodology. From the past experiences in the industry I had the understanding that there were some processes which development teams think is useless for the success of the project objectives. To have a broader view in these aspects questions were included in the questionnaire to find out respondents opinion on certain characteristics in both methodologies.

According to the results shown in figure 22 more than 50% of the respondents' believe that low management control is a drawback for small scale and medium scale projects. In fact they believed that low management affects all sizes of projects in a considerable amount. The other major aspect was the project structure. Again all the respondents' believed

that lack of project structure affects all sizes of projects. By looking at the figure 21 it is possible to come to an understanding that large projects do not adopt agile methodologies because of this factor.

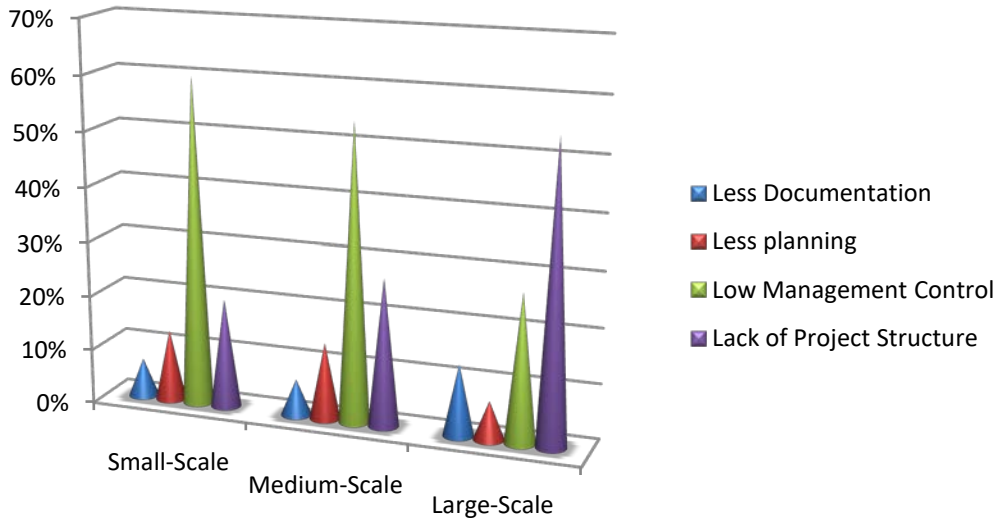

Figure 22: Low preferences of agile characteristics

Traditional methodologies always had the drawback on documentation. The results shown in figure 23 clearly indicate the respondents' opinion on the heavy documentation for all types of projects. Especially when it comes to small scale projects nearly 60%.

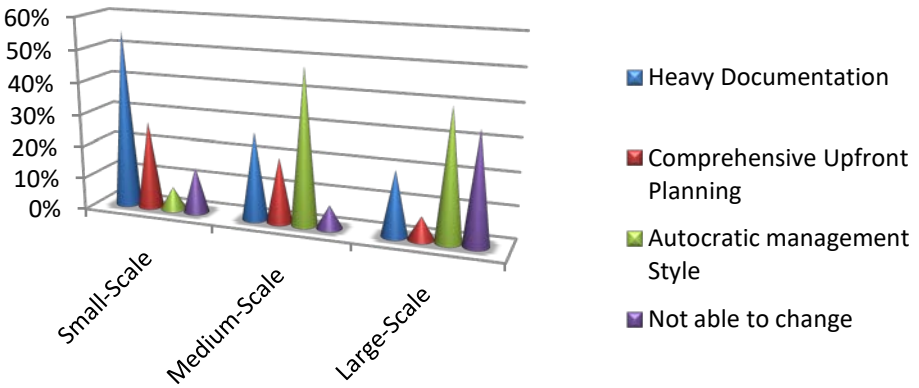

Figure 23: Low preferences of traditional characteristics

Agree that heavy documentation is a waste. Lindvall et al. (2002) clarify this in a survey paper by stating;

"Documentation should be assigned a cost and its extent be determined by the customer.

Many organizations demand more than is needed. The goal should be to communicate effectively and documentation should be the last option."

d) Methodology preferred

When analyzing data to find out which development methodology is preferred by the respondents I have realized that agile has come a long way during the past few years after it was properly published. But on the other hand it still has to go further to take over the whole software market.

i. *Methodology selection for different project sizes*

The results discover that almost all the respondents have agreed that agile methodologies are the best for small scale projects. This means that software organizations getting to know how to get their hands on agile methodologies to manage the tasks in small scale project environments. For medium scale projects both methodologies were voted. The gap between the results for the two methodologies was very less. This shows that agile is adopted by organizations than before for medium scale projects. But respondents had a different idea about large scale projects. Nearly

90% of the responds were bias to traditional methodologies. Only the remaining was for the agile and other methodologies.

The interesting fact was that organizations are using a mix of both methodologies when it comes to medium and large scale projects. Medium size projects are in this process more than the large size projects but it seems within the next few years large scale projects may also start to use a mix of both methodologies. Figure 24 below represents the methodology selection.

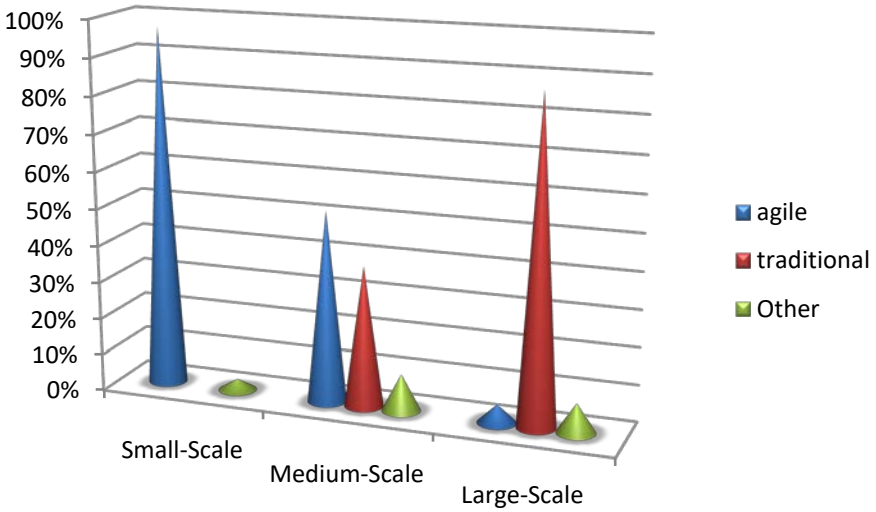

Figure 24: Methodology selection for different project sizes

ii. *Ratings for other mix techniques into development process*

The other fact was that some organizations mix other techniques also into their methodologies. Some respondents have rated for Scrum or Scrums and also planning poker which are new techniques to make the development processes more efficient. Figure 25 represents the total results.

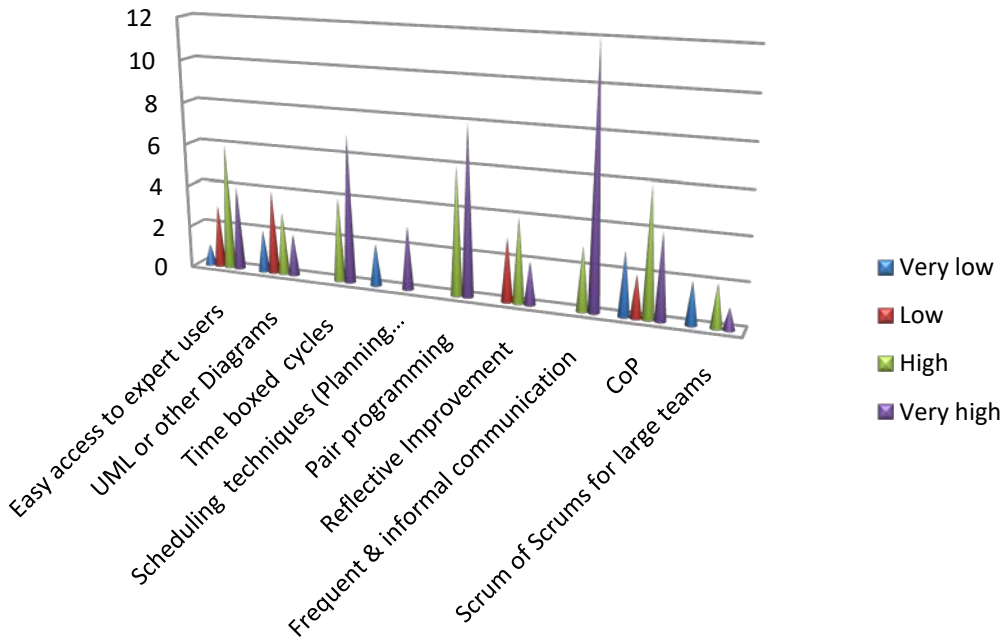

Figure 25: Ratings for other techniques

iii. *Use of agile methodologies*

Around 40% to 50% of the respondents' agree that for medium and large scale projects autocratic management is not necessary. This type of a management would keep the teams stick to the standard work and have no agility leaving the teams work without any innovation or creativity.

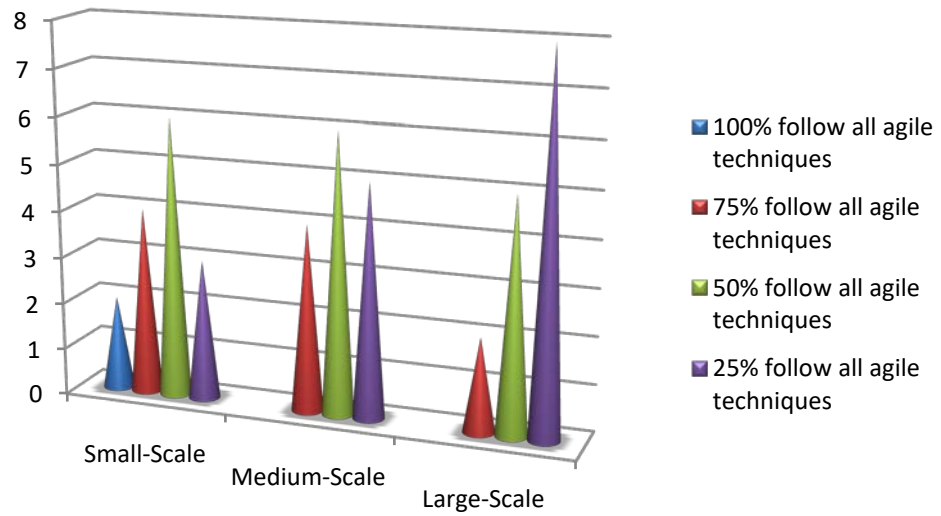

Figure 26: Use of agile methodologies

Figure 26 represents the extent which agile methodologies are used for different types of projects sizes. Only for small scale projects some organizations use 100% of the agile methodologies. Other than that for both small and medium scale projects majority of the respondents' agree only up to 50% of agile methodologies are used. There was a comment from a respondent saying that "It is hard to stick to agile methods especially when it comes to large projects. There are other techniques been used mixing with the practices in both agile and traditional methods?" This means that organizations are tend to use their own in house methodologies created to suits the projects they handle.

The findings of this project research study also confirm the appropriateness of the use of agile methodologies for small scale projects, traditional and agile methodologies for medium scale projects and traditional methodologies for large scale projects of an organization.

VI. Conclusion

The purpose of this research is to present a set of guide lines for a software organization to help choose the most appropriate development methodology according to most of the software projects they have in hand. The thesis starts with an overview of the software industry and explanation of the problem domain which is focused in the research. Through traditional and agile development methodologies, this discusses the different software development approaches used in the software industry. Further a discussion about the life cycles of selected approaches from both traditional and agile methodologies were carried out with identifying the roles, responsibilities and practices of each development approach. This would give the reader clear idea about the two methodologies and also the differences they have. Chapter 2 briefly presents a comparison on the methodologies and focuses on the problems in both methodologies. Finally, in order to get the professional opinions, the document presents the analyzed results from the survey conducted.

Throughout the research it was understood that the traditional methodologies were apparently handling a considerable portion in software industry. The basis was the complete planning, heavy documentation and extensive designs. Traditional approaches will still be useful in large, long lived projects that require special safety, reliability or security requirements. The military and defense industry gives a perfect example to prove this point. Lijek (2007) in a presentation discusses the reasons why agile methodologies are not adopted in the military and defense industry.

- Defense Contractor Mentality regarding change
- Safety Critical Systems
- Long development cycles
- Large teams
- Customer Relations

But in the near future with the improvements agile will be able to be adopted in these industries.

Agile methodologies cannot be defined by a small set of rules and practices. From the literature review and the survey results it became obvious that agile methods have the capability to respond to change faster, the ability to extract the hidden creativity and innovations out of the teams, the capability in balancing the structure and flexibility and to drive the organization through rough situations and uncertainty. Agile is more likely to dominate volatile environments with uncertainty and unpredictability where the exact customer needs are not clear. Organizations tend to respond to the market changes quickly with the customer needs. They make plans for the system but do not tie their view to it. Rather than making models they want to focus more on

the working software. They focus on constant interaction within the team members, customers and management and individual skills as well. With all the readings and findings it is clear that there is no "one-size-fits-all" solution.

a) Limitations

There were some obstacles on the way to the success of this thesis. At first, Gathering the information from the professionals and practitioners in the industry was a problem as it takes long time for most of them to respond to the questionnaire. There were some returned questionnaires half-completed which had to be discarded. Another barrier was the time factor. Even though there are lots of areas that can be focused under this topic it was not possible since the allocated time was limited. But within the time period a good and original piece of work was produced with great attention.

b) The Guidelines

The guide lines presented are to support an organization to select the most appropriate software development methodology for software projects they undertake. For an organization, it is hard to have more than single software methodologies operating. Generally the top management and human resources would prefer all projects to use the same method for ease of handling.

