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Applying Agile Principles and Methods in Industries Outside IT Landscape: A Systematic Literature Review

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Agile methods have become increasingly popular in various industries because of many benefits over the common waterfall like methodologies. Whereas, there are still many issues and uncertainties faced by co-workers, or those who want to use a flexible approach within a controlled environment. These challenges need to be identified and need to be addressed. In this research, we conducted a systematic literature review to identify challenges perceived by practitioners during their working or adopting agile methodologies. We developed and followed a Systematic Literature Review (SLR) approach for searching agile related studies to extract different challenges. In this research, we divided the SLR into three categories, which was further divided into sub-categories. After searching the related articles using SLR, we present our findings on the challenges of implementing agile methodologies in various type of organizations. This study found the generic agile challenges that can faced by any organization by adopting agile principles. These generic challenges are related to some areas such as managerial, communication, product development, and cultural domains. These challenges can relate to both with-in and outside organizations. We discussed these challenges in detail. To conclude this research, we determined that agile has strong potential to be followed by any organization. This proposed study analyzed that agile has challenges of its modification for other organizations, but these challenges can be solved and agile can be used as effective technique by most of the companies.

Keywords: Agile, IT, Systematic Literature Review, Industries.

Introduction:

The agile methodology was proposed in 2001 for providing a new development framework in the Information Technology (IT) sector [1]. It is based on incremental development and it confers the possibility of dividing whole project into several phases. There are four basic rules that are followed in agile methodologies [2] that include 1) the agile methodologies concentrate on individuals and interactions rather than focusing on the procedures and tools 2) the agile methodologies prefer working of the software over the documentation of the software 3) the customer feedback is more concerned than the negotiations performed in the agreement and 4) the changing requirements are handled in agile methodologies instead of depending on pre-defined requirements.

In recent times, the Agile Management (AM) has become an alternative to the Traditional Management (TM). The TM focus on developing the whole product simultaneously based on the waterfall model. The waterfall model is executed according to the planning and it cannot be iterated as agile model [3]. There is high risk factor is involved in waterfall model, whereas the agile model has certain risk in every iteration which can be minimized by changing product features according to the changing customer requirements.

The agile model is an iterative approach in which the requirements can be modified in accordance with the feedback of the customer. Agile methodologies are useful for the companies which are not sure about their end product requirements. The software industry widely uses agile model by developing a prototype and then improving that prototype on the feedback of customer. Some of the software companies use combination of agile models for developing a better product. Scrum models and extreme programming are examples of agile methodologies that are used by software industries on the small scale for developing multiple software.

The success rate of agile in software development has influenced other industries to take interest in these methodologies. These industries are overwhelmed by the benefits of agile and they have started adopting agile methodologies to overcome the several modern issues such as short time to market, low budget, quality of product and adaptability in customer requirements.

The challenges in most of the industries are evolving rapidly such as fast-growing industries, customer engagement, decision-making and time-consuming strategies to satisfy customers. These industries strive to bring agility in their organization to a level of performance to meet all these challenges in the best possible way. Moreover, the IT industry has successfully adapted these agile principles and overcome several challenges. The other industries should also transform to the agile principles to overcome these modern challenges.

The problem that arises during implementation of agile methodologies in other industries than IT is to modify these methodologies according to the industry requirements. The multiple organizations may not be able to adapt the same agile methods because of changing product and environment. Also, most of the agile methods work best for small projects and organizations but not scalable for others.

This research introduces a groundbreaking approach to systematic literature reviews, revolutionizing their methodology for increased effectiveness. The empirical review of agile practices across diverse industries contributes novel insights into their applications. Furthermore, the investigation into challenges faced when implementing agile outside the traditional IT context provides a unique perspective. The paper's novelty lies in its comprehensive analysis of challenges inherent in previous agile practices and the proposal of innovative solutions drawn from the existing literature, marking a significant advancement in the understanding and evolution of agile methodologies.

