The Importance of Agile Technique in Comparison to Sequential Design Models

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Abstract: **Software development procedures are constantly evolving to monitor, evaluate the quality, reduction of money and time. Numerous organizations are migrating away from traditional business models toward agile methodologies. The purpose of this paper is to illustrate both Traditional and Agile software development approaches and the numerous techniques associated with them. This analysis conducted to investigates the two radically different ways of thinking about product development: Traditional methods and Agile approaches. The report is supported by several studies commissioned by various organizations to determine the transition from the traditional to the agile paradigm. The follow-up and data analysis explore the success and failure ratio of the projects accomplished using agile or traditional methods respectively which allow this research to arise the announcement of the popularity of agile techniques and importance of agile in product development over the last couple of years.**

I.   INTRODUCTION

Currently, the era of IT where operations are performed through software development stages. The revolutionized modules of the software domain enhance business growth by producing product-based solutions [1]. In the previous history of development, these modules were designed on a limited scoped frame called a project. The rapid growth in the software industry provides cost-effective strategies with product-based software services [2]. These software products can encompass the service-oriented architecture design, where the services of the system are provided to the other components of the application implicitly or explicitly. The development of the software system has undergone multiple methodologies [3]. These methodologies are sequential design processes or iterative design processes. The sequential or linear design processes like waterfall became the most known methodology from 1970 till 2005. The sequential models were used by most of the organizations because of having limited project scope, limited cost, and limited-time range [4]. But, with time and with the enhancement of innovative technology, the sequential models got failed due to having system testing in the last phase of the project [5]. Also, the response of the client is inspected at the last phase as well.

The issues that were identified in the linear design methods become the need of replacing the linear methodology with some advanced advent [6]. As the sequential design process linearly develops the whole system, the final milestone is delivered to the client [7]. In this case, the client is purely unaware of the system and its issues. The overall development of the system could be unsatisfactory for the consumer which may have the occurrence of project rejection or failure. On the other hand, one of the major factors of the project is bad quality or bad visibility [4]. Hence, the risk factor is high in the sequential design process because the client is not directly associated with the system development team and its stakeholders.

The solution that should be implemented is to discard the linear pattern of development and to apply the advanced methodology named 'Agile'. The agile methodology was launched in the earlier years of the 20th century. The agile methodology promotes the approach of iterative design pattern, which means each phase of development is undergone through concurrent inspection, testing, and verification by the client. After approval of the client about the current phase milestone, the next phase is started and this series of iteration goes on until the final product is developed with the acceptance of the user or client. It means

the agile methodology focuses on the requirements of the user about their end product with satisfactory results [8]. Although, the time, cost, and scope of the project may have slight variation due to the association of the client on each cycle of the project phase [9].

In this research, it has been analyze that 'why agile methodology has replaced the sequential methodology'. The research is based on the determination of project success and failure ratio in the software industries by implementing both approaches. This paper has been structured as follows: Section 2 is the Literature view, where the previous research related to the topic is going to be mapped for the better identification of project success factors. Section 3 observes the utility of the sequential data model in different projects. Section 4 caters to the usage of agile methodology in different products. Section 5 interprets the core research discussion on agile productivity in the present time vs. the traditional model. Finally, Section 6 concludes the outcomes of the research.

II.   LITERATURE REVIEW

The impact of agile development and other traditional methods in the software industry is one of the most popular topics discussed in thousands of published papers concerning the domain such as success, coding techniques and, teaming, and individual projects. Though, the collected works on different development processes have extensively diverse on the treatments and techniques utilized in the phenomenon of methods used in software organizations [10]. Subsequently, different studies and surveys on numerous papers determined that it is significantly necessary to work on quality in terms of product and Quantity software development projects to conquer enhanced understanding about the growth and progression of projects. How the implementation methodologies and strategies affect system development and why Agile is more likely to be considered than other heavy methodologies [11].

The main idea of writing this paper is to study the migration of traditional methods against agile. As Pratibha Singh and Puja Patel concluded the frequent utilization of agile testing methods and their tools in the software, Traditional evaluation, and assessment methods permit defect detection, emphasis on different types of artifacts, which cause time-consumption and comprise exclusive professionals accordingly. In traditional models, the outcome becomes frozen, and if the customer wants to add any changes it's hard to make further variations that increase the workload, cost and show an immoral impression on customers [12].

