Interdisciplinary Journal of Information, Knowledge, and Management

An Official Publication of the Informing Science Institute InformingScience.org

IJIKM.org

Volume 18, 2023

AGILE PRACTICES AND THEIR IMPACT ON AGILE MATURITY LEVEL OF SOFTWARE COMPANIES IN NEPAL

Gangaram Biswakarma*	School of Management, Tribhuvan University, Kathmandu, Nepal	drgrbiswa@gmail.com
Poojan Bhandari	School of Management, Tribhuvan University, Kathmandu, Nepal	poojan.bhandari.pb@gmail.com

* Corresponding author

ABSTRACT

Aim/Purpose	Using the Agile Adoption Framework (AAF), this study aims to examine the agile potential of software development companies in Nepal based on their agile maturity level. In addition, this study also examines the impact of various basic agile practices in determining the maturity level of the agile processes being implemented in the software industry of Nepal.
Background	Even if most organizations in the software sector utilize agile development strategies, it is essential to evaluate their performance. Nepal's software industry did not adopt agile techniques till 2014. The Nepalese industry must always adapt to new developments and discover ways to make software development more efficient and beneficial. The population of the study consists of 1,500 and 2,000 employees of software companies in Nepal implementing agile techniques.
Methodology	The sample size considered was 150 employees working in software companies in Nepal. However, only 106 respondents responded after three follow-ups. The sample was collected with purposive sampling. A questionnaire was developed to gain information on Customer Adaptive, Customer Collaboration, Continuous Delivery, Human Centric, and Technical Excellence related to agile practices along with the Agile Maturity Level.
Contribution	This research contributes to the understanding of agile practices adopted in software companies in developing countries like Nepal. It also reveals the determinants of the agility of software companies in developing countries.

Accepting Editor Nelson K. Y. Leung | Received: November 14, 2022 | Revised: February 20, March 8, March 10, 2023 | Accepted: March 13, 2023.

Cite as: Biswakarma, G., & Bhandari, P. (2023). Agile practices and their impact on agile maturity level of software companies in Nepal. *Interdisciplinary Journal of Information, Knowledge, and Management*, *18,* 107-125. https://doi.org/10.28945/5091

(CC BY-NC 4.0) This article is licensed to you under a Creative Commons Attribution-NonCommercial 4.0 International License. When you copy and redistribute this paper in full or in part, you need to provide proper attribution to it to ensure that others can later locate this work (and to ensure that others do not accuse you of plagiarism). You may (and we encourage you to) adapt, remix, transform, and build upon the material for any non-commercial purposes. This license does not permit you to use this material for commercial purposes.

Findings	The results suggest that some of the basic principles of agile have a very significant role in Agile Maturity Level in the Nepali context. In the context of Nepal, human-centered practices have a very high level of correlation, which plays a vital role as a major predictor of the agile maturity level. In addition, Technical Excellence is the variable that has the highest level of association with the Agile Maturity Level, making it the most significant predictor of this quality.
Recommendations for Practitioners	As Nepali software companies are mostly offshore or serve outsourcing companies, there is a very thin probability of Nepali developers being able to interact with actual clients and this might be one of the reasons for the Nepali industry not relying on Customer Adaptation and Collaboration as major factors of the Agile methodologies. Continuous Delivery, on the other hand, has a significant degree of correlation with Agile Maturity Level. Human-centric practices have a very high level of correlation as well as being a major predictor in determining the Agile Maturity Level in the context of Nepal. Technical Excellence is the most significant predictor and the variable which has the highest level of correlation with Agile Maturity Level. Practitioners should mainly focus on technical excellence as well as human-centric practices to achieve a higher level of Agile Maturity.
Recommendations for Researchers	There has not been any such research in the Nepali context that anyone could rely on, to deep dive into their organizational concerns regarding agile strategies and plans. Researchers will need to focus on a more statistical approach with data-driven solutions to the issues related to people and processes. Researchers will need to cover freelancers as well as academics to get a different perspective on what can be the better practices to achieve a higher level of agile maturity.
Impact on Society	This study on Agile work is accessible not only to the software industry but also to the general public. The Agile technique has had a huge impact on society's project management. It has revolutionized how teams approach project planning, development, and execution. The paper's findings will further information regarding the Agile methodology, which emphasizes collaboration and communication, fosters teamwork and higher quality work, and promotes the exchange of knowledge, ideas, and the pursuit of common goals.
Future Research	Owing to the limitations of this study, it is necessary to analyze agile practices in the Nepalese software sector using additional factors that influence agile maturity. The conclusion that years of agile experience do not serve as a balancing factor for both agile practices and the Agile Maturity Level requires additional research. Whether a software outsourcing firm or not, the organization type had no bearing on the degree of maturity of agile methods; this leaves space for further research.