Implication of the Study:

The contributions described in the paper have a wide range of consequences for both theoretical and applied research. First of all, the development of a new approach to systematic

literature reviews represents a methodological breakthrough that will improve the efficiency and rigor of future studies conducted in a variety of fields. By using this creative strategy, researchers can produce more thorough and perceptive literature reviews. Second, practitioners and decision-makers can learn a lot from the empirical review study on agile approaches across industries. Using this empirical knowledge, organizations may maximize the adoption and application of agile approaches, customizing them to fit particular industry contexts for increased efficacy and efficiency. The comprehensive examination of the literature on the difficulties encountered when implementing agile outside of the typical IT area has application for companies looking to adopt agile approaches outside of the IT industry. By recognizing and comprehending these issues, focused solutions can be developed to address the challenges of implementing agile in a variety of organizational settings. This process also facilitates strategic planning and well-informed decision-making. Furthermore, the path for improvement inside agile frameworks is provided by emphasizing the problems with previous agile methods and suggesting alternatives based on the literature. These insights can be used by practitioners and organizations to better their agile methods, encouraging ongoing development and providing evidence-based remedies for problems from the past. In conclusion, these contributions have ramifications that go beyond the scholarly sphere and offer helpful advice to practitioners, researchers, and organizations alike. The paper's ideas help improve systematic literature reviews, agile techniques, and their application in a variety of industries. These developments are still ongoing.

This research study aims to conduct a comprehensive analysis of previous studies regarding the implementation of agile methodologies outside the realm of IT. By undertaking a systematic literature review, we intend to identify the challenges encountered and explore potential solutions associated with implementing agile practices in non-IT domains. The major contributions of this research study are as follows:

- A novel strategy for performing any systematic literature review.
- An empirical review study of the agile practices that are performed in various industries.
- A systematic literature review of the challenges that are usually faced while implementing the agile outside IT.
- Highlight the challenges in former agile practices and solutions to overcome those challenges from the literature.

The remaining manuscript is organized as follow. Section 2 will encompass a literature review. Next, the Systematic Literature Review (SLR) methodology that will be discussed in section 3, while section 4 will delve into the exploration and analysis of our findings, and finally concluding the study in section 5.

Literature Review:

Generic Agile Review:

The agile manifesto was introduced in 2001 by seventeen professionals of different software development models [2]. These professionals gathered in a meeting to find some common understanding for software development, and outcome of this meeting was an agile manifesto. Some of the main factors of this agile manifesto include customer involvement in development process, management of changing requirements, interaction of project team, and incremental development of software.

In early days of agile, there were several issues for the organizations while shifting toward agile software development. The issues were highlighted in [4], and this study also explained the advantages and opportunities that are created by adopting agile development. This research proposed the use of agile methods in highly fluctuating tasks projects and also in development of quality-oriented products. The organizations should evaluate their suitability before taking the initiative of shifting towards agile software development [5].

Researchers performed empirical study in [6] to understand the challenges and opportunities of adopting agile development model in an organization. This research study was performed in large software organization where several teams work on their respective projects. It becomes difficult to implement a new development model in such large organizations. Therefore, this study highlighted the issues and success factors regarding implementation of agile in large companies.

In [7], another transformation model was proposed to shift large organizations towards agile software development. The researcher performed literature review by analyzing 85 research papers, and provided a list of tasks that should be executed for adopting agile model. Therefore, the researcher suggested an agile model, which included all these tasks that can contribute for the successful transformation of agile model.

The study in [8] discussed the modern scaling challenges in agile development. The large companies face more issues in adopting a new development model rather than small-scale companies. A systematic literature review was performed, in which 76 research papers were reviewed for applying agile in large-scale organizations. This study determined several issues which were classified into six main groups. These categories are comprised of client challenges, project team challenges, agile related challenges, administrative challenges, product challenges and organizational challenges. This research also identified several advantages of adopting agile methodology. Team, project and business were the main categories of advantages of agile methodology. This study found the dependency of advantages and challenges of agile on each other. The future aspects of this research showed that the relationship of agile challenges and advantages can be further investigated using a case study approach.