V-model comes under the Waterfall model which results in opacity between integration, testing of a system, and units. Overall, the traditional models do not permit much revision, Once the product is on testing isolation so due to its stiffness, hard to mold and redoing the changes, the outcome will always be blurred until completing its life cycle that produces a high risk, it is complex for object-oriented projects, and reduces the life of the product and not suitable for the products who may be restrained to the great threat of changing [1]. The development process uses different kinds of implementation methodology or strategy; the success of software highly depends on the right choice of strategy [13]. The decision is taken according to the nature and requirements of the software. The traditional methods include extracting details containing all functional and non-functional requirements to its visualization before it starts then the design and coding phase (the true implementation) takes place. With this practice, a lot of time and cost is consumed by these process that involves feasible study to software requirement specification that holds much documentation work as well [7].

Once a phase has been completed it cannot be easily remade or changed. It has less flexibility to make big changes in the work that has already taken place. In contrast, the methodology that allows more flexibility is agile, the requirements and functionalities can be changed even after the project starts. The agile methodology fits best in such projects where the requirements are not clearly defined in advance. That means jumping to the implementation of an unplanned product is no problem to deal with [2]. The incremental model is universally measured as the pioneer of any existing agile methodology. The spiral model is similar to an incremental approach which reduces the risk of the project, RAD state to Rapid Application Development is also an iterative approach, and its fundamentalist function is to reduce the increment of reusability of components, time, boost customer's review and feedback [14] The agile model ensures a quality product, basically considered as a superior version of the incremental model. Agile holds a variety of methodologies implemented in distinct specialist products, the most used methods of agile are Scrum, XP, TDD, and Agile Unified Process to be utilized correctly to benefit the organizations and provide ease to practice for the developer [3]. Thus, agile methodology provides fast testing due to its testing automation. Transparency predicted cost and time, allow changes, incremental approach on quality assessments during the making of the product, etc. Fauziah Baharom made a survey in Malaysia on the current practices of Software development processes and methodologies. The core purpose of the survey is to evaluate different processes used in the variant IT and a few non-IT industries. The results determine that most of the organizations are still accepting and using the waterfall model and 39.02% of the organization never used a spiral and object-oriented model [4].

In 2019, a paper was published in which the survey notified regarding the software processes accepted by the research

software teams, concluded that most of the software developers use and prefer Agile and Ad-hoc methods and the demand for waterfall model and spiral model has been rarely and less approached by the organizations [5]. According to a report, 80% of the organization prefers the agile process against heavyweight in terms of adopting new methods and technology because it is less costly parallel testing reduces the risks and the follow-up meetings with clients make it much easier and simpler for the developers to understand the requirements to release a working prototype to in the client in that scrum. Mostly small projects are done within multiple scrums with the team working altogether in it from coding to integration, testing, and validation with lesser cost and time, this concludes the statement that the majority approaching agile methodology are the Innovators. [6] We also see that most of the lightweight software is followed by agile development methodology while heavyweight software is still being developed by following the Waterfall methodology.

The above points were taken from multiple research papers to analyze the previous studies of traditional models with the comparison of Agile. Here is the comprehensive table to distinguish between traditional and agile methodologies [15].

TABLE I: TRADITIONAL VS. AGILE

Traditional Model	Agile Model
Formal Information transfer, hierarchical business/organization.	Informal transferring of information within the organization (regular communication among managers, employees, other departments).
Results are rarely or less frequently presented to the customer during the production.	Clients engaged in the product throughout the development phase.
Customer view expected after the delivery of the complete product.	Improvement suggestions and client's feedback are frequently obtained on the release of the product (usually monthly).
The customer's product receiving and feedback are taken at the end of the software advancement process.	Repeatedly releases (usually monthly)
No frequent involvement / cooperation with other departments of the company.	Frequently collaborate with other units to attain client vision and satisfaction.
It offers a shared burden. Dependent on the stage, members of the team focus	The burden on staff to show improvement in project development

on other features of their work.	(weekly, every two weeks, etc.)

III. UTILITY OF SEQUENTIAL DATA MODELS

The software developers and project managers intend to ensure the efficiency of the software product with the help of the utility of the software process models. The products and projects develop under certain conditions to fulfill the client's requirements [16]. Testing of a software product is one of the methods to find errors, the two techniques apply to the product to make it error-free are verification and validation. Software testing is one of the essential parts for improving the quality assurance of a software product; different companies concern different models to plan and produce a better product [17]. From the 19's to the early 20's the traditional techniques are used for testing and evaluating their products and projects such as the Spiral model, V-model, RAD model, and waterfall model [7][13].