However, software developing is a complex and uncertain process. To cater for specific needs, Project requirements and different teams may have to produce different results. Therefore, it is important to consider adopting different methodologies or a mix and match of several techniques from different methodologies at least between two departments or two different project sections which operate independently in the same organization.

The following guidelines are created with the knowledge obtained from the research on the literature and the analysis and understanding gained from the survey results which involved the real software development organizations.

- Flexibility – Everybody involved with software development needs to be flexible, starting from the top management. They should understand different projects have different needs and there are different ways to make them successful.
- Priority on the needs – Different projects need Different techniques and artifacts. Therefore, it is important to identify them and prioritize them. For an example the use of other techniques and artifacts outside the working methodology (e.g. planning poker) for certain types of projects may lead the project to greater success. But the management has to remember that, this may need some training to the team members as a person may have to deal with a range of methods and/or artifacts.
- Cater according to the team – For different projects, Development teams may be different in size. So it is important to use suitable methodology or mix of methodology to cater for that requirement. As an example, XP and scrum are suitable for projects with small-scale to medium-scale development teams with 4 to 20 members. However, for large and medium scale teams Unified Process can be used.
- Define targets – There are specified artifacts for each approach in traditional development. So organizations rely on these artifacts and always try to stick to them. Rather defining the targets with the help of the customers on what to build may be more productive. The artifacts will be decided along with the targets which is more useful for all the parties involved in that specific project.
- The use of methods – Organizations with large or medium scale projects can combine subsets of different methods. SCRUM is a methodology which can be mixed with different other methodologies including XP and waterfall. However, for organizations, who handle small scale projects can settle with a single methodology.

Come up with a specific set of rules is not that easy in a rapidly changing field with uncertainty like software engineering. For different organizations, these guidelines can be used in different ways. With time and experience these can be improved more. The best way is to experiment these in a real time environment and observe the validity and the success, which will give an understanding on how to improve them for better results.

Acknowledgement

I would like to acknowledge and state my total pleasure to those whose efforts and support in one way or the other contributed to the successful completion of this research study. I particularly wish to convey profound gratitude to my supervisor, Dr. Nigel Kermode, for his invaluable support, encouragement, useful suggestions and supervision throughout this research work. I also wish to thank my friend Mr. Khondker Razeeb-us-Saleheen, my class mates and my brother, Mr. Channa punchihewa for his support during my study. I am as ever, especially indebted to my parents, Mr. and Mrs. Rahman for their love and support throughout my life. Moreover, to my Almighty who made all the things possible.

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Appendix 1: Questionnaire

The objective of this survey is to find out various methods been used in the software industry for software development. The data collected will be strictly confidential and will only be used for this academic research. Please share your views about your experiences and your personal opinions. If you require a summary of the findings please complete the optional section at the end of this questionnaire.

The questionnaire is divided in to three sections. The questions contained are all close end questions. But if you have any comments for any of the questions please include them with the questions.

For any questions or clarifications please contact me,

A.K.M Zahidul Islam
akmzahidulislam102@gmail.com

1. What is your job Title?

Programmer / Developer	
Analyst	
Software Architect	
Software Engineering	
Project Manager	
Executive	

Other (Please Specify):_____

2. How long have you been working in the software industry?

< 1	
1-4 Years	
5-7 Years	
8-11 Years	
> 11 Years	

3. How would you best describe your organization type?

Information Technology	
Telecommunications	
Engineering	
Medical	
Education	
Government	
Other	
Information Technology	

Other (Please Specify):_____

4. How many employees are there in your organization engaged in software development/ maintenance?

<10	
10 – 20	
21 – 50	
51- 100	
101-200	
>200	

5. How would your organization react in adopting new technologies/ methodologies?

Leader (Look forward to adopting new technology as it release)	
Follower (Adopt the technology after the leader)	
Conservative (Wait till it is proven to follow)	
Static (Do not adapt new technologies)	

Section 2: Methodology knowledge

6. Which of the following more appropriate to rate your knowledge in Agile Methodologies? (Agile methods: Extreme programming, SCRUM, DSDM, etc…)

Very high	High	Average	Poor	Very Poor

7. Which of the following more appropriate to rate your knowledge in Traditional Methodologies? (Traditional methods: Waterfall, Spiral, Unified Process, etc…)

Very high	High	Average	Poor	Very Poor

Section 3: Software development

8. Which of the following best describe the last project you were involved?

Small scale project (3 to 7 people)	
Medium scale project (5 to 20 people)	
Large scale project (20+ people)	

9. Consider the last 5 projects undertaken at your organization; provide Yes (Y) or No (N) to the following.

	Proj1	Proj2	Proj3	Proj4	Proj5
Was it delivered on time?					
Was it delivered within budget?					
Did it satisfy the user's requirements?					
Did it require rework?					
Was it delivered on time?					

Comments (if any):

The following questions are based on the project sizes mentioned in question 8. Select the appropriate selections with a tick or cross (X).

10. Which Agile methodologies you prefer for each type of software development project?

	Small scale	Medium scale	Large scale
Extreme Programming			
SCRUM			
DSDM			
Feature Driven			
Adaptive Software Development			
Other(please specify)			

11. Which Traditional methodologies you prefer for each type of software development project?

	Small scale	Medium scale	Large scale
Waterfall			
Unified process			
Spiral			
Other(please specify)			

12. What is the average size of teams you use for each size of development projects?

	Small scale	Medium scale	Large scale
2 - 15 members			
16 – 50 members			
51 – 200 members			
More than 200			

13. If you prefer to use any of the following techniques outside specific software development methodology use how would you rate them? (Rate only the preferred else leave blank).

	1	2	3	4
Easy access to expert users				
UML or other Diagrams (use cases, ERDs)				
Time boxed development cycles				
Scheduling with techniques like Planning porker				
Pair programming				
Reflective Improvement				
Frequent & informal communication				
Communities of practice				
Use scrums of scrums for large teams				

14. Compared with traditional methodologies which of the following agile values most appealing to you for the different software development project sizes?

	Small scale	Medium scale	Large scale
Individuals and interactions *over* Processes and tools?			
Working software *over* Comprehensive documentation?			
Customer collaboration *over* Contract negotiation?			
Responding to change *over* following a plan?			

15. Which of the following agile characteristics would you think is not suitable for the three sizes of software projects?

	Small scale	Medium scale	Large scale
Less Documentation			

Less planning			
Low Management Control			
Lack of Project Structure			

16. Which of the following Traditional characteristics would you think is not suitable for the three sizes of software projects?

	Small scale	Medium scale	Large scale
Heavy Documentation			
Comprehensive Upfront Planning			
Autocratic management Style			
Not able to change			

17. How would you think the agile approaches affect cost of the three sizes of software projects than traditional methodologies?

	Small scale	Medium scale	Large scale
Very high			
Slightly high			
No change			
Slightly low			
Very low			

18. How would you think the agile approaches affect quality of the three sizes of software projects than traditional methodologies?

	Small scale	Medium scale	Large scale
Very high			
Slightly high			
No change			
Slightly low			
Very low			

19. To what extent do you follow agile techniques for the three sizes of projects?

	Small scale	Medium scale	Large scale
100% follow all agile techniques			
75% follow all agile techniques			
50% follow all agile techniques			
25% follow all agile techniques			

20. Which methodology do you prefer for different software projects?

	Small scale	Medium scale	Large scale
Agile methodologies			
Traditional methodologies			
Other (Please specify):			

Any suggestions or comments or your views regarding software projects and methodologies.

Optional

If you would like to have a summary of the survey results, please provide contact details

Name: _____

Email: _____

Organisation: _____

Thank you for all your valuable time in completing this questionnaire.

Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 20 Issue 2 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Monitoring Social Distancing by Smart Phone App in the Effect of COVID-19

By Dr. Neelavathy Pari S, Balaji Vasu & Geetha A V

Abstract- Social distancing measures are necessary for many infectious diseases that spreads through droplets and microdroplets. According to WHO, the preventive measure for COVID-19 is to follow strict social distancing. It is not easy to enforce social distance easily in a crowded region and people often not maintain sufficient distance with neighbours. Driven by the need for energy-efficient and cost-effective social distancing monitoring, this paper proposes Smart Social Distancing (SSD) mobile application based monitoring, which can predict the social distancing between two people assisted by mobile bluetooth and mobile camera. SSD involves two major steps to predict the social distance: first the pedestrian in the video frames is identified with the aid of Deep Learning (DL) and in the second step, distance between the two pedestrian is estimated through image processing techniques. The application can also be configured to calculate the distance using Bluetooth Low Energy (BLE) by calculating its received signal strength. The application demonstrates 85% accuracy on predicting the social distancing and alert the user using beep sound or alert message.

Index Terms: social distancing, pedestrian detection, mobile app, deep learning algorithm, transfer learning, bluetooth low energy.

GJCST-C Classification: H.4.0

Strictly as per the compliance and regulations of:

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I. Introduction

On 31 Dec 2019, a number of pneumonia cases of unspecified aetiology in Wuhan, was notified to the WHO China Country Office. But, the influenza identified as COVID-19 quickly spread to many countries and on 11 March 2020, the WHO declared the outbreak a global pandemic [1]. Influenza outbreaks present a possible threat to humans because of their ability to rapidly adapt and impact people who are immunologically weaker. Readiness for pandemic flu is therefore a key step in response to these outbreaks [2]. In this regard, responding to the current COVID-19 pandemic and planning for possible pandemics needs critical preparation when there is no vaccine supply is to apply social distancing, quarantine measures along with rapid delivery of medical supplies such as personal protective equipment, anti-virus treatments, etc.

Some of the measures used in the past as in the case of Spanish flu of 1918 or the recent, H1N1 pandemic of 2009 was to wearing masks, maintaining personal hygiene, social distancing, contact tracing and isolation of infected individuals helped in containing the spread of the influenza to a larger extent. Thus social distancing is a crucial measure to control the spread of influenza outbreaks in a region. Moreover, according a recent study [3], assessed that one- time measures would not be adequate to reduce the occurrence of COVID-19, with the current critical care facilities of United States. According to the study it is indicated that these measures may be required till 2022. Especially in countries that lacks adequate public health and testing resources, "social distancing" or "physical distancing" measure helps in flattening the transmission curve, thus aiding in reduction of burden of the overwhelmed critical care units. Therefore, an one-time or single duration social distancing measure does not suffice to avoid intensive care resources from being overrun by the COVID-19 epidemic, as it retains enough of the population to be affected by the rebound in transmission, after the end of this pandemic cycle [4].

It is estimated that the lower bound of the economic benefit of social distancing measure in United States is approximately $8 trillion, which is greater than a third of its GDP. Moreover, the non-monetized benefits of social distancing include, quality treatment for non-COVID19 patients, short lock-down periods, buying time for developing a vaccine and strengthening the health sector resources [5]. Therefore, it is necessary to encourage appropriate social distancing.

The proposed system has two methods for monitoring social distancing and alerting the smart phone users. The first method was developed using smart phone camera which will get the feed and processed with on-device deep learning algorithm deployed in the mobile to predict the social distancing. The implementation and result of this surveillance method are discussed in below sections. The second method measures the social distance between two smart phones using Bluetooth Low Energy technique. When the user scan for nearby devices, the Received Signal Strength Indicator (RSSI) value is received during the scan callback. The distance between the other device can be calculated using the received RSSI value, the formula and algorithm used for distance calculation is discussed in below sections. If the user violate social distancing, the app is designed to alert the users by a beep sound and displaying alert message. The experiment were conducted on various places such as College entrance, Office premises, Government office, Cafeteria ans so on. 85% of accuracy is obtained on detecting the real time social distance by these two methods.

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The rest of the paper is organised as follows: Section 2 explains the background and literature survey of pedestrian prediction, calculate distance between two objects in the 2D image and Bluetooth techniques. And Section 3 explains the proposed system of monitoring app used to predict the social distancing and various algorithm used for the prediction. Section 4 explains implementation and results for the developed application. Finally in Section 5, summarizes the research conclusion and applicable feature work.