Keywords agile practice, agile maturity, software companies, agile adoption framework

INTRODUCTION

The efficacy of agile methods has been shown and accepted for decades. Agile software development is becoming increasingly popular worldwide, including in developing nations. South Asia is also a part of this global growth of software development, as numerous large and small software development organizations are already expanding at the same rate as their overseas counterparts.

However, the degree of Agile Maturity is becoming a critical concern as software development requirements and applications expand. Agile is a collective concept that includes different techniques that provide the ability to adapt quickly to new conditions. The Agile Maturity Level basically focused

on the acceptance of changes and customer value, frequent delivery of working software, how much the organization considers the significance of people working in the company, adoption of the technology and expertise, along with the relationships with clients or customers (Sidky et al., 2007).

Agile Software Development is characterized by collaborative social interactions and fast-paced and iterative changes in project requirements (Zaitsev et al., 2020). In agile, being an iterative process, changes are done and errors are rectified from iteration to iteration. This helps product development to be adaptive and quality assurance to be a continuous process. Agile methodologies hence provide more accurate and error-free software. Many companies want to use agile processes because they have many benefits. Some of the benefits are a faster return on investment, better software quality, and happier customers (Sidky et al., 2007). Instead of spending a lot of time writing specifications up front, agile principles focus on making software that works and that people can use quickly (Duka, 2013). It also highlights the importance of using consensus-building techniques within the team.

The Agile Adoption Framework (AAF) was developed to help solve the problem of how to use agile practices well and get the most out of them. Agile Software Development offers to handle requirement changes throughout the development life cycle, foster broad customer and developer interaction, and enable early and frequent product delivery (Xiaohu et al., 2004). The agile community stresses proximity and relationships among the development team members, delivering working software regularly, and customer-developer cooperation (Herbsleb & Moitra, 2001). Even though there is a clear set of rules and guidelines for the agile adoption process, with the number of agile development processes and toolkits available, it is harder for organizations to set up the process which fits best for them. There is no structured method for adopting agile in the public domain (Sidky et al., 2007).

Although agile software development approaches have gained wide acceptance in practice, concerns regarding the scalability and integration of agile practices in traditional large-scale system development projects are prevailing (Turetken et al., 2017). The agile maturity level tells; how agile the working methods are in a company. It reveals how adaptive, and willing to learn, employees and teams are in the organization. A company has reached the maximum Agile Maturity Level when all organizational levels have understood, accepted, and implemented the agile way of working. The Agile Maturity Level determination can help software companies to figure out their standing on the approaches followed to implement agile.

It is important to know what is going on with agile practices in different software development companies. These include, among other things, figuring out if an organization is ready for agility, what practices it should use, what problems it might face, and what preparations it needs to make before it can use agile methods. Software companies do not know where they are in the process of adopting agile. They do not know if they are good enough, if they are getting better, or if they are not doing things the right way.

In the case of Nepal, even though most companies are already using agile development processes, it is significant to know how far along they are and how well they could do with agile processes. Even though agile processes for making software have been around for almost 20 years, Nepal's software industry did not start using them until around 2014. Agile means "responding to change," and agile methods or practices are always changing. The Nepali industry always needs to keep up with the changes and find ways to make software development more effective and useful.

Therefore, this research is focused on a comprehensive analysis of how agile is being used in Nepali software companies at present. Using the Agile Adoption Framework (AAF), the study aims to examine the agile potential of software development companies in Nepal based on their Agile Maturity Level, as suggested by AAF. In addition, this study also examines the impact of Customer Adaptive, Customer Collaboration, Continuous Delivery, Human Centric, and Technical Excellence practices in determining the maturity level of the agile processes being implemented in the software industry of Nepal.