A. WATERFALL MODEL

The waterfall model separates the phases and build a sequential relation between each phase, which means every phase is interdependent on another phase as if the first phase is not completed so the next phase is impossible to execute due to which it found difficulty in estimating time and cost for each phase in the process of development (see Fig 1). When the product is ready it is hard to make further changes by going back to the previous phases, but still, its usability is seen for a long because of its simplicity and understand-ability in terms of phases [8] [18].
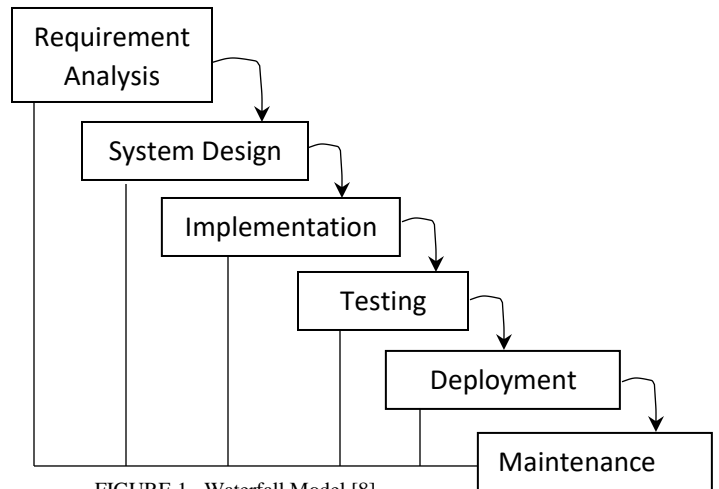

FIGURE 1. Waterfall Model [8]

B. V-MODEL

V-model is known as the variant of the waterfall model because it consists of the advanced features of the testing of

the waterfall model (see Fig 2). As the testing techniques are sequential, it is observed that there is a distinction between system testing, integration, and unit and they are not clear properly [19][20].
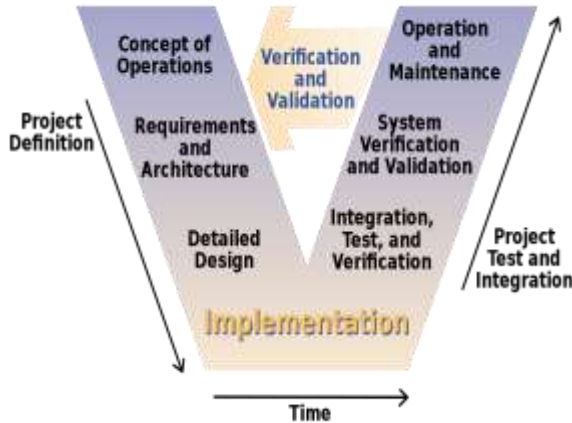

FIGURE 2. V-Model [19]

C. SPIRAL MODEL

The Spiral model has similar functionality as of iterative model, it monitors and measured the rapid processes of software development. It possesses four phases such as client communication, planning, analysis of risk, construct and release, client evaluation and these phases iterate repeatedly that's why it is called a spiral model. This model is used to minimize the risk of the product and project (see Fig. 3).
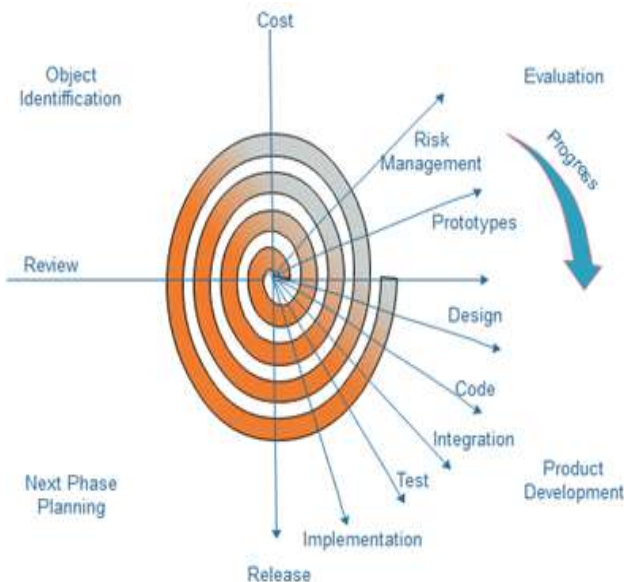

FIGURE 3. Spiral Models [20]

D. RAPID APPLICATION DEVELOPMENT

RAD focuses on the short development process cycle such as it emphasizes the reduction of the time utilized in the making of a product, increases the reusability of the components, initial reviews to occur quickly, and motivates the feedback of the clients. RAD intends the incremental software development approach. Table-I showing the usability of sequential frameworks in different years [20] (see Fig 4).