II. Related Work

In this section, three types of techniques are reviewed which is used in the proposed system: (1) Pedestrian Prediction Method, (2) Distance Calculation by Image Processing Method, (3) Bluetooth Distance Estimation Method.

a) Pedestrian Prediction Method

Various methods has been developed by various authors for pedestrian detection in both 2D and 3D image space. Jianqi Zhong et al. [6] developed pedestrian motion detection in 3D image since the human motion depends on 3D space. The authors developed twin deep neural network based on pose estimation. In [7], multi-task deep learning with no action recognition is used to estimate the time for pedestrian road crossing. This detection system is developed to avoid road accidents based on movement of people who crossing the roads. Quintero et al. [8] proposed Gaussian dynamic models and Activity recognition for detection pedestrian in order to avoid road side accidents. The proposed method is developed from multiple features of pedestrian activity such as: walking, stopping, starting and standing. Rehder et al. [9] studied pedestrian prediction using Deep Neural network which can be used in traffic management and to avoid collision in autonomous vehicle. The authors trained the model using monolithic neural network via reverse reinforcement learning. Choi et al. [10] developed Deep learning based pedestrian trajectory considering the location relationship between the people. The displacement between neighbouring frames for every pedestrian in the sequential video frames are calculated. The motion information are encoded using LSTM (Low Short Term Memory) and uses MLP (Multilayer perceptron) to map the location.

b) Distance Calculation by Image Processing Method

The distance between two object in 2D image can be calculated by different image processing techniques and mathematical formulations like Euclidean and Manhattan distance formula. Johny Singh at al [11] developed distance calculation of a object in 3D image using Stereo camera. The distance of the object is calculated using Euclidean distance between centroid of the bounding box and the camera and they obtained the result with 2.08 average error. JongBae [12] proposed a method to detect pedestrian and distance estimation using smart phone based thermal cam- era which can run in low light environment. The detector was created using multi-stage cascade learning and distance is estimated by calculating the position of the pedestrian in the 2D thermal image. On their experiment they obtained 91% accuracy in detecting pedestrian and 85% in distance estimation. Chong Sun et al. [13] in their paper discussed distance estimation between two persons using latent variables by minimizing a distance function. They developed latent metric learning method using effective metric matrix.

c) Bluetooth Distance Estimation Method

Bluetooth low Energy (BLE) is a low cost, lost power portable technology which is growing exponentially. Lam and She [14] in their paper discussed on the distance estimation of the moving object using BLE. They Received Signal Strength Indicator (RSSI) from the noisy environment and overcome by using Kalman Filter (KF) to smooth the RSSI measurement. The filtered RSSI value is trained by Support vector machine using non-linear kernel function to estimate the distance. The mobile users received limited rate for distance estimation and there is some delay on calculating the distance. Yoon et al. [15] used BLE and ultrasound signal to calculate the distance between the device. The received RSSI value are not accurate due to various environment factors. For estimating distance, the authors introduced propagation constants estimation based on Time difference of arrival between BLE and ultrasound signals. The estimated error increases as the distance increases in real time, they obtained distance estimation with 10cm average error distance. Yuan and Chang [16] proposed Indoor positioning system based on RSSI value from the BLE beacon. The authors used weighted multi point algorithm with cellular network assistance for calculating real time distance and achieved error rate of 0.8%.

III. Social Distance Monitoring

For measuring social distance two methods are proposed, one is using mobile camera which can process the video frames and calculate the distance. Next method uses smart phone Bluetooth low energy BLE (Bluetooth Low Energy) hardware and calculates distance by its signal strength. Explained step by step process of both the methods in the below section.

a) Camera surveillance Method

The smart phone camera captures the video frames to track the social distancing. Image rendered frame by frame are passed into the loop of the image detection algorithm. Image processing are done for noise removal and passed to the pedestrian trained

model. The outcome image will draw a rectangular bounding boxes when any persons are identified in the image. The classified image with person are feed to calculate distance using euclidean algorithm. The whole working process of the system is explained in the Fig. 1.

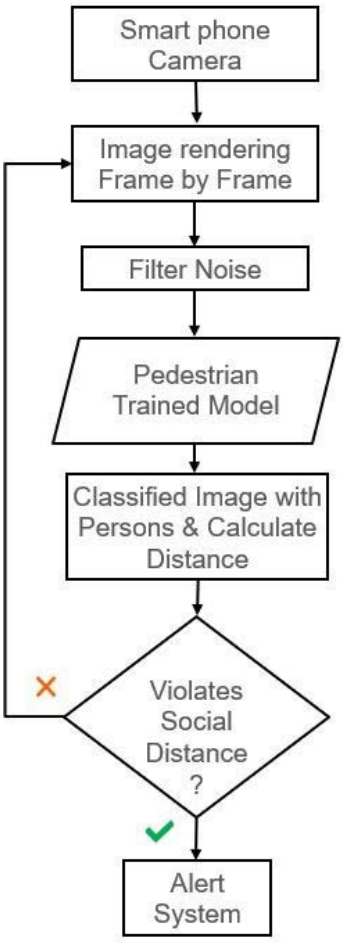

Fig. 1: System Flow

i. *Predicting Pedestrian*

The pedestrian prediction training model is trained by Tensorflow environment. The following steps are required in order to train the model.

- Gathering Images and Labeling data
- TFRecords Creation
- Training and Exporting model

For gathering the data set, the images are downloaded from INRIA Person data set and Penn-Fudan database which different image formats are converted to JPEG format. Maintained 80% of images to training and 20% to test testing folder. The tensor flow needs more number of images in various background to train the model with good precision and accuracy. After downloading the data set, the labelling of all the images are done by creating a rectangle box on the target object using the tool called labelImg.

The TF Record file is tensor flow format used for storing a sequence of binary records. After labelling process all the images are saved in xml file using the rectangle bounding box coordinates, the tffile are generated for both train and test folder by exporting all the xml files into csv file. With the help of tensor flow api, the csv file is converted into tfrecord file.

Algorithm 1 Person Detection Algorithm

Input: Test Image from Camera feed
Output: Image with person indicators as Bounding Boxes

```
for iterator1 = [1: num of frames in Camera Feed] do
    Apply filter to image
    Compute integral image
end for
for iterator2 = [1: num of shift steps] do
    for iterator3 = [1: num of stages in classifier] do
        for iterator4 = [1: num of filters in iterator3] do
            Filter Detection
            Accumulate filter outputs
        end for
        if accumulation fails per stage threshold then
            Reject sub-window as Person
        end if
    end for
    if sub window passed all three stages then
        Accept sub-window as Person
    end if
end for
```

The transfer learning is used for training the model which is the technique of applying already trained model for training another model which can take less time to train and yeilds better results. For example knowledge gained for training cars can be transfered to recognize trucks. The Single Shot Detection(SSD) with MobileNet pretrained model is used to train with COCO dataset called ssd mobilenet quantized coco model. The MobileNet is choosen which are optimized for indereence in mobile. Once the model is trained with above configuration, the model is evaluate with COCO evaluation technique by downloading COCO API. Fig. 3 is the sample image used for training the pedestrian model.

Single Shot Detection (SSD) is the object detection algorithm in real time. The Faster R-CNN uses region proposal network to create a bounding boxes and utilize the box to classify object. The SSD object detection works on two steps, first it will extract the feature map from the image, next by applying convolution filters to detect objects.Conv4 3 layer is used for each cell which are capable of predicting 4 object prediction in single image frame. The Fig. 2 illustrates the SSD model used with Conv5 3 along with VGG-16 layer which is used to extract feature map. After training the model, the inference graph is generated and it is exported to the mobile app as tensor flow lite(.tflite). The Algorithm 1 explains step by step logic used for

pedestrian detection process, for every frame in the image it detects the persons and draw the bounding boxes.

ii. *Calculating Distance*

Once the pedestrian is predicted from the image, the distance between the two persons are calculated by using Euclidean algorithm. The euclidean distance between two point measure the length of segment connecting two points.

Euclidean distance Euclidean distance between any two points $p_1 = \{x_1; x_2; :::; x_n\}$ *and* $p_2 = \{y_1; y_2; :::; y_n\}$ is given as follows:

$$ED(p_1, p_2) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + ... + (x_n - y_n)^2}$$

$$ED(p_1, p_2) = \sqrt{\sum_{j=1}^{n} (x_j - y_j)^2}$$

Manhattan distance Manhattan distance between any two points $p_1 = \{x_1; x_2; :::; x_n\}$ and $p_2 = \{y_1; y_2; :::; y_n\}$ is given as follows:

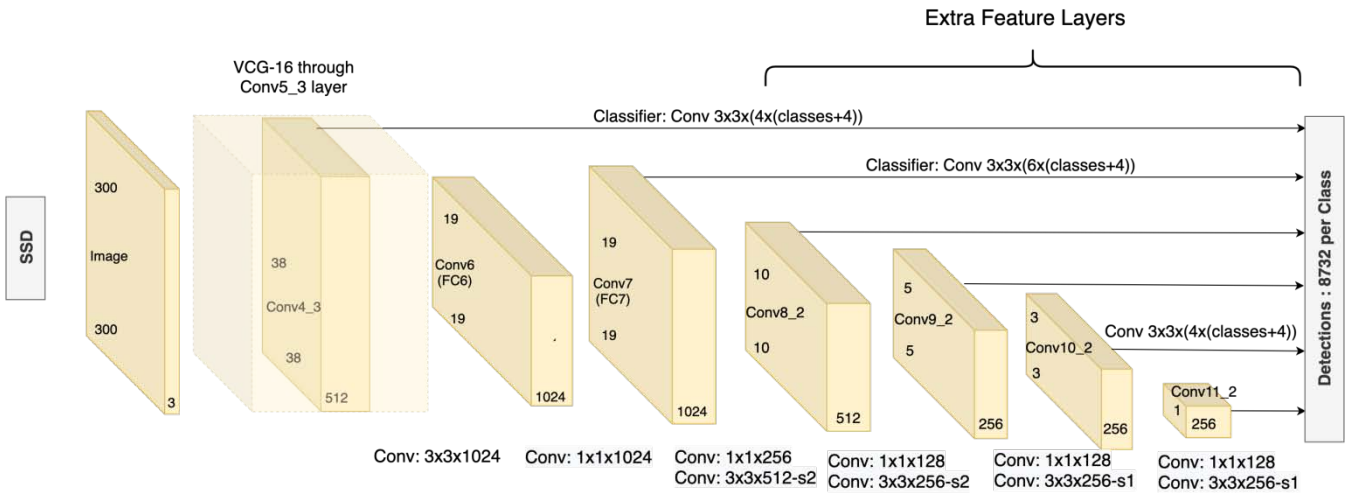

Fig. 2: Single Shot Detection Model

Fig. 3: Pedestrian Detection

$$MD(p_1, p_2) = |x_1 - y_1| + |x_2 - y_2| + ... + |x_n - y_n|$$

$$MD(p_1, p_2) = \sum_{j=1}^{n} |x_i - y_i|$$

From the frame image of pedestrian detection, the list of bounding boxes that covers every persons are retrieved. With the help of bounding boxes the center point of each is calculated using the top, left, right and bottom pixel values of bounding boxes. Then

the center point of each bounding boxes are passed to distance calculation algorithm to calculate the distance between them. From the algorithm two lists of persons who maintain safe social distance and list of persons who are at unsafe distance are derived.

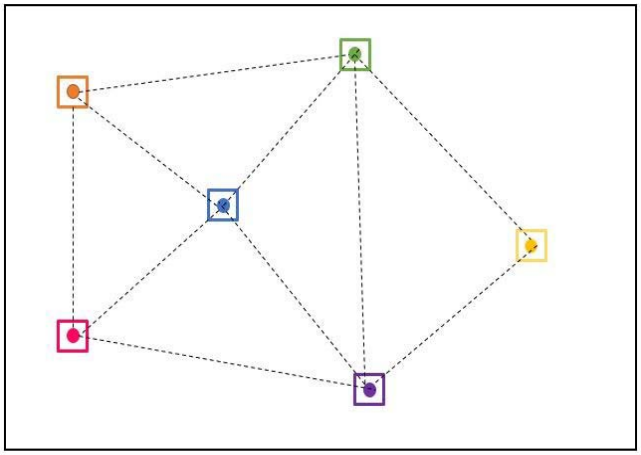

Fig. 4: Processing Bounding Boxes in Frame

Algorithm 2 Social Distance Measurement Algorithm

Input: An array of point (x,y) such that x is the x-coordinate of the point and y is the u-coordinate of the point
Output: Array of points with unsafe distance

```
if P.length <2 then
    return nil
end if
for iterator1 = [P.length : 1] do
    for iterator2 = [1:≤, iterator1] do
      D = Compute Euclidean Distance (P[iterator1], P[iterator2]) / Avg Person Width
      if (D ≤ safe Distance) then
        add Unsafe Pair(P[iterator1]; P[iterator2])
      end if
    end for
end for
return unsafe Pair
```

Algorithm 3 Percentage and Zone Calculation

Input: An array of safe and unsafe Points
Output: Percentage and Zone of Social Distancing

```
if unSafeList.length ≤ 0 then
    return nil
end if
percentage = calculatePercent(safeList, unSafeList)
if percentage in safeThersold then
    color = Green
else if percentage in averageThersold then
    color = Orange
else if percentage in dangerThersold then
    color = Red
end if
```

Algorithm 4 BLE Distance Calculation

Input: Received RSSI Value on scanning devices.
Output: Estimated real time distance between two smart phones

```
if BLE Not Supported then
    return nil
end if
Scan the nearby devices
for iterator1 = [1 : devices.length] do
    AdvertiseMessage()
    D = calculateDistance(device.rssi)
    realTimeDistance = findAverage(D)
    if realTimeDistance _ thresold then
        displayAlertMessage()
    end if
end for
```

For instance if there is 6 persons bounding boxes in one frame as given in the Fig. 4. The first person is compared with remaining all five persons distance. If the first person maintains safe distance then the point is added in safe list. Followed with second person will be compared with other four persons excluding the first one, if the second person doesn't maintains social distance with any other points then it is added to unsafe list. Similarly the other iterations of persons are followed with remaining persons in the list. With the help of this technique, at the end, the number of safe and unsafe list of data is stored in the data structure. The above algorithm is processed in every frames of the camera feed which is received after processing from object detection algorithm. Redraws the bounding boxes with predicted persons with safe and unsafe with different color in indication. The Algorithm 2 explains the execution for measuring social distancing using euclidean distance. With every frame received from camera feed with rectangular frames, the midpoint of every rectangle is calculated and the two points are passed to measure the distance.

iii. *Percentage Calculation*

Once the distance of every bounding boxes are calculated, the list of safe and unsafe distance are obtained. To alert the pedestrians who doesn't follow social distancing, the alert window mentioning the percentage of people following safe distance and color indication of zone whether the region is in safe zone (Green Indication), area which is likely to safe and danger which means average group will fall under this category (Orange Indication) and finally unsafe zone where most of the people doesn't maintain social distance (Red Indication) are displayed in order to create alertness and awareness to the users.