Agile Review Outside IT:

Nowadays, the organizations of different fields other than IT have started adopting agile for the development and management processes [9][10][11][12][13][14][15][16][17]. The hardware development is consisted of different phases, which usually follows the classical development model, in which phases are connected and irreversible. The risk factor is always high in such type of development. For example, the decline of product may result into heavy cost of redesigning product. In [9], researcher proposed an agile model for the development of hardware products, which have software installed in it. This proposed model is a combined model involving both hardware and software development. There are always created separate teams that works for the hardware and software development of product. The combined agile method can provide the opportunity of interaction of teams and sharing of knowledge between the teams. This interaction and shared knowledge facilitate during the testing of the products [9].

In [10], study is performed to evaluate the importance of agile methodology in field of hardware development. This study concentrated on understanding the change in agile approaches depending upon time and domain factors. There are two separate case studies analyzed in this work. Both of the case studies are related to developing physical products. The first case study revealed the various advantages of agile in terms of intangible factors such as clarity, dedication, and communication The study in [18] determined the various challenges that need to be faced while applying agile in hardware development. The main objective of this research was to highlight the issues of applying agile for the development of physical products. The researcher demonstrated the advantages and issues of applying agile methodology in UVCA [19] environments. This research study analyzed several project and updated case studies to evaluate agile methods, with the help of experts of industry and academia. It was found that agile approach was not properly implemented in developing physical products, because the agile concept was basically introduced for software development. The changing requirements and other advancements have made former methods ineffective, therefore the need of agile in

hardware development has become imminent. The study proposed to reconsider the agile approaches and made possible changes in methods to make more effective for hardware development [18].

The necessity of agile has become more inevitable in construction industry due to rapid change in process, expectations and requirements of the clients. There are different research studies that has been performed to evaluate agile for the construction industry. In [20], the agile approach was explored for execution in the construction industry. This research conducted a case study using a questionnaire technique. The researcher asked several questions to the professional of construction industry. The professional responded to these questions in their own way, and this study was concluded on the basis of findings from the professionals. In [21], the researchers performed a case study to determine that whether agile approach can be implemented in the construction industry. They conducted the interviews of several stakeholders of construction industry and performed a SWOT analysis for transformation of construction industry to the agile approach. The researchers prepared a questionnaire and then used survey technique to gather data form the stakeholder. This analysis found that mostly stakeholders were aware of the agile approach, but still there is need of building trust and cooperation between the stakeholders.

In recent times, there are several agile transformations that has been proposed for the healthcare organizations. The study in [22] summarizes various factors and practices that can assist during the agile transformation for a healthcare system. The researcher explored the compatibility and effectiveness of agile processes for healthcare organizations in [23], the researchers performed the literature review to analyze agile model in the healthcare. The definitions of various factors are examined in terms of agile healthcare. The study found agile as an effective approach in healthcare because of changing requirements of the stakeholders and customers. The understanding of agile is necessary to make it scalable for the healthcare organizations.

SLR Methodology:

The main purpose of SLR is to find the previous researches on a specific research topic or question and to use various techniques to analyze the data, and discuss results on the basis of the analyzed data [24]. The SLR methodology is divided into three main categories i.e., planning, implementation and reporting as given in fig 1. These categories are discussed in detail along with their sub-categories in the subsequent section.

Planning:

The planning of SLR is related to identifying the problem of the proposed research study and developing review protocol for the research study. The detail discussion is performed about the problem statement and possible aspects of the study are analyzed at this stage of SLR. We divided the planning of SLR is divided into three sub-categories i.e., purpose of the systematic literature review, developing the review protocol, and validating the review protocol. The details of these sub-categories are discussed as follow.