The traditional approaches and methods were associated and used by many organizations and companies for a long time and still, their need and usability are seen. Developers followed different traditional sequential data models in their variety of different products and projects based on their client demand. Table II summarizes [9], the popularity of the sequential model in terms of its usability in various projects in different eras. There are also other SDLC models on the headlight in a current situation such as Agile methodologies which are discussed in the next heading [10].
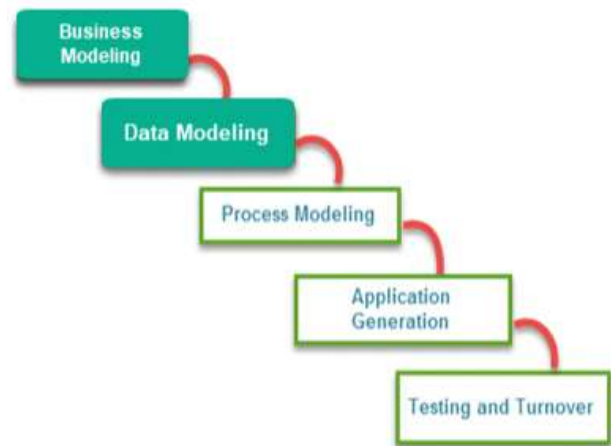

FIGURE 4. RAD Model [20]

The software developers and project managers intend to ensure the efficiency of the software product with the help of the utility of the software process models. The products and projects develop under certain conditions to fulfill the client's requirements [21]. Testing of a software product is one of the methods to find errors, the two techniques apply to the product to make it error-free are verification and validation. Software testing is one of the essential parts for improving the quality assurance of a software product; different companies concern different models to plan and produce a better product[22]. From the 19's to the early 20's the traditional techniques are used for testing and evaluating their products and projects such as the Spiral model, V-model, RAD model, and waterfall model [7].

Traditional Frameworks	Year	Product/ Project
Waterfall	(the early 1970s)	A large Energy Management System (EMS) for Southern California Edison
Spiral model	(2005)	UNIX-based, text-oriented, client-server Library Information System
V-model	(1991)	(INCOSE) satellite systems involving hardware, software, and human interaction
Waterfall	(the 1990s)	A large EMS system for Hong Kong Electric Company
V-model	(1982)	FAA Advanced Automation System (AAS) program
Waterfall	(1990s)	Tren Urbano, a heavy rail transportation system for San Juan Puerto Rico.
Spiral model	(2000s)	Gantt chart software-GanttPRO a tool for simple task handling.
Waterfall	(1990s)	A SCADA, AGC, and Water Housekeeping system for Statkraft Tokke Control Center.
V-model	(1992)	Defense technology.
Waterfall	(1980s)	A large EMS system for Florida Power and Light.
V-model	(2000s)	medical software
Waterfall	(Late 1980s)	A large EMS for Houston Light and Power.
V-model	(2000s)	Aviation fleet management software project.
Waterfall	(Early 2000s)	A large rail traffic control system for Canadian National Railway.
Spiral model	(2000s)	Evolution of Microsoft Windows operating system.

IV. THE UTILITY OF AGILE MODEL

Ever since the Agile Manifesto got introduced in 2001, a great number of organizations and software developers have taken part in introducing different techniques with relevance to the model[21] [23]. The various agile methods are Scrum, XP, pair programming, etc. [24]. In agile rather than following a single development lifecycle like that in the sequential development, it uses 'iterations' of development where client satisfaction is ensured. Each iteration or increment in the software comes as a feature and the final build will contain all the features that the client requires[25].

A. SCRUM

Scrum is one of the most commonly used agile frameworks. It utilizes the concept of iterative and progressive development. Scrum especially focuses on how to handle activities in a team-based production environment [11] (see Fig 5). It offers the simple basic principles framework for resolving problems and producing good results and faster software and applications that are useful. Scrum is based on the principles of continuous improvement, empiricism, and servant master, iterative, and incremental development [26].