Algorithm 3 explains the logic for percentage calculation based on the safe and unsafe distance determined. The app user are alerted by displaying

various color zone whether the peoples are maintaining safe or unsafe distance.

b) Bluetooth Module

Another method of calculating the distance between the two persons using smart phone is Bluetooth Low Energy (BLE) technique. When two persons installed this app with the help of BLE support 4.0 the approximate distance can be calculated. RSSI (Received Signal Strength Indicator) is the strength of the beacon signal received at smart phone. The RSSI value ranges from -26 (few inches) to -100 (40-50 meters) distance. Along with RSSI there is another factor called Measured power used for the calculation. The formula for the distance calculation using BLE is given below.

$$Distance = 10^{((Measured\ Power - RSSI)/(10 * N))} \quad (1)$$

IV. Implementation and Results

a) Experimental Setup

For Pedestrian prediction and distance calculation experiments were conducted in Windows 10 machine (2.60 GHz, i7 processor, 32 GB RAM and 1GB Graphics Card) for training the model and exporting the model in smart phone. Following tools like tensorflow, opencv and other supporting libraries are installed for training the model. Once the model is trained and exported to tensor flow lite model with the help of use Android Studio developed the android application. After developing the app it is tested in Samsung S7 Android device with Oreo supported. The results of the camera surveillance method are discussed in below sections. For the Bluetooth distance calculation, developed and installed the app in different smart phones with BLE supported. When two smart phones are bring to closer distance alert message and sound will be popped in both the phones.

b) Training and Evaluating Model

The proposed system is trained and evaluated on INRIA Person data set and Penn-Fudan datasets which contains more real world human image data sets. This data set provides pedestrian bounding boxes for pedestrian detection and pedestrian attributes for estimating the pedestrian behavior. In order to test the detection performance, various experiments are conducted in different places. In the first detection experiment, the performances of the algorithm are investigated using the classical approach without action recognition on the INRIA data set. The Table 1 and 2 shows the accuracy, precision and F1-Score obtained during training the model. The Fig. 5 shows the accuracy and loss on training and validation of the model.

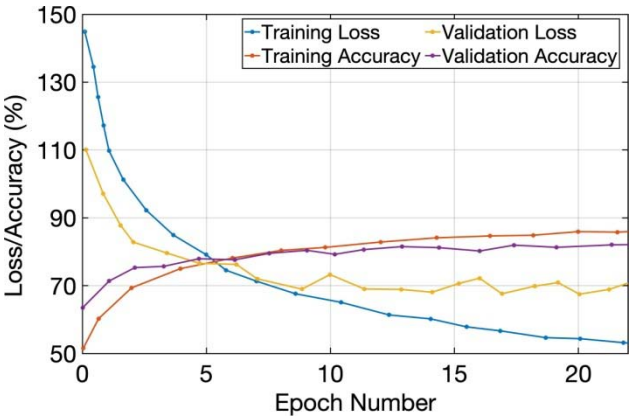

Fig. 5: Training and Validation Evaluation

Table 1: Performance Metrices

Terms	Description
True Positive (TP)	Number of samples correctly distinguished as malicious
True Negative (TN)	Number of samples correctly distinguished as benign
False Positive (FP)	Number of samples erroneously distinguished as malicious
False Negative (FN)	Number of samples erroneously distinguished as benign
Accuracy	(TP+TN)/(TP+TN+FP+FN)
Precision	TP/(TP+FP)
Recall	TP/(TP+FN)
F1-Score	2*((precision*recall)/ (precision +recall))

Table 2: Performance Results

Accuracy	Precision	Recall	F1-Score
91.10	92.50	83.06	85.3

c) Pedestrian Prediction Result

The Tensor Flow lite model is exported for Android mobile app development, with the help of Tensor Flow SDK and API the object detection are predicted in live camera feed. Once the persons are identified with their bounding boxes it is passed to distance calculation algorithm module. The Fig. 6 displays the persons predicted from the trained model

along with the distance calculation determining whether they are safe or risk position. The experiment was conducted with group of people with using the model, it detects the pedestrian with 91% of accuracy. The limitation of using mobile phone camera is that it is capable of only covering small distance.

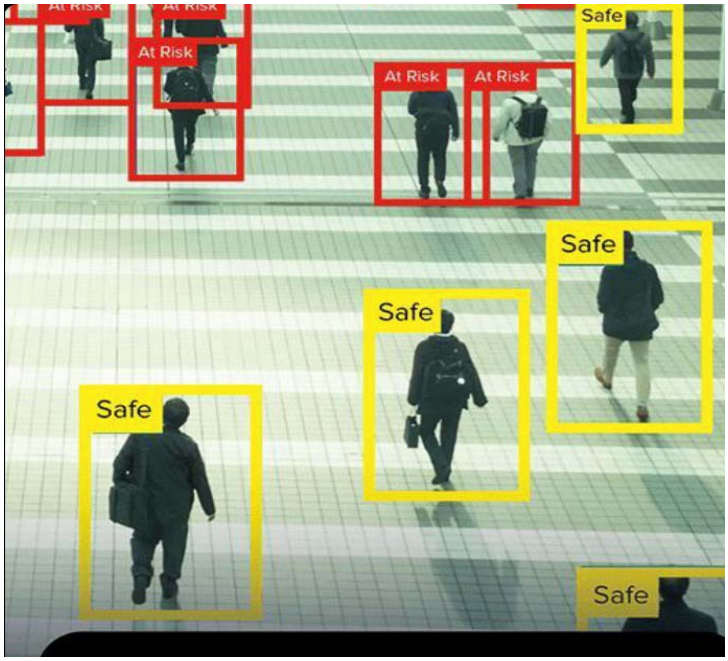

Fig. 6: Pedestrian Result

d) Distance Calculation Result

For distance calculation in image, the center point of every bounding boxes from the object detection result are obtained and distance between the two mid points are calculated. The distance are in pixels value, for real time determination of distance value, the pixels value are processed with some image processing technique. The whole pixel distance is divided with average human width in order to get exact distance in real values considering different zoom levels of camera. Once the distance are calculated a line is drawn between the two persons for indication, the green color indicated the two persons maintains the safe distance and red color indicates the two persons are at risk. The Fig. 7 shows the mobile app with persons who maintains safe and unsafe distance. This experiment was conducted in public places, where people usually roams at high density and identified the social distance prediction is about 85% accurate as real values.

Fig. 7: Distance Calculation Result

e) Bluetooth Module Result

For distance calculation using Bluetooth low energy, developed another mobile app feature which has option to turn on social distance monitoring. When user turns on,

The scanning for BLE will be triggered where the device discovery for other bluetooth device will take place. Once the new device is identified the device details like UUID, RSSI value are identified in the device discovery callback. With the help of RSSI signal strength, the distance are calculated using Eq. (1). The App is installed on two devices and alerts are displayed on both phones when they are placed within a distance of less than one meter. The Fig. 8 shows the popup between two android devices which are less than one meter. The implemented mobile application estimates the distance calculation of the proposed system on two android phones keeping with measured distance say 1, 2 and 3 meters. The estimated value has the error value between 10 to 20 cm on average comparing to its real time value. The Table 3 shows the results obtained from various phone which returns the approximate value of real time distance. The different values of RSSI are collected and its average is calculated to determine the final distance. The values may vary device to device based on the hardware of Bluetooth signal receiver. From the Table 3, it is inferred that the average distance estimation error decreases as the distance increases. The Fig. 9 shows the comparative graph of actual distance and estimated distance in various mobile distance.

Fig. 8: BLE Distance violation alert in two Android devices

Table 3: Distance calculation on RSSI value

S. No.	Mobile Model	1m	2m	3m
1	Samsung S7	1.18	1.98	2.84
2	OnePlus 5	1.04	2.10	3.02
3	Honor Lite 9	1.5	2.19	3.21
4	Moto E Plus	0.98	1.86	2.78
5	Samsung S10	1.06	2.05	3.10

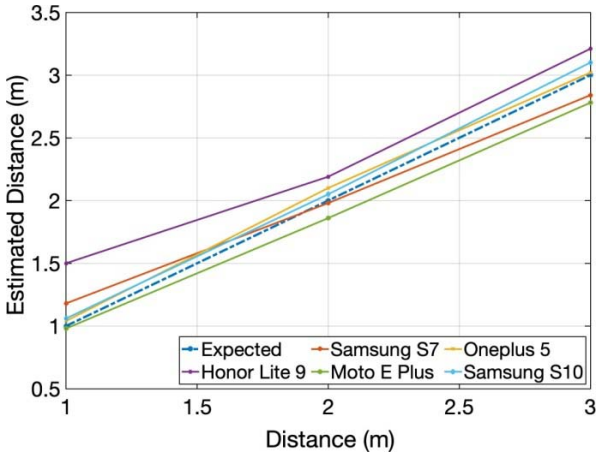

Fig. 9: Distance Measurement for Various Mobiles

V. Conclusion and Future Work

The paper presents two methods of monitoring social distancing for smart phone users. In camera surveillance method, pedestrian detection is implemented using deep learning algorithm and distance between two persons using euclidean formula. In Bluetooth distance calculation, calculated the real time distance by receiving its signal strength between two android devices. It is cost effective approach since this system is implemented in mobile app, people don't want to spend cost for other infrastructure for surveillance and monitoring. Developed this model in Android mobile, as a future work it will be extended in iOS environment as well for supporting iPhone users. As discussed, the smart phone camera are capable of covering only small distance, the first approach can be leveraged in all public surveillance camera for social distance monitoring.

Acknowledgments

The author would like to thank Tourenathan-G5organisation for downloading the transfer learning model from their Github link. The authors would also like to extend our thanks to Madras Institute of Technology campus, Chennai and their staff for their help and support in making this work possible during this pandemic situation.

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Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 20 Issue 2 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Dheergayu: Clinical Depression Monitoring Assistant

By Dias A.A.M.R, Kolamunna K.G.T.D, Fernando N.I.R & Pannala U.K

Abstract- Depression is identified as one of the most common mental health disorders in the world. Depression not only impacts the patient but also their families and relatives. If not properly treated, due to these reasons it leads people to hazardous situations. Nonetheless existing clinical diagnosis tools for monitoring illness trajectory are inadequate. Traditionally, psychiatrists use one to one interaction assessments to diagnose depression levels. However, these clinic-centered services can pose several operational challenges. In order to monitor clinical depressive disorders, patients are required to travel regularly to a clinical center within its limited operating hours. These procedures are highly resource intensive because they require skilled clinician and laboratories. To address these issues, we propose a personal and ubiquitous sensing technologies, such as fitness trackers and smartphones, which can monitor human vitals in an unobtrusive manner.

Index Terms: clinical depression, emotional health monitoring, facial features extraction, visual computing, machine learning, predictive model, heart rate variability, depressive sleep patterns, static facial features, dynamic facial features.

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Dheergayu: Clinical Depression Monitoring Assistant

Dias A.A.M.R[α], Kolamunna K.G.T.D[σ], Fernando N.I.R[ρ] & Pannala U.K[ω]

Abstract- Depression is identified as one of the most common mental health disorders in the world. Depression not only impacts the patient but also their families and relatives. If not properly treated, due to these reasons it leads people to hazardous situations. Nonetheless existing clinical diagnosis tools for monitoring illness trajectory are inadequate. Traditionally, psychiatrists use one to one interaction assessments to diagnose depression levels. However, these clinic- centered services can pose several operational challenges. In order to monitor clinical depressive disorders, patients are required to travel regularly to a clinical center within its limited operating hours. These procedures are highly resource intensive because they require skilled clinician and laboratories. To address these issues, we propose a personal and ubiquitous sensing technologies, such as fitness trackers and smartphones, which can monitor human vitals in an unobtrusive manner. Image processing and machine learning techniques have been used to analyze user contextual data such as heart rate and blood pressure variances, sleeping pattern variances and static and dynamic facial features. Each single component of this application has positive outcomes and good accuracy rates when comparing with current trending applications. Even underlying trained machine learning models used in this application have positive accuracy rates above 70%. By this proposed system we are planning to bridge the gap between high performance modern sensing technology devices and traditional mental health diagnosis steps into a new pre-emptive era.

Index Terms: clinical depression, emotional health monitoring, facial features extraction, visual computing, machine learning, predictive model, heart rate variability, depressive sleep patterns, static facial features, dynamic facial features.

I. Introduction

Depression can be identified as a significant medical disorder that affects more than 264 million people [1] every year all around the world. Depression goes unrecognized and untreated most of the time due to lack of knowledge in this area, and even the treatment starts, it is regularly hard to identify its visibility. Apart from that, the world health organization has mentioned that depression goes untreated due to the untrained medical officers and lack of resources. Due to the mentioned scenarios, it poses several challenges to diagnose and treat depressed patients. In previous studies, depression diagnosis is often based on subjective screening questionnaires or structured clinical interviews that rely on timely in-person visits as well as accurate recollections by the patient. This makes early detection of depression symptoms exceedingly difficult among this population. There are different types of depression categories identified [2],[3] in the world, but all those types share the same characteristics such as sleep variations, physical inactivity and mood swings. Apart from the detrimental effect on activities, it can lead to other problems such as reduced social interaction, drug abuse, a decrease of personal hygiene, increased alcohol use, and neglecting medicines [3]. Researchers have proved that people can use technology to manage their day to day tasks without any hassle [4]. At the same time people tend to use technical equipment to monitor their fitness activities. Due to that reason, we proposed implementing a comprehensive solution that will monitor depression using a fitness band and a mobile phone.

The rest of this paper is organized as follows. In section II, the Related work will be introduced. Then, System architecture will be discussed on Section III after that, the data analysis and methodology are explained in section IV. Section V contains the implementation results of the proposed system. Section VI concludes the research paper.