THEORETICAL BACKGROUND

AGILE PROCESS

The last several decades have witnessed a steady, irreversible trend toward the globalization of business, and software-intensive high-technology businesses. Economic forces are relentlessly turning national markets into global markets and spawning new forms of competition and cooperation that reach across national boundaries.

The bottom-up approach used in agile processes allows developers to determine the effort and estimation rather than managers setting the deadlines. This provides more granular insight into the volume and complexity of work and the convenience to get it done. The software development industry has been adopting agile methods instead of traditional software development methods because they are more flexible and can bring benefits such as handling requirements changes, productivity gains, and business alignment (Campanelli & Parreiras, 2015).

Agile software development has had a major influence on how software development is conducted. It has become an umbrella term for several changes in how software developers plan and coordinate their work, how they communicate with customers and external stakeholders, and how software development is organized in small, medium-sized, and large companies from the telecom and healthcare sectors to games and interactive media. We see the agile development methods as a reaction to plan-based or traditional methods, which emphasize "a rationalized, engineering-based approach" incorporating extensive planning, codified processes, and rigorous reuse (Boehm, 2002).

By contrast, agile methods address the challenge of an unpredictable world by recognizing the value competent people and their relationships bring to software development (Nerur & Balijepally, 2007). In this paper, we will first define what we see as agile software development and define other central terms that will be used. Further, we give a broad overview of research conducted in this field and describe the themes of foundations and background of agile development, agile methods in practice, principal challenges, and new frontiers. Finally, we state what we see as some of the main challenges and main future directions for research on agile software development.

AGILE SOFTWARE DEVELOPMENT

Agile software development has significantly altered the software development process. These approaches are replacing traditional software development methods in the software development industry because they are more adaptable and can give benefits such as the ability to handle changing requirements, increased productivity, and improved business alignment (Campanelli & Parreiras, 2015).

Agile development approaches are a reaction against traditional or plan-based methods that emphasize "a rationalized, engineering-based approach" that incorporates extensive planning, defined processes, and stringent reuse (Boehm, 2002). Agile approaches acknowledge the value that skilled people and their relationships bring to software development, thereby tackling the challenge of an unpredictable world (Nerur & Balijepally, 2007).

In 2001 (Beck et al., 2001), 17 prominent persons founded the agile software development process, a guiding force for agile practitioners that defines four core objectives for enabling high performance, efficiency, and results: individuals and their interactions over processes and tools; delivering working software over comprehensive documentation; customer collaboration over contract negotiation; responding to change over following a plan. The Agile Manifesto specified 12 principles for agile software development when creating it (Beck et al., 2001).

Using all 12 agile principles to describe each agile level will bring unneeded complexity. The five agile principles that capture the essence of all 12 principles can be identified through careful grouping and summarizing into 5 levels of agility: (i) embrace change to deliver customer value; (ii) plan and deliver

software frequently; (iii) human-centric; (iv) technical excellence; and (v) customer collaboration (Sidky et al., 2007).

Agile Adoption Framework Based on SAMI

Within the scope of his dissertation titled "Sidky Agile Measurement Index," Sidky presented an Agile Adoption Framework (Sidky et al., 2007). The Sidky Agile Measurement Index is broken down into a step-by-step, five-stage approach that serves as a guide for the organization during the software development process. The endeavor that Sidky has made to connect the agile levels with the agile practices that are founded on agile principles has been quite successful. The group of practices that are stated concerning each level is – Collaborative; Evolutionary; Effectiveness; Adaptive and Encompassing.

(a) *Collaborative:* The goal of this level is to improve communication and teamwork during software development. Retrospectives, planning games, self-organizing teams, coding standards, knowledge sharing, and on-site customer meetings are all examples of agile practices that are used at this level (Sidky et al., 2007).

(b) *Evolutionary:* The goal of this level is to improve how people work together and how often software is delivered. At this level, the set of practices includes short iterations, continuous delivery or frequent releases, sprint planning, tracking progress, simple designs, and customer contracts that show how development has changed over time (Sidky et al., 2007).