FIGURE 5. Scrum Model.[27]

B. EXTREME PROGRAMMING

XP short for "Extreme programming" is another form of agile framework that encourages regular "releases and builds" in short development cycles. The objective is to maximize productivity and add checkpoints wherever new customers' specifications are adaptable[26]. The approach originally comes from the intent of taking the beneficial elements of conventional software development practices to "extreme" levels. Extreme Programming is a method in software development that facilitates professionals to more efficiently generate higher software quality. XP identifies phases of assessment, design, and deployment with new methods that make a significant impact on the final product value [12] (see Fig 6).
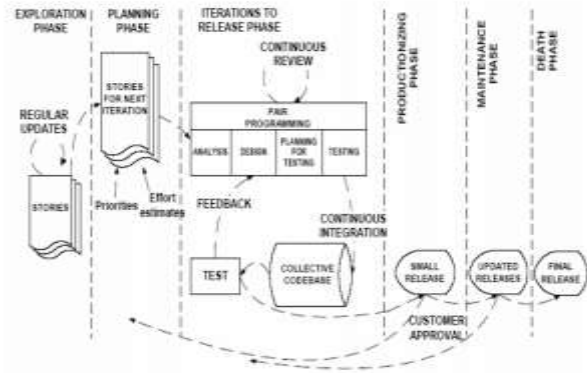
FIGURE 6. Extreme programming Model.[28]

The values of agile modeling are considered to be an extension of the 'Extreme programming' method. Most of the values of the AM are the same as XP however, its principles also include the multiple effective models, transparency between the client and developers, and knowledge for modeling [29]. It is a set of characteristics, practices, and values for software modeling that can be implemented efficiently and in a lightweight manner to a software project. Agile Modeling has been designed to adapt and use existing methodologies such as XP and RUP to enable professionals to create a software application that fulfills the client's expectations [13].

C. FEATURE DRIVEN DEVELOPMENT

The word feature in the name 'Feature Driven Development refers to the presentation of a small piece of useful functionality[30]. Feature Driven Development (FDD) is a model-based software development methodology aimed at regular, meaningful, and practical delivery Outcomes. It's an iterative procedure targeted at large teams assigned to the project [13] (see Fig 7).
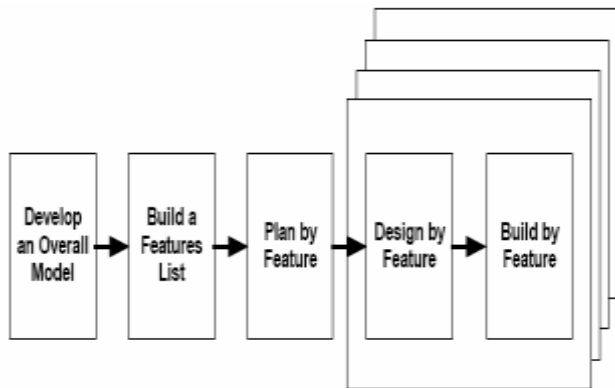

FIGURE 7. Feature Driven Development Model.[28]

D. KANBAN

Kanban means 'visual' or 'card' in Japanese and is a visual form of an agile framework. It is a method for managing the logistics chain from a manufacturing perspective, and it is not a structure for controlling inventories[31]. Taiichi Ohno, at Toyota, created Kanban to develop a method for improving and maintaining a high level of manufacturing. Kanban has been an important method in promoting the functioning of a production environment overall, and it has proven an ingenious practice that encourages change[32][33](see Fig 8 and Table-III).
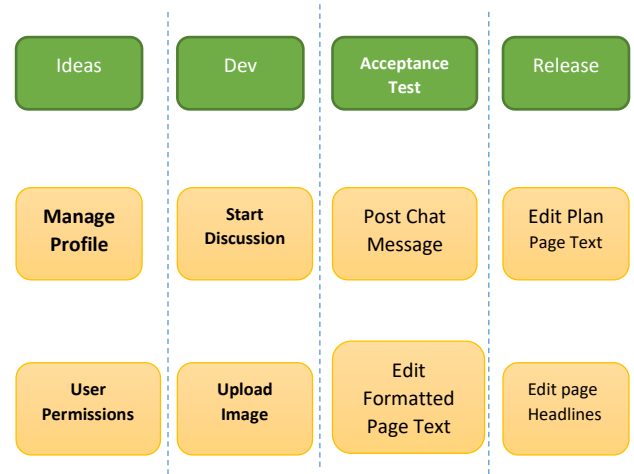