II. Related Work

This part of the literature study will review existing approaches about depression diagnosis. Traditionally psychiatrists are specialized to work in anxiety and depression disorders. It has mainly focused on subjective screening and laboratory-based approaches [5]. Recently there has been an advent of studies into cellular sensor networks and intelligent environments for remote monitoring applications. As a result, a significant portion of researchers have tried to develop mobile apps and social network behavioral patterns to diagnose affective conditions, such as emotion, social alienation and frustration.

In this section, in this section, we present relevant works that used to develop health data. The research of CARDIA [6], Fit flex [7] have used wrist-worn actigraphy monitors to collect sleep data. This model has facilitated to measure the sleep parameters of a depressive personnel. The Research of interactive virtual agent-based health care delivery network [8] of Sim Sei, was able to develop decision making support

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mechanism through an integrated system. A Reduced Region of Interest (ROI) based research on static facial emotions have used local binary patterns as the extraction technique [9]. The researchers were able to find out the significant six facial features. The heart rate variability research was able to introduce wearable equipment to detect depression based on cardiograph data. [10]

Compared to the existing work in mental health monitoring [8,9], "Dheergayu" is distinct in following features, Dheergayu proposes an integrated system for monitoring Depressive Disorders, and the solution centralized with enabling multi-health data capturing and analyzing models. The centralized model be able to sense and produce the severity level of depressive cases.

III. System Architecture

When designing "Dheergayu" we introduce an automated framework with two (2) distinct components. Fig. 1. Shows the component which executed on cloud-servers. The stated component requires a minimum t2.medium [11] Amazon Web Services (AWS) instance to operates its implemented services at optimal efficiency.

a) Dheergayu Cloud Deployed Services System

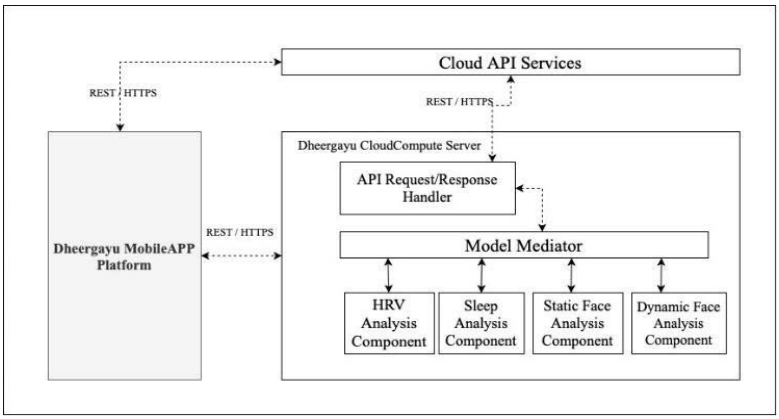

Fig. 1: High-level Architecture of Dheergayu Cloud Deployed Services

When designing Dheergayu Cloud services, we considered the possibility of scaling, availability and higher efficiency of designed architecture. By this implementation it is possible to deliver services for multiple stakeholders such as patients, caretakers and doctors. The designed architecture can communicate through API Request/Response Handler. Each of the data for core modules are accessed by developed Model Mediator. Each core module uses inhouse AWS Relational Database Services as a persistence layer. Under the methodology, will explain the procedure of each underlying component. Cloud API services deliver the Google Firebase Services, Google Secure Signing Authentications and Firestore Services to the entire system.

b) Dheergayu Mobile Application

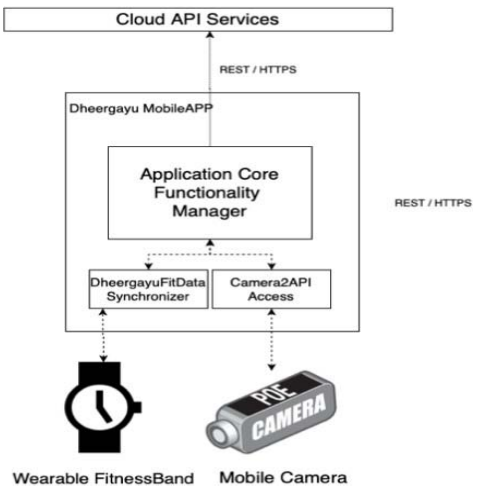

Fig. 2: Mobile Application Architecture with Data Capturing devices

As shown in Fig 2, "Dheergayu" Mobile application, delivers the native data capturing, data communication and it can act as mediator of patient and cloud services. The application provides Dheergayu Data Synchronization Module to synchronize the data. The patient data is cached into the application persistence and it will be synchronized into "Google Fit API" services by preconfigured user time intervals.

IV. Methodology

This project is about developing a clinical depression assistant which gives depression severity status based on Heart Rate Variability [12], Cyclic Alternation Pattern [13] and Random Eye Movement [14] of sleep, Static facial features [15] and Dynamic facial features [16] of a patient. The stated patient data access from the patient's fitness tracker and Camera of a smartphone via developed application. Under the methodology, reviews the analysis of each health data of a patient, to produce suggestions and further recommendations to improve decision making for caretakers and doctors. The goal of this project design is, assist patients in their difficult situations with the help of minimum user interactions.

a) Research Dataset

The availability of empirical data is of vital significance for the evaluation of the research problem. The used datasets are important for model creations and feature extractions. Due to the delicate existence of clinical records, the dataset distribution is neither large nor unrestricted. Under the research of depression analysis, we used the following data sources [17][18][19] [20][21].

Table 1: Datasets were used to Studies

Data set	Dataset meta information		
	Dataset Type	Dataset Size	Availability to third parties
[17]	Multi-site Prospective Cohort Study to Investigate Obstructive sleep Apnea (OSA) and depressive disorders 9736 PSGs	9736 PSGs	NO
[18]	Cyclic Alternating Patterns sets of depressive patients	108 PSGs	YES
[19]	Cyclic Alternating Patterns sets of depressive patients	212 PSGs	YES
[20]	Static facial expression dataset	35,817 pixel-based images	YES
[21]	Dynamic facial expression dataset	28,709 pixel-based images	YES

b) System Methodology

As shown in fig. 3 explains the workflow of depression analysis process. The outputs are aggregated into Overall Severity Signal. Stated outputs are probabilistic signals which are bundled with each classified outcome.

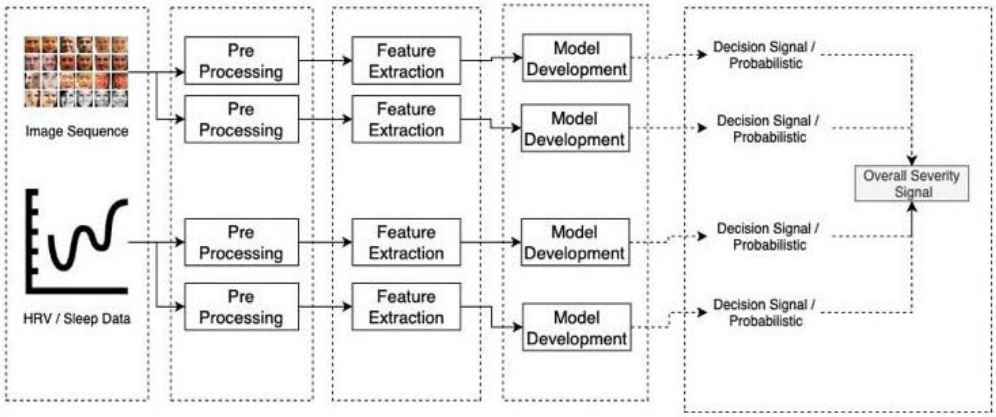

Fig. 3: High level data analyzing architecture

c) *Analysis of Dynamic Facial Features*

i. *Eye Blink Detectio*

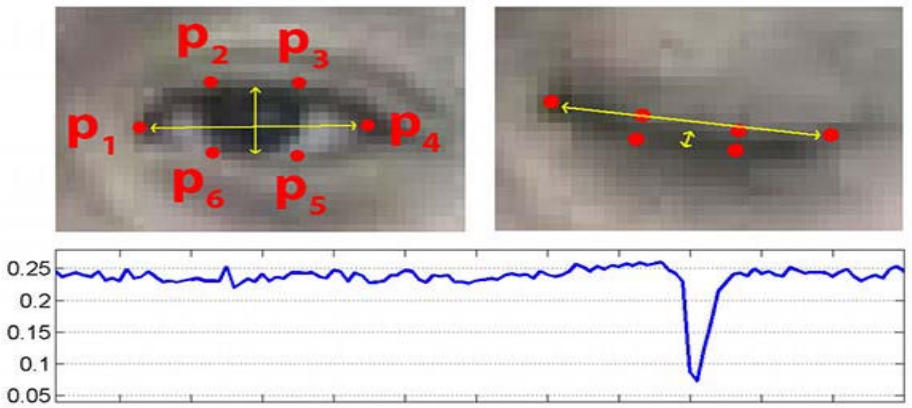

Fig. 4: Sample eye-blink capturing image, In respectively into p1-p6 facial coordinates

Eye aspect ratio concept which defined in the "Real-Time Eye Blink Detection using Facial Landmarks" research paper which based on the work by Soukupova and Cech [22] used to identify the blinks of the depressed person. As shown in Fig. 4 this feature only extracts the eye of the provided video and each eye is represented using six coordinates.

The EAR method used for this feature is mentioned below, EAR value is constant when the eye is open, but the value will drop to zero when a blink occurs. By using the landmark distance (1) this feature has ability to identify the blinks of the depressed person.

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|} \quad (1)$$

After identifying the blink count this feature should identify whether this blink count is normal or related to depression. According to [23] depressed people have a low blink rate. It has been reported that the normal spontaneous blink rate is between 12 and 15/min [24]. By getting these mentioned points this feature will generate a report that indicates the depression rate by using the blink rate.

d) *Analysis of Static Facial Features*

The development of facial image analyzing plays an important role in the face recognition field [25]. As well as the observation of facial emotions of a depression patient is provided huge support for decision making for the treatments by recognizing the depression level of the patient. This analysis of static facial images could give the early mentioned support in an effective way.

i. *Data Acquisition*

CK+48 facial emotion dataset [20] were used to model development. The stated dataset contains 981 facial expressions in 48x48 dimensions and are categorized to 7 emotions as anger, contempt, disgust, fear, happiness, sadness and surprise. In the Pre-processing stage translating facial images into grayscale images.

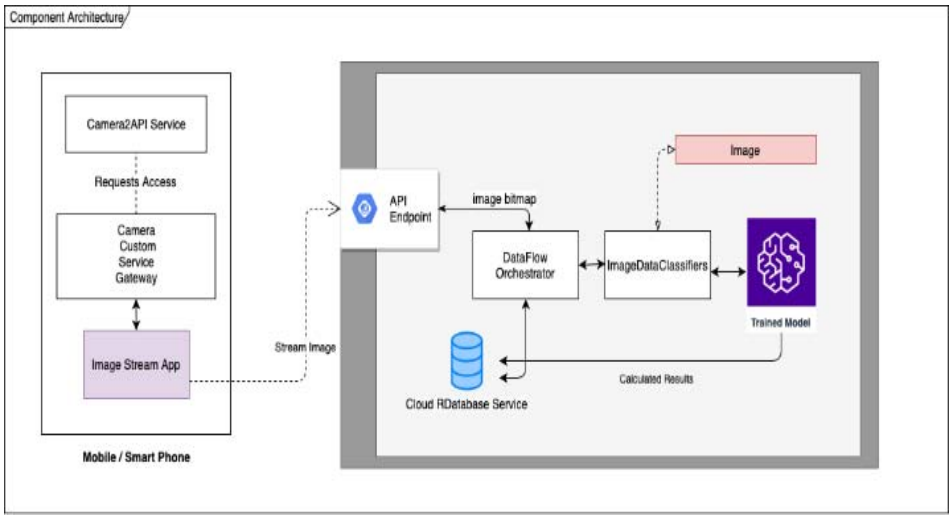

Fig. 5: The Workflow of Static Facial Feature Analysis

ii. *Face Recognition and Emotion Detection*

Face recognition and facial landmarks detection done by using the C++ library called Dlib [26]. Emotion detection is done with feeding coordinates data of those extracted facial landmarks that are vectorized to Support Vector Machines classifier called Support Vector Classification with linear kernel. It could get 88% accuracy of emotion detection through 10 runs.

iii. *Depresssion Analysis*

As shown in Fig. 5 we developed a Hidden Markov Model (HMM) based component to get the depression status of a patient using previous emotion data by setting initial values with the prior knowledge and HMM provides the depression level in a probabilistic way. Use of the previous status of the patient supports the creation of a network to identify the depression pattern.

e) Analysis of Heart Rate Variability

Under the research study of HRV model development following datasets [17], [18] were used. The datasets contained cardiograph data of 185 patients who had depressive disorders and 145 subjects were selected as control group (non-depressive disorders). Total 257 subjects were selected for model development. Data set contains attributes such as HRV, blood pressure, age, gender with 14 columns and 257 rows. In the data preprocessing stage, Principal Component Analysis used to manage the dataset more effectively.

In HRV detection, HRV is the physiological phenomenon of the variation in the time interval between consecutive heartbeats in milliseconds [27]. Using logistic regression model analysis, the HRV, based on the age, gender, blood pressure and HRV rate. Model used fitness band data for its predictions. Model provides 94% of accuracy of the training dataset. According to [28] depression patients have a lower HRV than normal people. and HRV depends on the age limit of the person. As shown in Fig. 6 the describes the performance of the evaluated model.