Purpose of SLR:

The problem statement is considered as the primary reason for conducting any research study. In this research study, SLR is performed for the purpose of identifying agile challenges and their solution for implementation in various industries and organizations outside the IT field. The systematic literature review can help us for reviewing most of the latest research work that has been performed for the agile implementation. The basic use of agile was in IT field, but many other industries have started implementing it in their organizations. Therefore, it has become necessary to identify agile challenges outside IT and highlight the best feasible agile principle for adaptation outside IT.

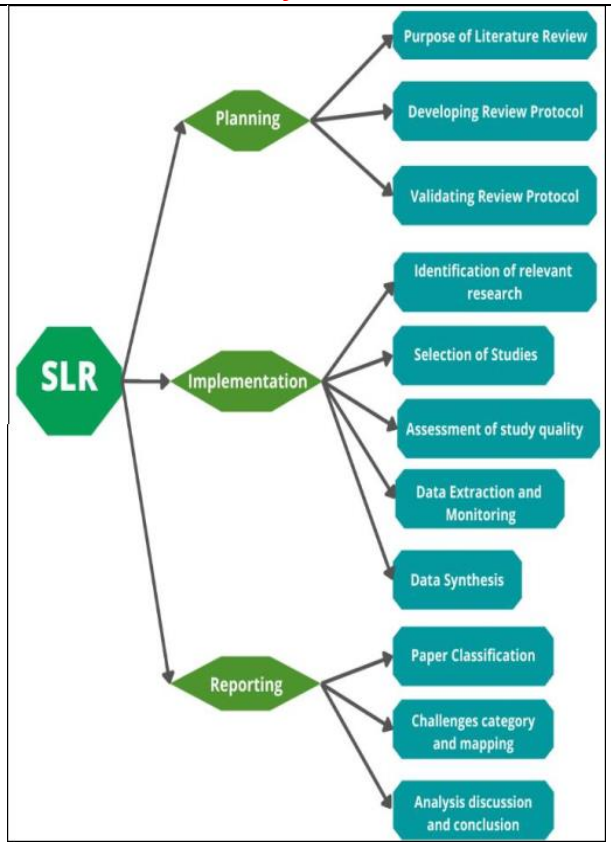

Figure 1: SLR Methodology

Developing the Review Protocol:

There are two main factors involved in this stage of planning. These factors include the inclusion and exclusion criteria and preparation of data extraction form. Both of these sub-stages help in those studies where the knowledge is insufficient about previous studies.

Inclusion and Exclusion Criteria:

The inclusion and exclusion criteria define the limitations for the SLR. These criteria are determined after defining the research questions and describing scope of the research study. There are various factors that can influence both inclusion and exclusion criteria. In this study, the research questions are related to agile development outside IT scope. This study has focused on finding the general challenges of agile in any organization. The criteria for adding or removing studies developed according to their topic names. We utilized several conference papers, recognized journals, and authentic websites for collecting resources for this literature review. The gathered studies from these resources implemented the agile in several organization including healthcare, construction and product development. Therefore, the criteria are set for including or excluding based on the fact that these studies had implemented agile in the industry or organization.

Preparation of Data Extraction Form:

The data can be collected from several research papers, but it is necessary to the manage data and organize the results gathered by the SLR. It is necessary to create some techniques or tools in order to organize the obtained results. There are several spreadsheets and catalogue organization applications available for organizing the results that are used by the research community. In this research, we gathered data manually in a separate folder. We organized data according to the publication date. In this research, we tried to gather latest data of last 10 years for the review. The full text data was collected for reviewing purpose.

Validating the Review Protocol:

The validation of the above-mentioned review protocols is necessary to perform a validate SLR for agile challenges and solutions. The professionals have better skills to organize the review protocols and validate them based on their knowledge. The quality assessment is performed for the methods and techniques proposed to the collect data in the SLR. After validating the review protocol, the next stage of SLR get started i.e., implementation stage. The validation of the protocol can prevent from time wastage and wrong direction of the research. The correctness of relevant data is necessary for proper and authentic review.