(c) *Effectiveness:* At this level, the organization has already figured out how to communicate and work together well, and it's getting things done quickly. The next goal at this level is to make the development process more efficient and effective (Sidky et al., 2007). So, this level is called "Effective" because it uses a number of agile practices. Risk-driven iterations, product backlogs, metaphors, self-organizing teams, frequent face-to-face communication, continuous integration, refactoring, and unit testing are some of the practices that make up this set.

(d) *Adaptive:* This level helps adopt practices that make the software development process more stable and automated (Sidky et al., 2007). At this level, the company asks the customer for feedback to figure out how well the software works. Iterative development, continuous customer satisfaction, frequent releases, adaptive planning, daily stand-up meetings, agile documentation, user stories, and onsite customer meetings are all important practices at this level (Sidky et al., 2007).

(e) *Covering:* At this level, organizations accept changes in the way they develop software and keep their agile nature. Several important practices are put in place to make sure that the organizations are as mature as possible. These include project estimation, low-process ceremonies, and planning games (Sidky et al., 2007).

Model Measuring Maturity of Agile Process

According to the agile manifesto, consumers, developers, and all project stakeholders must engage often to ensure the developed product fulfills the customer's business needs (Jain & Suman, 2016). Agile methodologies can assist GSD projects to overcome distance challenges when combined with supportive practices and resources. Agile's benefits surpass its implementation challenges (Jain & Suman, 2016). Companies have demanded agile methods for a decade. When applying agile concepts, organizations must determine how "agile" they are and can be (Elssamadisy, 2008). Software development organizations can use many methodologies and models to measure agile process maturity. Some key frameworks, including AMM, SMM, AAF, BM, and Agile Scaling Model (ASM), are presented in Tables 1 and 2. AAF has the best assessment outcomes of all the models/frameworks. Its clear framework might be expanded to include agile best practices (Ozcan-Top & Demirörs, 2013).

Table 1. Agile maturity models/frameworks

Maturity Model/Framework	Owner	Abbreviation
Agile Maturity Model	Patel and Ramachandran	AMM
Scrum Maturity Model	Yin	SMM
Agile Adoption Framework	Sidky	AAF
Benefield's Model	Benefield	BM
Agile Scaling Model	Ambler	ASM

Table 2. An overview of assessment results

Models	AMM	SMM	AAF	BM	ASM
Fitness for Purpose	FA	LA	LA	LA	PA
Completeness	PA	PA	PA	PA	PA
Definition of A. Levels	NA	PA	FA	NA	PA
Objectivity	LA	PA	LA	NA	NA
Correctness	PA	FA	FA	NA	NA
Consistency	NA	FA	FA	NA	NA

Note: NA: Not Achieved, PA: Partially Achieved, LA: Largely Achieved, FA: Fully Achieved

Previous Studies

The study of Sidky et al. (2007) mentioned that the cornerstone of the concept of agile software processes is the dependence on people and their interactions. Agile developers are committed to producing only the highest quality code possible because high-quality code is essential in high-speed development environments, such as the ones characterized as agile. They mentioned that to achieve the encompassing level of agile maturity, several essential practices are implemented that ensure the highest level of maturity for the organizations through project estimation, low process ceremony, and planning games. Feedback is also critical for planning future iterations since it determines the scope and direction of the software development endeavor. Xiaohu et al. (2004) mentioned that agile software development has gained significant popularity because it promises to handle requirement changes throughout the development life cycle, promotes extensive collaboration between customers and developers, and supports early and frequent delivery of a product. Despite apparent major contrasts between agile development and Global Software Development (GSD) approaches, there is growing interest in evaluating the practicality of employing agile practices for GSD projects (Taylor, et al., 2006).

Likewise, Jain and Suman (2016) write that agile approaches have become a popular means of building software, while global software development has become the standard, and the advantages of agile approaches outweigh the difficulties of implementing them. The Agile Adoption Framework provides the best assessment outcomes of all the models/frameworks. Its clear framework might be expanded to include agile best practices (Ozcan-Top & Demirörs, 2013). The main problems for organizations when implementing agile principles are determining how "agile" they are and how agile they can be (Elssamadisy, 2008). Campanelli and Parreiras (2015) mentioned agile approaches are replacing traditional software development methods in the software development industry because they are more adaptable and can provide benefits such as handling requirements changes, productivity increases, and business alignment.