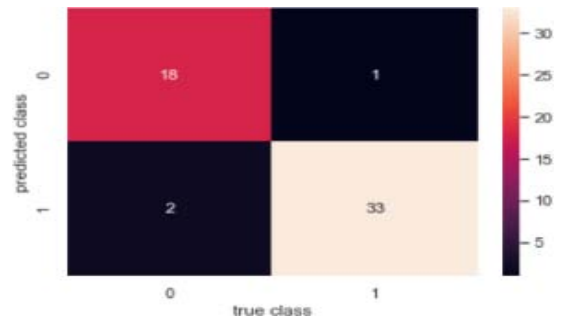

Fig. 6: confusion matrix of results

As shown in Fig. 7 diagram the analysis part model identifies the risk class and normal class based on the training data. Risk class has more probability to be a depression patient.

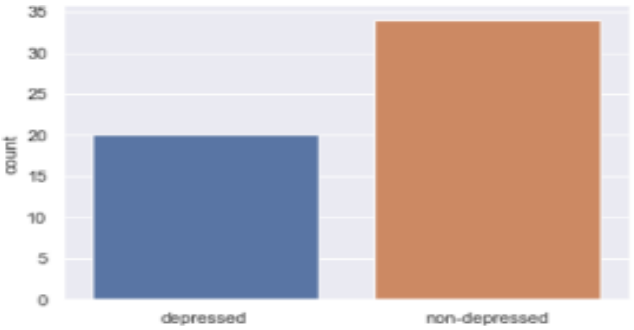

Fig. 7: Test Results outcomes

To add probabilistic outputs for logistic regression results were used Bayesian techniques (2).

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \quad (2)$$

This is the technique that used to provide the probabilistic result based on the historical predicted data. Analyzing historical data, "Dheergayu" can predict more accurate results based on the user data and history results.

f) Analysis of Depressive Sleep

i. *Data Acquisition*

Under the study, data [17][18][19] of the total 671 participants with evidence of having sleep disorders, 142 subjects were selected (Insomnia – 63, Obstructive Sleep Disorder – 36, normal controls - 43). The selected proportion has Sleep Obstructive Disorder (OSA) [29], Insomnia [30]. The subject's sleep was recorded from Electroencephalogram (EEG) channels, epochs of 30 seconds.

ii. *Data Preprocessing*

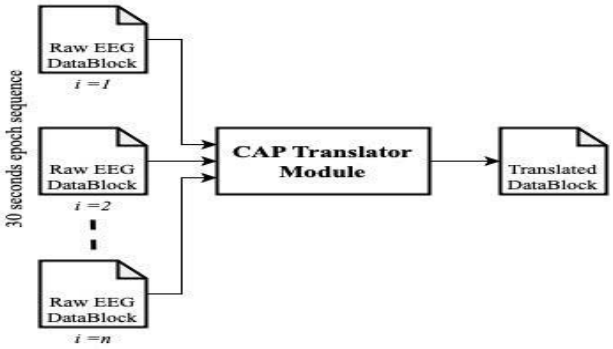

Fig. 8: Workflow of Raw EEG Translation process. The outputs are aggregated into a CAP data block

Initially raw EEG Data Blocks transferred into Cyclic Alternation Pattern (CAP) Translator Module (fig 8) of 30 epoch periods. First CAP Translator Module computes and generates datagram based on sleep event (See table II) of ith transmitted file.

Table 2: Summary of EEG Frequency Variance For Different Sleep Stages

Stage	EEG Frequency			
	Delta *(< 4Hz)*	Theta *(4 – 7 Hz)*	Alpha *(8 -13 Hz)*	Beta *(> 13Hz)*
AWAKE			x	x
S1		x	x	
S2		x		
S3	x			
REM		x	x	

iii. *Cyclic Alternation Pattern Model Development*

There are many specific physiological conditions correlated with sleep. Under the study, mainly focused on Cyclic Alternation of a Sleep and Random Eye Movement (REM) stages. The CAP is a periodic EEG translated datafile that was taken into model development.

As shown fig 9, The eight (8) procedures of data loading, discretization, base rule and optimized rule modeling, optimizations, evaluations with k-folds, Model Serialization and Deployment. The developed model is able to estimate depression states as 'Low',' Moderate' or 'High'.

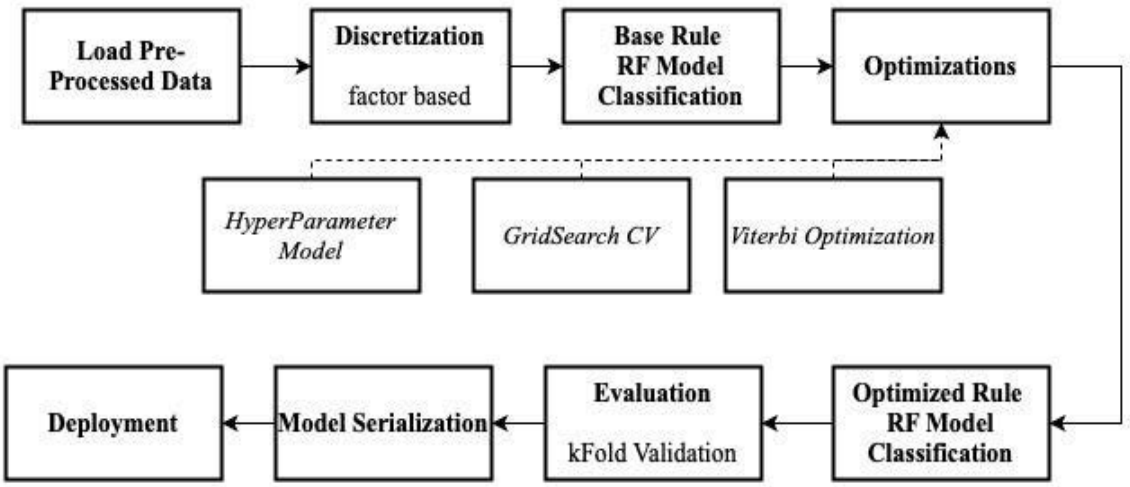

Fig. 9: Workflow of Depressive sleep classification model development

First, the loaded datagram contains, the records of Total Sleep Time (TST), Total Time in Bed (TIB), Sleep Efficiency (SE), The densities of each sleep stage (S1, S2, S3), REM Density (RD). The dataset is small, to eliminate unbalanced partitioning, model used discretization techniques to split data sets with prior, split factors. The discretization used depressive sleep type for further splitters.

In this sleep component analysis development, we used, Random Forest algorithm for classification. This model used discretization split for training and testing. After initial modeling, the Sleep analysis model uses three optimization techniques to improve accuracy of the algorithm. In the Grid SearchCV optimization, find the best possible ensemble learner with given Hyper parameter sets. In process k-fold validation used for compute accuracy of the optimized model. The given k value (any discrete number) and model with parameters λ can compute error in K^{th} as follows (3)

$$E_k(\lambda) = \Sigma\, i_{kth}\left(y_i - x_i\beta^k(\lambda)\right)^2 \qquad (3)$$

Following equation provide, total cross-validation error for all given k values (4)

$$CV(\lambda) = \frac{1}{K}\,\Sigma_{k=1}^{k} E_k(\lambda) \qquad (4)$$

V. Results and Outcomes

After performing the test phase, we found that there are significant differences between healthy and depression groups. At research beginning, the system accuracy will evaluate with modular based testing. Under the testing phase we used sixteen (16) real-world respondents for result evaluation. The system test was conducted with two scenarios.

a) Modular Based Testing

From the 16 respondents, 14 responses are selected into modular based testing. Under the testing process 2 cases are classified as positive cases (Clinically identified as having depression disorder), 2 participants of 16 eligible participants were dropped from the analysis because of missing data and anomalies.

Table 3: Summary of Modular Testing Result

Model	Component	depress	Non-depress	Avg. probability
Logistic Regression	HRV	2%	98%	0.88
Random Forest Classifier	Sleep	1%	99%	0.92
Support Vector Machine	Static Face	4%	96%	0.89
Keras sequential model (3 layers)	Dynamic Face	3%	97%	0.87

As shown as table III, the modules were tested on isolated environments to identify the base mark of each individual component. All the developed components have reached a success ratio of 0.82. All the testing dataset were not used to model development.

b) Mediator Based Testing

In Mediator Based testing approach, stress tested with developed mediator of cloud server. The mediator developed with ensemble learners. In the prediction analysis that focused on depression, 2 participants of 16 eligible participants were dropped from the analysis because of missing data and anomalies.

As shown in Table IV, tested with a 14% depression population.

Table 4: Overview of Testing Population

	Depress	Non-depress
Input data	2	12

As shown in Table V, the mediator was able to reach a 92% success ratio.

Table 5: Overview of Mediator-based Testing Result

	Depress	Non-depress	Average Probability
results	2	12	0.82

VI. Conclution

This research was carried out to identify the depression of clinically identified patients in a more accurate and efficient way with the help of machine learning and visual computing technologies that are widely used today. “Dheergayu” application, which is the outcome of this research, is fully equipped with four different features to monitor depression of a specific person. Most importantly this app will generate a report by using the outputs of all four features that will help the doctors to identify depression with different aspects. Face is one of the most important and versatile features when it comes to depression analyzing. Throughout the research “Dheergayu” team were able to identify different facial aspects of a person that can vary overtime due to the depression. “Dheergayu” application has the ability to capture videos and pictures of depressed people and get the outcome which is depression status by using the trained models and algorithms that are developed to monitor depression by using visual aspects of the face. Sleep and HRV are the other two features that “Dheergayu” team has identified during the research, which has a great impact and variance with depression. Application always communicates with the fitness band to collect sleep and HRV data of the person and it will be processed with the developed models and algorithms in a backend cloud server. Since these two features are using a smart watch, “Dheergayu” application has the capability to monitor live data in every movement.

Complete application is responsible for maintaining records that are generated by all four features and the novelty of this research is that there is no such solution to monitor depression with such a low-cost equipment and such features that are mentioned in the research paper. Since all the machine learning models and algorithms that are implemented in this solution has a higher accuracy, “Dheergayu” application can provide a comprehensive solution to the depression disorder.

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Global Journal of Computer Science and Technology: C
Software & Data Engineering
Volume 20 Issue 2 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Machine Learning Algorithm for Development of Enhanced Support Vector Machine Technique to Predict Stress

By T. Mohana Priya, Dr. M. Punithavalli & Dr. R. Rajesh Kanna
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Abstract- Stress is a common risk factor for many diseases. A correct and efficient prediction model is required to predict stress levels for targeted prevention and intervention in the personal healthcare domain. Before preventing the event of stress-related diseases, stress should be detected and managed early. However, surveys are used to evaluate an individual's stress condition with ease of measurement and requiring little time. However, anything that puts high demands on a person makes it stressful. This includes positive events such as getting married, buying a house, going to college, or receiving a promotion. Of course, not all stress is caused by external factors. Stress can also be internal or self-generated, when a person worries excessively about something that may or may not happen, or have irrational, pessimistic thoughts about life. This article aims to develop a predictive model to find the interruption of stress using an efficient way. One of the successive machine learning algorithm is SVM. This paper proposed to enhance the parameters of SVM which is used to improve the efficiency for predicting stress. This article proposed an Enhanced Support Vector Machine classifier to predict Stress. The stress dataset is downloaded from the Kaggle repository with 951 instances and 21 attributes.

Keywords: *stress, classification, SVM, KNN, machine learning.*

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Abstract- Stress is a common risk factor for many diseases. A correct and efficient prediction model is required to predict stress levels for targeted prevention and intervention in the personal healthcare domain. Before preventing the event of stress-related diseases, stress should be detected and managed early. However, surveys are used to evaluate an individual's stress condition with ease of measurement and requiring little time. However, anything that puts high demands on a person makes it stressful. This includes positive events such as getting married, buying a house, going to college, or receiving a promotion. Of course, not all stress is caused by external factors. Stress can also be internal or self-generated, when a person worries excessively about something that may or may not happen, or have irrational, pessimistic thoughts about life. This article aims to develop a predictive model to find the interruption of stress using an efficient way. One of the successive machine learning algorithm is SVM. This paper proposed to enhance the parameters of SVM which is used to improve the efficiency for predicting stress. This article proposed an Enhanced Support Vector Machine classifier to predict Stress. The stress dataset is downloaded from the Kaggle repository with 951 instances and 21 attributes. This research work takes the stress data on employee-related stress attributes.

Keywords: stress, classification, SVM, KNN, machine learning.

I. Introduction

Stress or depression may lead to mental disorders. Work pressure, working environment, traveling distance, height, weight, food habits, etc. are some of the major reasons behind building stress among the people. Many researchers had tried to predict stress interruption using machine learning techniques including Decision Tree, Naïve Bayes, Random Forest, KNN and SVM, etc.

The primary objective of the chapter is to develop an enhanced Support Vector Machine (SVM) classifier for Stress prediction.

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The research work of this article implements the machine learning algorithm for predicting whether a person is interrupted by stress or not. The implementation for the stress dataset has been developed by Enhanced Support Vector Machine, and its performance is compared with KNN and SVM.

II. Literature Study

The below table 1 shows that the performance of existing machine learning techniques[23] to predict the accuracy. The literature study was conducted by reviewing 23 articles which were published in reputed journals [1-23].

Table 1: Existing Machine Learning algorithms for Stress Dataset[1-23]

Classifier	Accuracy	Precision	Recall
Bayes Net	88.59%	0.824	0.834
Multilayer perceptron	85.43%	0.836	0.867
Naive Bayes	84.2105%	0.717	0.890
Logistic regression	84.9649%	0.824	0.838
J48	86.42%	0.871	0.879
Random Forest	83.333%	0.833	0.825

According to the existing study the highest accuracy is obtained by J48 (i.e) Decision Tree. So the proposed system concentrates on to develop a model which provides highest accuracy than the existing works.