Implementation:

The implementation of agile review is the second stage of SLR, in which the previous literature is searched from different sources such as digital libraries, search engines, identified journals and academic books. We divided the implementation phase into five other subcategories. The detail of these subcategories is explained in the following sections.

Identification of Relevant Search:

The identification of relevant search is related to developing different research strategies such as search approach, publications bias, catalogue management and research documentation. There are several search techniques available for searching and identifying the relevant data such as keyword techniques and browsing techniques. We utilized both of these techniques for searching the relevant data. The keywords are words that are pasted on any search engine or in search category of online library. The search engine uses that keyword and identifies the relevant studies to that keyword. There are several resources for using the keyword search such as google scholar, ResearchGate, ScienceDirect, and other online libraries. These all resources provide the already published data relevant to the researched keyword. We explored several websites for identifying the relevant and authentic data according to given research questions.

We use the keywords like "Agile Issues", "Agile Challenges", "Limitations of Agile", "Agile Challenges and Solutions", "Agile Challenges Review", "Challenges for Adopting Agile", "Agile in Healthcare", "Agile Issues in Industry", "Agile in Product Development", "Agile Implementation in Product Development" for searching the relevant studies.

Selection of Studies:

The next stage after creating a list of reference is to gather all the required papers for the SLR. There are two types of screening of papers proposed by the researchers for selection of studies in any systematic review. The studies usually prefer double screening of the studies for the selection. The single screening is about exploring the topic names and abstracts of the studies, which is not considered as a preferred method for the selection of studies in any systematic review. The double screening method is proved as very different than single screening, which is about analyzing the full text for the review. Therefore, we used the double screening and read full text for selecting studies in this systematic review. The single screening can be used for identifying the number of studies that will help in the systematic review analysis.

Assessment of Study Quality:

The assessment of study quality is correspondent to previous phase of implementation. The quality of the research material is as much important as the criteria for inclusion and exclusion. These criteria of inclusion and exclusion support in evaluating the quality of these primary studies by checking the impact factor of journal in which relevant paper is published, quality of catalogue resources, and research index of the authors of studies. There can be multiple biases involved in the primary study such as citation bias, time lag bias, location bias, and language bias. These all types of reporting biases are evaluated during the assessment of the primary studies [25].

Data Extraction and Monitoring:

This phase of implementation is related to extracting the accurate information from the

selected resources such as conferences, journals, book reviews, and other publications. The data is extracted in the arranged manner i.e., review name, review author, details of publication, and other related details of the documents [11]. The catalogue management applications provide an effective way of arranging information in their respective orders. This organized data enhances the efficiency and effectiveness of the data extraction process during the implementation of SLR. The few important points that are considered for the analysis of data are as follow [26].

- The gathered documents are associated with their research questions in the SLR.
- The keywords are associated with the reviewed literature
- Notes section of the catalogue references
- Location of the relevant points and map them to respective research question

Data Synresearch:

This data synresearch is the last phase in the implementation of the systematic reviews. It is used to summarize the data that is selected and analyzed in the primary studies. The synresearch can be anyone of the two possible types depending upon the nature of research i.e., quantitative or qualitative. Nowadays, the qualitative approach is a popular technique used for data synresearch, it is also known as meta-synresearch technique. The other technique that is used to summarize data is known as quantitative technique. It stores the data in the form of tables and charts.

In this study, the literature review is performed to analyze the data qualitatively and identifies the challenges that can be occurred in agile implementation for industries and organizations outside IT. Therefore, the critical analysis is performed based on the qualitative synresearch for extracting agile challenges and solutions.

Reporting:

The analysis is discussed in the final phase of SLR, after conducting review in the second phase. The clear and understandable reporting is required to make the SLR more effective and impressionable for the readers. The use of highly recommend methods can make the SLR more significant. There are three main subcategories of reporting i.e., paper classification, challenges and solutions, and analysis discussion and conclusion.