FIGURE 8. Kanban Model.[34]

TABLE III

USAGE OF AGILE MODELS IN PROJECT/PRODUCT

Agile Frameworks	Year	Product/ Project
Scrum	2019	A holistic game named The New Product Development Game has been a great example of scrum it has six autonomous features and characteristics i.e. built-in instability, a project team with self-organizing, development overloaded phases, multi-learning, control of subtle, and transferring of organizational learning.
Extreme Programming (XP)	2016	In XP programming the team size should be lesser than 5 people because of having tiny groups. It is quite confidential and the hardest industrial action.
Feature-Driven Development (FDD)	2018	The FDD model is widely used as process orient and centric client development that highly motivates designing and developing features o software systems. It mainly follows the pattern of ETVX.
Kanban	2019	The Kanban controls the production -between forms to analyze Just-In-Time (JIT). It is producing in fabricating Toyota projects in Japan.

V.   RESEARCH DISCUSSION

This section of our research has a clear and propagated view of the current findings of agile methodologies. As we all have prior knowledge about the frameworks, they initiate years and services of them. These methodologies have been used worldwide with the dependency on domain utilization. The finding that has been conducted was identified with a few interrogations through a formal method. In this region of Karachi, Pakistan, there are more than a thousand software companies that are providing their best solutions and services based on integration and development techniques[35]. Therefore, the questionnaires were designed to acknowledge the experience in this Karachi region. There were various questions were asked about development experience, utilization of agile, the framework of agile, and the number of projects that are being executed with the agile facilities. The following are the graphical data that represents the ratio of agile findings with the help of bar charts and graphs.

A.   ADOPTION OF AGILE IN INDUSTRIES

Figure 9 is addressing the percentage of agile that is being followed by software organizations.
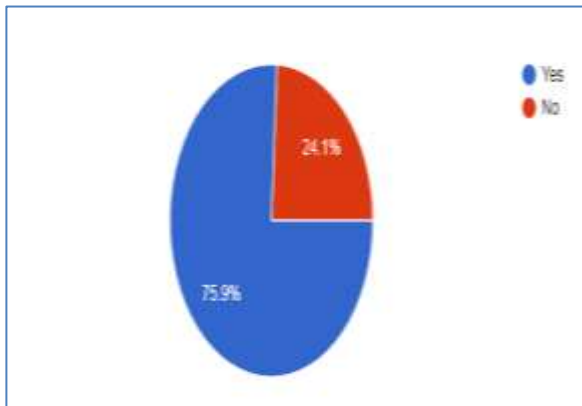

FIGURE 9. Agile vs. Traditional Methods

The red marked area i.e., 24.1% is showing the negative value and the rest of the blue marked i.e., 75.9% is showing the positive indication that agile is used in more than 75% of organizations in the region. If more than 2:3 industries are following the agile frameworks then it could be concluded easily that agile is providing flexible work solutions with the advent of time, cost, and budget. Hence, the implication of agile as compared with the sequential design model is applied over this graph. The traditional models have been eliminated in the majority of industries and the product-based organization has been shifted to agile implications.

B.   ADOPTION OF AGILE FRAMEWORK

The graph (Fig. 10) is representing the different frameworks of agile (which are also described in the above sections as well). These numerous frameworks of agile provide better compatible results based on product requirements. The most well-known agile frameworks have been listed in the survey question and then the most commonly used framework i.e. Scrum occupied the major area among all. Scrum is the best known for managing team-related activities into sprints and these sprints help in serving the project iterations in a continuous iterative flow. Therefore, scrum is widely used as an agile framework to manage rapid actions and changes.
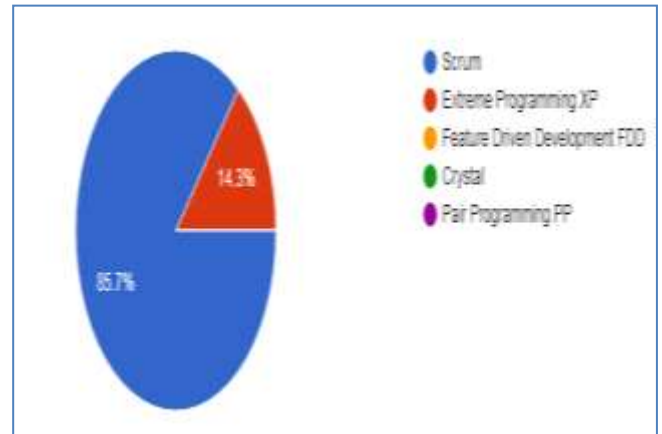