III. Objectives

The primary objective of the chapter is to develop an enhanced Support Vector Machine (SVM) classifier for Stress prediction. Support Vector Machine is enhanced for this research by tuning its Hyperparameters. The Hyperparameter for SVM is its kernel function. This research uses the RBF kernel function, which is used as a way of computing the dot product of two vectors x and y in some (very high dimensional) feature space.

RBF is tuned with its parameters; "Gamma" and "C' complexity parameter. "Gamma" can be seen as the inverse of the radius of influence of samples selected by the model as support vectors. "C" parameter is used to increase the complexity level of "gamma". The accuracy level is increased when the RBF kernel is tuned with "Gamma" and "C" parameters. The concerns received from the existing study are resolved by the proposed research work(i.e) Enhanced SVM when using RBF kernel functions. Finally, the efficiency is measured by the performance obtained by the Enhanced SVM classifier.

IV. The Research Flow for Stress Prediction

Research framework involves the steps taken to implement SVM to predict Stress through the research. This section presents the Enhanced SVM methodology used by the research work (i.e) model to predict stress. The following Figure 6.1 shows that the methodology used in this research work. It has several steps.

The firststep is collecting the dataset. Dataset for this research work is downloaded from the Kaggle repository which contains 951 instances and 21 attributes.

The second step of the research, the dataset is applied for Data preprocessing which makes the data to be nominal values. This preprocessing work is done by using WEKA tool using by "Discretize" filter.

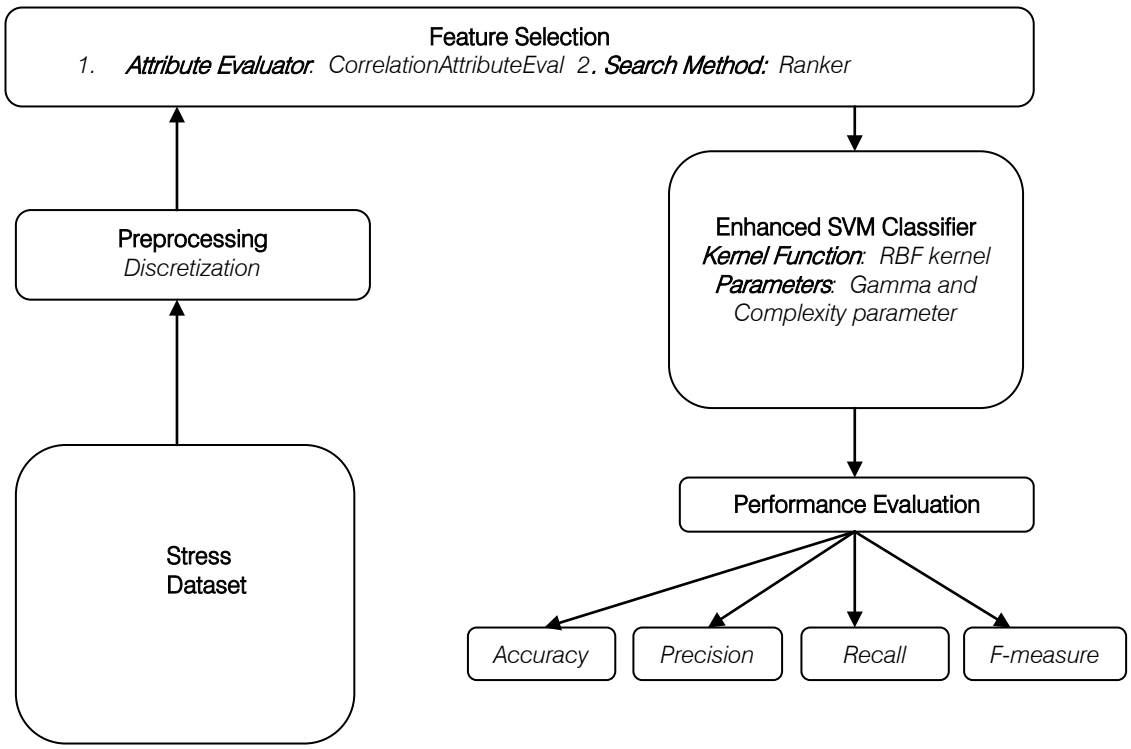

Figure 1: The Research flow for Stress Prediction

The third step is feature selection. In this step of the research is to select the subset of attributes based on certain conditions. This research uses "Correlate Attriburte Eval" from "Attribute Evaluator" and "Ranker" approach in "Search Method". At the end of this step, top ranking attributes are grouped into subset.

The fourth step is developing Enhanced SVM classifier to predict the Stress interruption. Existing SVM classifier is enhanced by tuning the RBF(Radial Basis Function) kernel function with its Hyperparameters. There are two parameters are tuned to increase the efficiency of RBF kernel function. 1. Gamma 2. C-Complexity parameter.After tuning these two parameters, SVM works efficiently than any other method performedto predict Stress interruption. After implementing the Enhanced SVM classifier, the expected output is either 'Yes-1' or 'No-0'.

Finally the performance is evaluated in terms of Accuracy, Precision, Recall and F-Measure with existing methodologies.

a) Data Collection

The data for the research is taken from Kaggle repository. The below table 6.3 shows that the list of attributes of Stress dataset. This Stress dataset contains 951 instances and 21 attributes. The below table 6.1 list out the name of attributes and the range of values for each attribute is given.

Table 2: Description of Stress Dataset

S.No.	Name of the Attribute	Values
1	ID	Number
2	Reason for absence	Disease
3	Month of absence	Jan -1 to Dec-12
4	Day of the week	Monday -2, Tuesday -3, Wednesday -4, Friday -5, Saturday -6
5	Seasons	Summer -1, Autumn-2, Winter -3, Spring -4
6	Transportation expense	In amount
7	Distance from Residence to Work	In Kilometers
8	Service time	In hours
9	Age	In Numbers
10	Work load Average/day	In hours
11	Hit target	Achieved-1 Not Achieved -0
12	Disciplinary failure	Yes -1, No-0
13	Education	School-1, Graduate -2, PG-3, DR-4
14	Son	Summer-1, Autumn -2, Winter -3, Spring -4
15	Social drinker	Yes-1, No-0
16	Social smoker	Yes-1, No-0
17	Pet	Number of pet
18	Weight	In Kilogram
19	Height	In Centimeters
20	Body mass index	In Kilogram
21	Stress Interruption	Yes-1, No-0

The above table 2 shows that the dataset which is related to Stress of working people. There are several reasons for the working people to be stressful.

b) Data Pre-Processing

The data set is pre-processed with a machine learning tool WEKA. In this step the data values are converted into nominal values. Dataset may contain numeric data but classifier handles only nominal values. In that case research needs to discretize the data, which can be done with the following filters:

weka.filters.supervised.attribute.Discretize

The "Discretize" filter is stored in the package "weka.filters.supervised.attribute". Here Weka is the root package for all other sub packages.

c) Feature Selection

In Machine Learning, feature selection also known as attribute selection or variable subset selection. It is the process of selecting a subset of relevant features for model construction. Feature selection techniques are used for the research is

Feature Selection involves two steps. In the first step "Attribute Evaluator" will be chosen. In the second step suitable "Search method" will be selected for "AttributeEvaluator" to select the highly relevant attributes from the dataset.

This research work uses the "Correlation Attribute Eval" approach in "Attribute Evaluator" to choose the relevant attributes for the subset. To find the relevant attributes for the subset generation "Ranker" method is chosen in the "Search Method" which gives a ranking for the correlated values.

```
=== Run information ===
Evaluator:    weka.attributeSelection.CorrelationAttributeEval
Search:       weka.attributeSelection.Ranker -P 3 -T -1.7976931348623157E308 -N -1
Relation:     Stress-weka.filters.unsupervised.attribute.Remove-R1
Instances:    951

Search Method:
        Attribute ranking.
        Ignored attributes: 03

Attribute Evaluator (supervised, Class (numeric): Stress in hours):
        Correlation Ranking Filter

Ranked  attributes:
 0.11376  13 Son
 0.06576          8 Age
 0.06507          14 Social drinker
 0.02758          5 Transportation expense
 0.0267   10 Hit target
 0.02475          9 Work load Average/day
 0.02435          6 Distance from Residence to Work
 0.01903          7 Service time
 0.01579          17 Weight
 0.0144   18 Height
-0.00561          4 Seasons
-0.00894          15 Social smoker
-0.02828          16 Pet
-0.04624          12 Education
-0.04972          19 Body mass index
-0.08836          2 Month of absence
-0.12425          11 Disciplinary failure
-0.17312          1 Reason for absence

Selected attributes: 18,13,8,14,5,10,9,2,7,17,4,15,16,12,19,6,11,1 : 18
```

Figure 2: Ranking for Attribute

An efficient machine learning technique required only top ranking i.e. dominant attributes for prediction of stress accurately. Because, the top ranking attributes are only highly relevant attributes for predicting the class. To choose the top ranking value, "Ranker" method is tuned with "Threshold" value.

Threshold value for ranking: In ranker "Threshold" is its property which takes number as values. Threshold value is used to select the subset of ranked attributes either from positive or negative by given its initial rank value. This research work uses threshold value is 0, which uses only positive ranked values for feature selection.

```
=== Attribute Selection on all input data ===
Search Method:
        Attribute ranking.
        Ignored attributes: 11
        Threshold for discarding attributes:   0
Attribute Evaluator (supervised, Class (numeric): Stress in hours):
        Correlation Ranking Filter
Ranked attributes:
 0.1138  13 Son
 0.0658   8 Age
 0.0651  14 Social drinker
 0.0276   5 Transportation expense
 0.0267  10 Hit target
 0.0247   9 Work load Average/day
 0.0243   6 Distance from Residence to Work
 0.019    7 Service time
 0.0158  17 Weight
0.0144  18 Height

Selected attributes: 18,13,8,14,5,10,9,2,7,17 : 10
```

Figure 3: Ranking Attributes after Threshold value

The above Figure 3 shows that the list of attribute in the subset after "Threshold" value is assigned to the "Ranker" method. Figure 6.2 shows that both positive and negative ranked values. To remove the negative values, set Threshold=0. It filters the attributes which are negatively ranked. Finally, out of 18 attributes from subset, only 10 attributes are chosen for new subset after applying "Threshold" value. After completion of feature selection, the new subset will be given as input for the proposed classifier, SVM.

V. Enhanced Support Vector Machine for Predicting Stress

This research work is carried out to enhance SVM features for the prediction of Stress interruption accurately. To reach the objective, SVM is enhanced with RBF (Radial Basis Function) kernel function and with tuning parameters of RBF.

This research uses the RBF kernel function to map the data. RBF kernel works by mapping the data to a higher dimensional feature space using an appropriate kernel function and a maximum margin is found for separating hyperplane in feature space [15].

The accuracy problem is usually represented by the proportion of correct classifications. A soft margin can be obtained in two different ways. It is important to add a constant factor to the kernel function output whenever the given input vectors are identical.

And, the magnitude of the constant factor to be added to the kernel or the bound size of the weights controls the number of training points that the system misclassifies. The setting of this parameter depends on the specific data at hand.

To completely specify the support vector machine it requires to specify two parameters; a) the kernel function and b)the magnitude of the penalty for violating the soft margin. Hence, to improve the accuracy of SVM, the RBF kernel function is applied in this research; this is the best criterion used for achieving better results. The next section discussed the procedure for Enhanced SVM methodology.

a) Enhanced SVM Algorithm

Algorithm 6.2 explains the necessary steps to be followed to improve the performance of Support Vector Machine.

Algorithm 1: Enhanced Support Vector Machine Algorithm for Stress prediction

Input: Initial Stress Dataset S={1,2,…n}

Ordered Stress dataset based on rank score R={ }

Enhanced SVM –to test values for number of top most ranking attributes with RBF kernel

Output: obtain and evaluate performance metrics such as Accuracy, Precision, Recall

Procedure:

Step 1: Collect Stress dataset S

Step 2: Pre-process the data using "Discretize"

Step 3: Select the subset of attributes using "CorrelationAttributeEval" and "Ranker" method

Step 4: Eliminate the minimum ranked attributes by using "Threshold". Set Threshold=0

Step 5: Update the subset after eliminating minimum ranked value.

Step 4: Implement the classifier Enhanced SVM on subset

Step 5: Tune the parameters of SVM

Step 5.1: Select RBF (Radial Basis Function) kernel function

Step 5.2: Use the "Gamma" parameter. Set "Gamma" =1

Step 5.3: Tune the "Gamma" by "C "Complexity parameter. Set C=0

Step 6: Evaluate the performance

Step 7: End

This article is proposed by applying the RBF kernel function with gamma factor and complexity factor C in Support Vector Machine algorithm. This parameter tuning helps to improve the efficiency of Support Vector Machine Algorithm in proposed work.

b) Kernel Function

Kernel functions are used to linearly or non-linearly map the input data to a high-dimensional space (feature space). The idea of the kernel function is to enable operations to be performed in the input space rather than the potentially high dimension feature space. Hence the inner product does not need to be evaluated in the feature space

This research work chooses RBF kernel function in SVM for searching values in feature space.

The RBF kernel on two samples x and x', represented as feature vectors in some *input space*, is defined as

$$K(\mathbf{x}, \mathbf{x}') = \exp\left(-\frac{\|\mathbf{x} - \mathbf{x}'\|^2}{2\sigma^2}\right)$$

where ||x−x′||2||x−x′||2 is the squared Euclidean distance between two data points x and x′. SVM classifier using an RBF kernel has two parameters: gamma and C.

c) Gamma Parameter

Gamma is a parameter of the RBF kernel and can be thought of as the 'spread' of the kernel and therefore the decision region. When gamma is low, the 'curve' of the decision boundary is very low and thus the decision region is very broad. When gamma is high, the 'curve' of the decision boundary is high, which creates islands of decision-boundaries around data points.