Paper Classification:

The criteria for paper classification are defined in the planning phase of SLR. The paper classification is the distribution of papers into several categories depending upon the research questions asked in the studies. There are different categories developed for the SLR in previous studies such as human, procedures, organizations, and technology [26]. In our work, we also classified these papers into the three categories depending upon the research questions. We gathered the agile challenges paper in one category, the solutions for agile problems in second category, and best practices for agile in the third category. This classification helped in analyzing the data properly.

Challenges Category and Mapping:

There are several challenges in applying agile for outside IT. There are several categories created for identifying challenges and solutions. The challenges from the extracted data are mapped to the corresponding category of challenges.

Analysis Discussion and Conclusion:

The final report is completed in this phase of SLR. There are few instructions provided in [11] for creating systematic review reports. The report is comprised of title of the study, author name, summary and abstract of study, background knowledge, research questions to be reviewed, methods used in the SLR, inclusion and exclusion criteria, results obtained in the study, discussions, conclusions, acknowledgements, conflict of interests, references, and appendices

Results and Analysis:

Discussion:

In this study, novel SLR mechanism is used to articles related to agile in several industries. We used keywords that can help out in finding studies which shows the challenges and solutions for implementing the agile methodologies.

The Table 1 gives the number of papers that has been reviewed and used in SLR. First, we considered number of papers on the basis of their topic name. After that, we reviewed the abstract and data of the articles for evaluating the final paper required for this research. Many of the gathered papers were easily accessible, whereas few were obtained by contacting the author. In the final stage, we utilized remaining papers for discussing the agile challenges and solutions outside IT.

Table 1: No. of Studies Used in SLR.

Papers	Agile Challenges	Solutions for the Challenges
Considered	45 (out of 1150 searchers)	45 (out of 1150 searchers)
Left after abstract review	13	13
Left after article review	19	24
Accessible	29	29
Retrieved from author	3	3
Relevant and used	13 [12][27][28] [29]	8 [12] [30][31][32]

The agile methodology provides a lot of benefits including incremental and faster developments, enhanced adaptability, and better alignment etc. The agile solution has become a necessity for most of the field. The researchers had implemented it in the software field during the initial days. The success of agile developed interest for the other fields to migrate their organizational methodology into agile. Therefore, some of the researchers implemented agile in different fields such as education, business management, and government administrations etc. The researcher faced various issues and challenges during and after implementation of agile in various industries. We found several challenges in agile and their proposed solutions through SLR. We will discuss these challenges and solutions by categorizing them into two sections, which are explained below.

General Agile Challenges and Solutions:

In this section, we have discussed generic agile challenges that can be faced by any large organization or industry. We have divided these general challenges according to different areas. Then, we have discussed the challenges and their solution extracted from different studies as given in Table 2. The different discussed areas are comprised of development process, business process, communication, conflicts of stakeholders, management issues, and cultural issues [29-33].

The first area discusses the challenges that can be occurred in development process of any field such as product development, development in construction industry etc. The second area discusses the agile challenges in terms of business processes. The issues related to human resources, process measurements and process standard ratings. There can be various conflicts between the stakeholders such as different viewpoints, uncertain environments, and managerial issues. Communication plays an effective role in any field. The agile can have several issues regarding the communication within the organizations. The lack of communication can create chaos among the stakeholders of any project. Therefore, daily meetings were proposed to handle this lack of communication issue. This communication area of any organization can play important role in failure or success of the project. These challenges must be addressed to maintain the environment of the organizations or industries. In the last, the development of cross-cultural knowledge is an important challenge in agile. This can be increased by increasing awareness of agile among the teams and increase knowledge about cultural background of the colleague employees [34-37].

Table 2: General Agile Challenges and Solutions.