FIGURE 10. Agile frameworks

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C.   ORGANIZATIONS WHO ADOPT AGILE TECHNIQUE

In fig 11 the data analytical graph reveals the adoption level of agile methodology among different organizations, rousing the trendiness of agile methodology [36]. It indicates the number of organizations and their usability of agile techniques in their products respectively, the survey illustrates the popularity of agility by comprising 20 different companies and taking view of their thoughts and approaches towards agile techniques. Here 11 companies with their usability ratio have been scaled above which convinced the efficiency of agile methodology in the

software development cycle. The rating is measured from (0 to 3) and their percent values have been extracted to see the involvement of the agile process in the individual organizations.
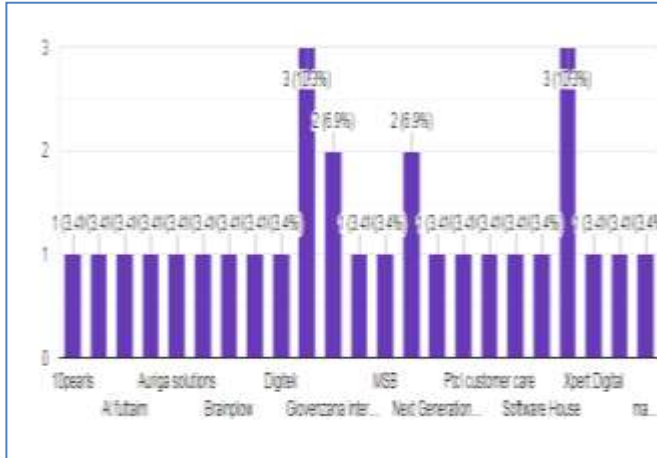

FIGURE 11. Acceptance of agile frameworks

D. NUMBER OF PROJECTIONS ON AGILE

The graph describes the acceptance of the agile process in the advancement of products, the number of projects that have been made under the shade of agile techniques are identified by this statistic (see Fig. 11).
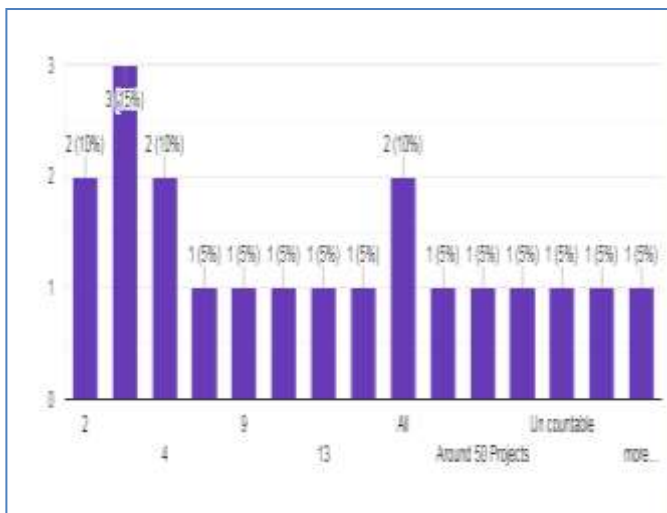

FIGURE 12. Agile Frameworks in projects

Therefore, it is observed that none of the organizations refuses the involvement of agility in their product development. In the current time, every organization has experienced the usage of the agile process and tasted the flavor of success in terms of customer satisfaction, avoidance from rework, time management (see Fig. 12).

VI.   CONCLUSION

In 20th century the development of agile methodology has been increased widely and discarded the approaches of sequential design processes. As the growth of the industry is being scaled up to productive-based projects and the advancements in the software industry need a directed path for managing and controlling project activities through a rigid plan. Therefore, the agile methodology comes in the context of software products to ensure productivity within a life cycle of a project under the acceptance of the project sponsor. The comparison of agile and sequential design models highlights the flaws of sequential models and the benefits of agile methodology. This approach is not only followed in the western world but also adopted in the Asian culture as well. A survey of agile usage has been performed in the region of Karachi, Pakistan. It has views of more than 20 software companies that are currently following the principles of agile on their products with beneficial outcomes.

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