Boehm (2002) emphasized that agile development methods as a reaction to plan-based or traditional methods emphasize "a rationalized, engineering-based approach" incorporating extensive planning, codified processes, and rigorous reuse. Agile techniques recognize the value that talented people and their relationships bring to software development, addressing the problem of an unpredictable world (Nerur & Balijepally, 2007). Likewise, Khan and Niazi (2012) found that for software development outsourcing suppliers, 'lack of technical expertise' and 'poor quality of service and system/process' are critical. 'Poor infrastructure,' 'lack of project management,' 'communication gap,' 'lack of control over a project,' 'poor relationship management,' 'country instability,' 'lack of protection for intellectual property rights,' 'hidden costs,' and 'language and cultural challenges' are all issues that outsourcing vendors must address. Dixit and Lohani (2017) found that the software market of Nepal is increasing as the number of both domestic and offshore projects grows and the survey shows that the software development industry is expanding in Nepal and has the potential to earn foreign currency by generating revenue from outsourcing.

Even though there are many studies on agile software development best practices, they have not taken Nepal's software industry and agile processes into account. Agile techniques are a current solution figured out by specialists that have proven effective in the software business. As a relatively new concept, Nepal's software sector has just recently begun employing them. This shows that Nepal needs more research on Agile practices and methodologies.

HYPOTHESES DEVELOPMENT AND RESEARCH MODEL

HYPOTHESES DEVELOPMENT

Based on the consideration of basic agile principle-based practices to be the independent variables and experiences with agile along with the type of software organizations acting as moderators, the hypotheses for this study are as follows.

Customer-adaptive refers to the practice to embrace the changes requested by the clients. Throughout the software development process, a welcoming and accepting attitude should be maintained (Sidky et al., 2007). This practice signifies the agility to deliver new changes in a proper time frame. For any software company to be agile in a true sense, customer adaptability is a major aspect where they can adapt as per the nature and requirements of the business. Agile is a notion that encompasses a variety of strategies that enable rapid adaptation to changing circumstances (Pirlea, 2019).

H1: There is a significant effect of Customer Adaptive practices in determining the Agile Maturity Level of software companies.

With an agile approach, representatives from customers also have an equal opportunity to work with the development team. The better the collaboration, the better will be the result. Perhaps the most crucial value of the Agile Manifesto is customer collaboration. Some of the Agile Manifesto's principles mention customer collaboration explicitly or indirectly (Batra et al., 2017).

H2: There is a significant effect of Customer Collaboration practices in determining the Agile Maturity Level of software companies.

Continuous delivery refers to the frequent delivery of workable products (PSI). This helps to realize any changes or improvements needed in the product in an earlier phase. It is critical for planning future iterations because it determines the scope and direction of the software development activity (Sidky et al., 2007). Continuous delivery is made possible with continuous integration of the changes done. Continuous integration and continuous delivery have made an efficient agile delivery process as well as improved the productivity of the system (Arachchi & Perera, 2018).

H3: There is a significant effect of Continuous Delivery in determining the Agile Maturity Level of software companies.

Human-centric practices refer to the activities where human interactions are placed as a top priority as per Sidky et al. (2007). These 'human' variables are significantly more important in the formation of agile organizations – companies that can demonstrate organizational agility in a chain that spans from the warehouse to the boardroom (Pope, 2021).

H4: There is a significant effect of Human Centric practices in determining the Agile Maturity Level of Software companies.

The practices which help an organization achieve excellence in the technology and the techniques they implement to develop software. Developers must learn to write clean code and create software that can withstand future changes. These characteristics could be promoted as agile team values, influencing team behavior (Alami & Paasivaara, 2021).

H5: There is a significant effect of Technical Excellence in determining the Agile Maturity Level of Software companies.

More experienced teams value autonomy in their work, method flexibility, and the need to evaluate and adapt them over time (Julian et al., 2019).

H6: Work experience with agile practices moderates the relationship between agile practices and the Agile Maturity Level.