Areas	Challenges	Solutions	Ref
Development Processes	Combining agile with several industrial process.	Experimenting with limited confined or failing projects with agile methodology or a mixture of agile and traditional methods.	[12]
	Problems of controlling changes in resources allocated for the project.	Focusing on allocating independent teams and resources for a single iteration or project	
	Variability in life cycles of agile process.	The conventional development cycle should be modified with the agile cycle.	
	Requirement process.	Improving the agile requirement gathering process by obtaining more information from the stakeholders.	
	Problems of evolving requirements all the times during implementation of agile projects.	The daily meeting process of the teams working on the project and discussing the changes required in the project.	
	High quality products within restricted time and limited knowledge.	Latest developed techniques for quality and time management in agile such as extreme programming.	[32]
Business Process	Human resource issues.	To equip people to follow non-conventional methods	[13]
	Measurement of process.	Using agile scaling methods such as requirement burn down instead of conventional measuring techniques such as milestone.	
	Standard ratings of process.	It is feasible that informed analysts may find ways to incorporate agile methods as alternatives in most cases.	
Conflict of Stakeholders	Management viewpoint variations between conventional and non-conventional agile paradigms.	Facilitating the project manager to play their part as a motivator and protectors.	[14]
	Administration problems.	The need for a fast-paced workplace includes pair stations, status chart walls, a structure that allows teams to easily connect and deliver information, sufficient components that should support uninterrupted coalition.	
	Ambiguous circumstances because of cultural variations	People who participate in different cultural practices are recommended to acquire knowledge of the cultural background of their peers.	[13]
Communication Issues	The agile can create chance of increasing communication within the organizations, but it increases the risk by overstressing the tactic information in a project team	The shared information in daily meetings should be related to project description and deadlines, but not about the technical information of the project.	[15]
	A study suggested that the use of use of agile methodologies increases the differences among the	The lack of communication may result as a misunderstanding among the stakeholder.	

	stakeholder which may result as a decline of the project [29].		
Management Issues	Management issues in remote jobs.	Continuous communication via email, msg, skype, or call.	[16]
	Work improvement as well as keeping the teams and customer satisfied.	The manager should try to gain trust of the employees or team members by discussing the details and issues of the project with them.	
	Encouraging the customer involvement.	Try to respond quick changes to the project and instead of following a specific plan, try to change it according to the customer desire.	
	The involvement of agile management should be present in the continuing effort for a balance between seemingly contrasting and controversial agendas for flexibility and order, as well as for improvement and order	Maintaining this balance provides the basics for effective and continuous user interaction that are essential to address the challenges of successfully embedding electronic research applications.	
	Stakeholders are reluctant to give a decision.		[17]
Cultural Issues	Developing cross-cultural knowledge in the industry.	It is suggested that integration can be done through our knowledge-sharing framework. The three-layer model provides a way to better understand the needs arising from contextual context and to raise awareness of the software engineering process culture.	[32]

Conclusion:

The agile methodologies have become famous in many fields because of its success in the information technology. There are various fields in which organizations have started implementing in the agile methodologies. In this research research, the study was carried out to find these agile challenges and their proposed solutions. We proposed a systematic literature review (SLR) approach for searching agile challenges. In this systematic review, we divided the SLR into three categories, which was further divided into sub-categories. After searching the related articles using SLR, we present our findings on the challenges of implementing agile methodologies in various type of organizations. As a conclusion, the agile is an emerging model that has potential to be followed in several fields. The organizations can face challenges while transferring to agile, but the agile will benefit companies in term of success. The study found that agile has challenges for modifying into processes of other organizations, but these challenges can be solved and agile can be used as effective technique by most of the companies. This research has a few limitations that may present opportunities for further research. As our research was conducted on the basis of low-quality data. There are various companies that have started working on modifying agile for their companies. In future, when the companies will adopt agile on regular basis, it will create opportunities to identify agile challenges more explicitly.

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