When Gamma = 0.01, low gamma like 0.01, the decision boundary is not very 'curvy', rather it is just one big sweeping arch. When Gamma = 1.0, the big difference in curve when increase the gamma to 1. Now the decision boundary is starting to better cover the spread of the data. So, the research chooses the best Gamma parameter is 1.0 after experimenting successive incremental of "Gamma" parameter.

d) C-Complexity Parameter

The C parameter in support vector machine trades off correct classification of training examples against maximization of the decision functions margin. The only thing will change by the C is the penalty for misclassification.

Larger value of C will be accepted and the decision function will be working better at classifying all training points correctly. Therefore, the complexity parameter is increased from 1 to 10 in this research work.

When C = 1, the classifier is clearly tolerant of misclassified data point. When C = 10, the classifier is highly tolerant of misclassified data point.

Table 3: Performance of Gamma and Complexity parameter in RBF kernel function

S. No.	Gamma value	Complexity parameter	Accuracy	Execution Time (in seconds)
1	2	10	92.76	0.98
2	1	10	96.33	0.33
3	0.9	10	91	0.30
4	0.07	10	90.1	0.28
5	0.05	10	88.19	0.21
6	0.01	10	82.13	0.17
7	0.01	1	62.01	0.16

From the above table 3, it is observed that the accuracy is increasing up to certain level of Gamma factor and Complexity parameter. The most dangerous and common effect of increasing gamma parameter is overfitting. The experiment starts from the Gamma =0.01 and the Complexity parameter C is not specified. But it is produced low accuracy and the time taken is also very low.

To increase the accuracy and also to choose misclassification values, the Complexity parameter C is applied as 10 after experimenting the C value in the research. The accuracy is 82% when "Gamma=0.01" and "C=10". It is better than when "C=0". So the research work decided to increase the "Gamma" factor for the constant "C" parameter. The highest accuracy (96%) is produced by enhanced SVM when Gamma = 1 and Complexity parameter =10.

This study also analyzed the performance of RBF Kernel with Polynomial and Linear Kernel functions by using Accuracy and Execution Time.

Table 4: Accuracy and Execution Time for Different Kernel functions

Kernel function	Accuracy (%)	Execution Time (in seconds)
RBF Kernel	96.33	0.33
Polynomial Kernel	91.69	0.71
Linear Kernel	85	0.323

It is observed from the above table 4 that SVM with RBF kernel performance is higher than that of the polynomial kernel and linear kernel in prediction of stress. The SVM with RBF kernel produced 96% accuracy compared to the polynomial kernel.

This section implemented the parameter tuning in Enhanced Support Vector Machine, and the efficiency will be measured by evaluating its performance with existing methodology SVM and KNN.

VI. Performance Evaluation

For experimental work, the open source Machine Learning tool WEKA is used.

The following metrics are used to evaluate the performance of proposed Machine Learning Algorithm which is discussed detail in Research Methodology.

$$\text{Accuracy} = TP+TN/\ TP+FP+TN+FN \quad \ldots 1$$

$$\text{Precision} = TP/\ TP+FP \quad \ldots 2$$

$$\text{Recall} = TP\ /\ TP+FN \quad \ldots 3$$

$$\text{F-Measure} = (2 * \text{Precision} * \text{Recall})\ /\ (\text{Precision} + \text{Recall}) \quad \ldots 4$$

VII. Result and Discussion

Various experiments are conducted with Stress datasets to evaluate the performance of the proposed Enhanced Support Vector Algorithm. To assess the performance of the proposed algorithm, the results are compared with the earlier studies results (i.e) SVM and KNN.

Table 5: Performance Evaluation of ML Techniques in Stress dataset

S.No.	Techniques	Accuracy	Precision	Recall
1	Enhanced SVM	96.33%	92.63%	90.26%
2	SVM	91.69%	89.96%	88.25%
3	KNN	90.78%	89.68%	87.21%

The above table 6.7 shows that the experiment results of Enhanced Support Vector Machine, KNN and SVM for stress dataset. From the above table, it is understood that the Enhanced Support Vector Machine yields very good accuracy (96%) than the existing KNN (91%) and SVM (92%) uses polynomial kernel. The highest accuracy of enhanced SVM is achieved by tuning the RBF Kernel function, Gamma Factor and increasing the Complexity parameter.

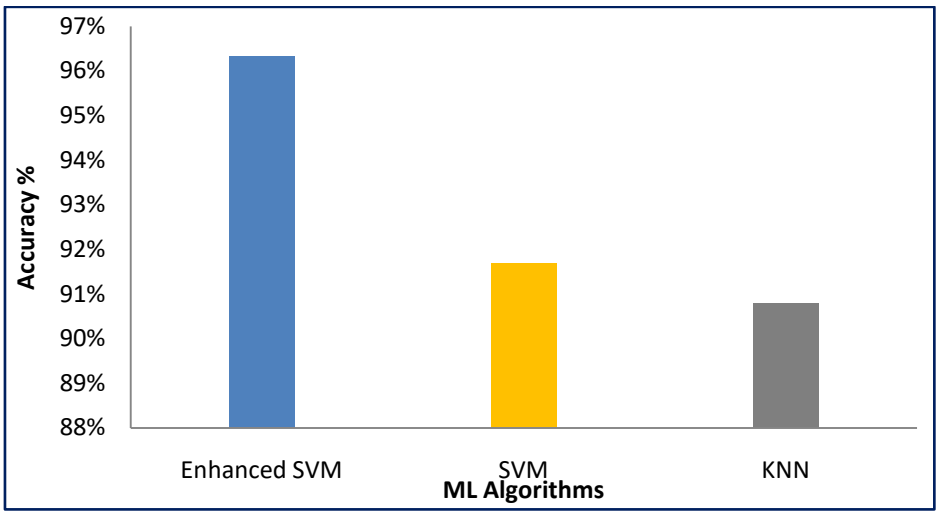

Figure 4: Accuracy vs ML Algorithms

Figure 4 shows that Accuracy vs Machine Learning algorithms in stress dataset. Proposed SVM algorithm achieves better accuracy 96% compared to other techniques like KNN(91%) and SVM (92%) in the Stress data set.

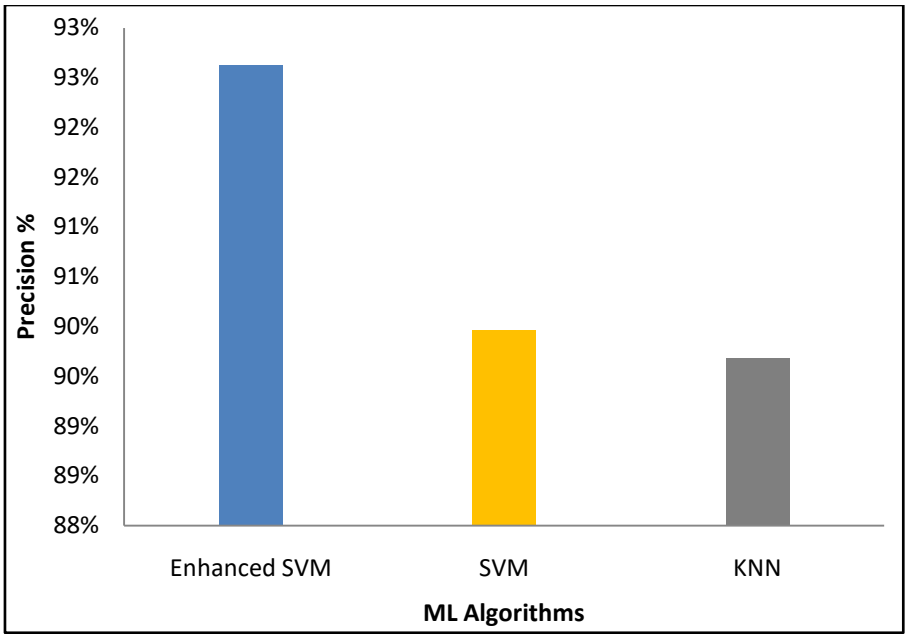

Figure 5: Comparison of Precision vs ML Algorithms

Figure 5 shows that precision rate in Enhanced SVM, KNN and SVM. Proposed SVM algorithm achieves better precision 93% which is higher than the other techniques KNN (90%) and SVM (90%) in the Stress data set.

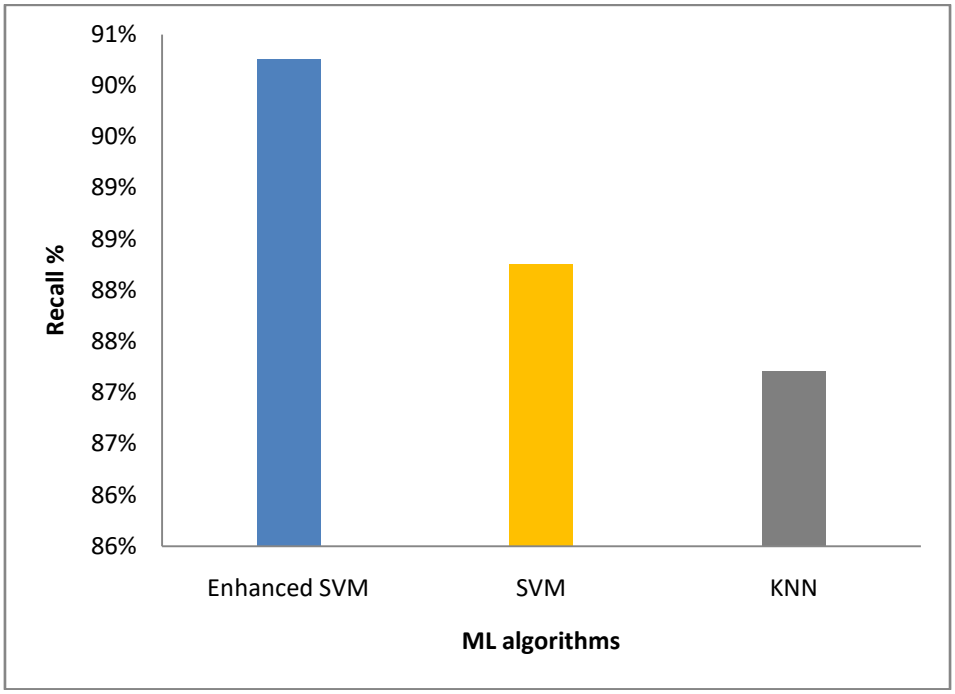

Figure 6: Comparison of Recall vs ML Algorithms

Figure 6 shows that comparison of recall rate in Machine Learning algorithms, Proposed SVM algorithm achieves better precision (i.e) 90% which is higher than KNN (87%) and SVM (88%) in the Stress data set.

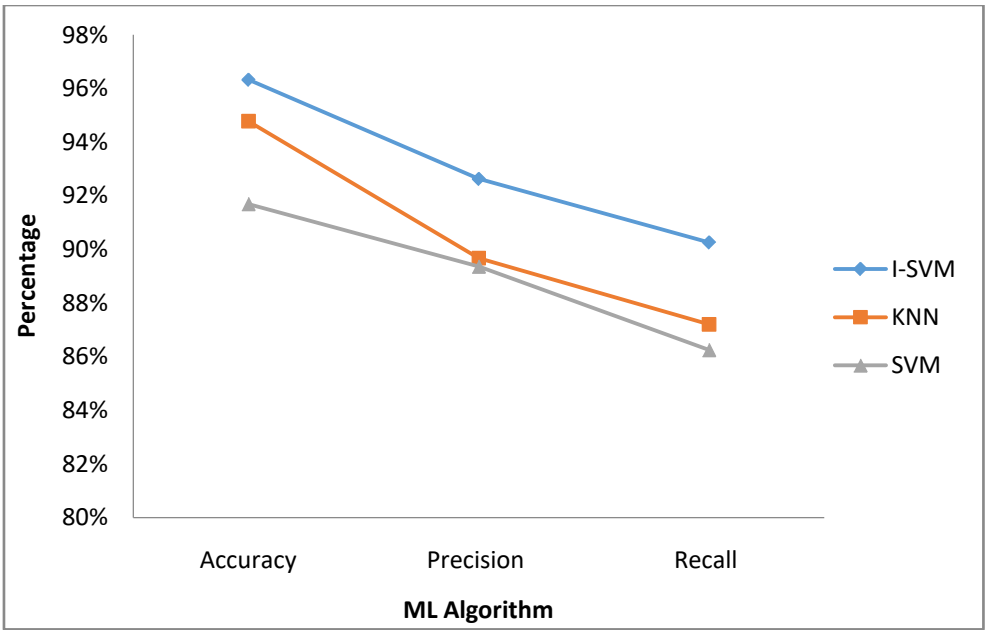

Figure 7: Comparison of Classifiers

Figure 7 summarized the comparison of all the performance metrics, which is used in stress dataset. Among the different category machine learning algorithms, Enhanced SVM produces better results when compared to exiting machine learning algorithms such as SVM and KNN.

VIII. Conclusion

In this research, an Enhanced SVM which improves the efficiency of the machine learning algorithm to prediction of Stress. The performance of enhanced SVM is compared with the existing SVM and KNN method. Those techniques are studied and evaluated using Stress dataset. It has been analyzed that tuning the RBF kernel with Gamma and Complexity parameter, Enhanced SVM can outperform than KNN and earlier works. Proposed SVM algorithm achieves better accuracy i.e. 96% when compared to other techniques like KNN(91%) and SVM (92%) in the Stress data set with minimum execution time. This research work also recommends that the significantly evaluated classifier Enhanced SVM can be used for real-time prediction of stress and early-stage heart failure can be avoided. However, more training data whether from hospitals or from domain-experts can be added for increasing the prediction performance of the classifiers.

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8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10.Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

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Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9754350