The following three organizational elements for agile software development endeavors were established after evaluating the influence of numerous factors critical for obtaining success when implementing agile methods: company culture, team structure, and management support. Failure causes include a lack of managerial support, a large organization's size, and traditional organizational culture (Mishra et al., 2021). Here, the organization type refers to a company serving an outsourcing company or an offshore, a product-based company, or a combination of all.

H7: Software development organization type moderates the relationship between agile practices and the Agile Maturity Level.

Research Model

The conceptual framework for this study is based on the Agile Adoption Framework developed by Sidky et al. (2007). Primarily, the framework consists of 5 different agile principle-based practices which will determine the maturity level of agile implementation categorized into 5 different levels. The agile levels are the deterministic levels of the maturity of agile practices in a software development company. There are 5 stages of agile and categorized into 5 different levels by Sidky et al. (2007).

Level 1: Collaborative. This level emphasizes the importance of establishing communication and collaboration among all stakeholders. Agile software development is built on the foundation of cooperation.

Level 2: Evolutionary. Early and ongoing software delivery is what evolutionary development is all about. It is also essential because every agile method requires it.

Level 3: Effective. The production of high-quality, functional software in a quick and effective manner is the next criterion that an agile development process must embrace. This characteristic is required to prepare the development process for frequent change without endangering the software system under development.

Level 4: Adaptive. This level is responsible for establishing the process's agility in responding to change. This level requires defining and responding to various levels of input.

Level 5: Encompassing. The final level focuses on creating a lively environment that will allow an organization to maintain and nurture agility.

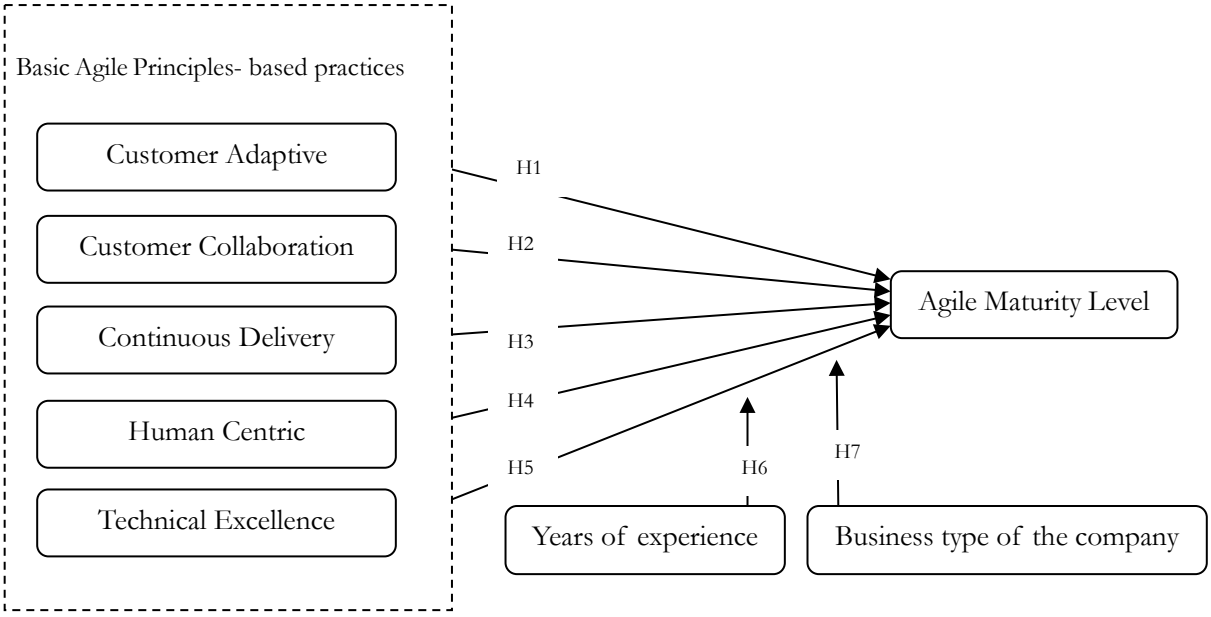

Figure 1. Theoretical framework for the study

METHODS

RESEARCH DESIGN

This study was carried out using a deductive approach to scientific research with a quantitative approach, which involved generating a set of hypotheses and then devising a research strategy to evaluate those hypotheses. During the study period, relevant data and information were collected, assessed, and analyzed methodically in order to reach a conclusion.

POPULATION AND SAMPLE

The population of the study consists of 1,500 and 2,000 employees of software companies in Nepal that implement agile techniques. This statistic was derived from Agile Nepal, an official Scrum Alliance-approved user group. The sample size was determined with a thumb rule of 150. However, 106 respondents responded after three follow-ups. The sample was collected with purposive sampling, where it was ensured that the employees are utilizing agile techniques in their work.

Respondents' profiles include organization type, agile experience, gender, age, and education. Table 3 shows respondent demographics. Of the respondents, 22.9% are women, and 77.1% are men. For age, 52.1% of respondents are 21-30, 44.8% are 31-40, and 3.1% are above 40. For education, 58.3% of responders are graduates, 20% are postgraduates, 18% are undergraduates, and 2.1% have diplomas. Only 53.1% of respondents have more than 6 years of software development experience, with 9.4% having around 2 years, 22.9% having 4 years, and 14.6% having 5 to 6 years. For experience with agile software development, 32.3% have more than 6 years, 35.5% have roughly 2 years of experience, 17.5% have 4 years, and 14.6% have 5 to 6 years. Likewise, 50% of the 96 replies were from offshore employees, while 13.5% came from product-based and outsourcing organizations. Twenty-three percent (23%) of respondents work in product-based, offshore, or outsourcing enterprises.

Table 3. General information of respondents

Factors	Distribution	Frequency	Percent
Gender	Female	22	21%
	Male	84	79%
Age (years)	21-30	55	52%
	31-40	48	45%
	Above 40	3	3%
Qualification	Diploma	2	2%
	Undergraduate	21	20%
	Graduate	60	57%
	Postgraduate	23	22%
Years of Work Experience	0-2	9	8%
	3-4	25	24%
	5-6	14	13%
	More than 6	58	55%
Years of Work Experience with Agile practices	0-2	36	34%
	3-4	17	16%
	5-6	19	18%
	More than 6	34	32%
Type of Organization	Product Based Company	13	12%
	Serving to Outsourcing Company	14	13%
	Serving as Offshore	53	50%
	Serving as Combination of all type	26	25%

INSTRUMENTATION

The questionnaire had multiple sections. Independent and dependent variables were described through multiple choice, open-ended, and 7-point Likert scale questions. The questions were organized into 3 parts – demographic questions, agile practices, and agile maturity level.

The first group included demographic questions, such as organization type, agile experience, gender, and role in the organization. Here, the survey was not made anonymous to get a sense of authenticity from the respondents but was made clear that their personal information would not be used in any form of presentation or publication. Also, the name details were not mandatory so respondents had the choice of maintaining anonymity.

The second section consisted of 5 variable groups of item questions measured on a 7-point Likert scale to gain information on Customer Adaptive (6 items), Customer Collaboration (3 items), Continuous Delivery (8 items), Human Centric (12 items), and Technical Excellence (20 items), related agile

practices in the respondent's organization. The questionnaire was developed by taking reference to the study of Sidky (2007).

The third section consisted of 5 sub-groups of item questionnaire on a 7-point Likert scale to measure the Agile Maturity level based on the SAMI index presented by Sidky et al. (2007) on various aspects: regarding the acceptance of changes and customer value (5 items); regarding the frequent delivery of working software (5 items); considering the significance of people working in the company/organization (5 items); regarding the technology and expertise (5 items); and regarding the relationships with clients/customers (5 items).

Data Analysis Procedure

Responses were converted to CSV, cleaned, and loaded into SPSS for analysis. Scholars use SPSS 24v to evaluate complex statistical data because it is strong and has an easy-to-use reporting and visualization suite. Using descriptive statistics, the questionnaire item data was analyzed. The study's hypotheses were evaluated using inferential statistics. The research uses descriptive analysis, correlation, and multiple regression. Statistics summarized the data. Following is the model used for multiple regression:

$$AML = \beta 0 + \beta 1CA + \beta 2CC + \beta 3CD + \beta 4HC + \beta 5TE + \epsilon$$

Where, AML = Agile Maturity Level, CA = Customer Adaptive, CC = Customer Collaboration, CD = Continuous Delivery, HC = Human Centric, and TE = Technical Excellence ($\beta 0$ and ϵ are the constant term and the error term whereas $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$, and $\beta 5$ are the regression coefficients respectively).

Common Method Bias Test

Common method bias may affect this cross-sectional study. Podsakoff et al. (2003) recommended the Harman one-factor test to investigate Common Method Variance. Principal component analysis calculated the Common Method Variance for all measurement items. Several components with eigenvalues smaller than one accounted for 29.13% of the variance. Most importantly, the first component accounted for 29.13% of the variation, proving the data are free of Common Method Variance concerns.

RESULTS

Basic Agile Practices and Agile Maturity Level in Software Companies

The objective of the research was to determine the basic agile practices and agile maturity levels in software companies in Nepal. The level of basic agile practices and agile maturity in software companies in Nepal is described as Customer Adaptive, Customer Collaboration, Continuous Delivery, Human Centric, Technical Excellence, and Agile Maturity Level is described as a mean value with a scale of 7-point Likert scale.

The mean of Customer Adaptive is 4.06 (SD=0.926) which states that the organization of the respondents is gradually improving the adaptation to client requests and frequent changes. The mean of Customer Collaboration is 4.64 (SD=1.201) which states that though the concept of collaborating with the client is newer but still the organization does have those practices which focused on client collaboration. The mean of Continuous Delivery is 5.42 (SD=0.904) which states that the organization of the respondents is working on the frequent delivery of the PSI. The means of Human Centric practices and Technical Excellence are 5.60 and 5.08 respectively. This suggests that these two practices are also being focused on in the regular agile practices by the respondents. All the above leads to an average of 5.16 (SD= 0.801).

Table 4. Descriptive analysis of basic agile practices and agile maturity level in software companies in Nepal

Variables	N	Min	Max	Mean	S.D.
Customer Adaptive	96	1	7	4.06	.926
Customer Collaboration	96	1	7	4.64	1.201
Continuous Delivery	96	1	7	5.42	.904
Human Centric	96	1	7	5.60	.762
Technical Excellence	96	1	7	5.08	.740
Agile Maturity Level	96	1	7	5.16	.801

The results show that almost all companies have Customer Adaptive practices improving. Understanding the high-level requirements has the best use, while the practice of starting the work in iteration without major upfront analysis has the lowest application. The practice of encouraging clients to introduce changes earlier in the project is also a somewhat focused process with average use, while the client's articulation of changes is the average practice of getting feedback from the client throughout the project development has been less exercised.

The practices for continuous delivery have been good throughout the companies. With each practice averaging, there has been significant improvement in the processes regarding continuous delivery. Handling the iterative delivery of PSI and risk assessment in each iteration are the best practices within the organization, while project planning for each iteration is widely practiced with average use.

The human-centric practices seem to have a very good level of implementation whereas almost all the companies seem to have around 6 as an average for all the practices. Daily meetings seem to be best practices, while the environment of assistance does not seem to have been good compared to other practices. The practices regarding technical excellence show a positive inclination towards a better maturity level, and respondents seem to be more confident regarding their technical competence.

Most of the practices for technical excellence have an average usage and few practices which seem to be challenging are moderately applied. Test-driven development seems to be a challenging factor with the least average usage among the 20 different practices that are used to determine the level of technical excellence, which is one of the driving factors for agile maturity level. The acceptance of changes and customer values is on the moderate side. Frequent delivery of workable software is achieved on average, while the significance of people in the organization lies at a moderate level. Technology and expertise have a high focus, while client relationship seems to be less focused compared to others.

Relationships Across Various Practices Regarding Customer Adaptive, Customer Collaboration, Continuous Delivery, Human Centric and Technical Excellence with Agile Maturity Level.

Based on the correlation matrix as shown in Table 5, it can be observed that Pearson's r value for the relationship between independent variables and the dependent variable is significant for most of the independent and dependent variables, except for Customer Adaptive practices which show no correlation with the r value being 0.137 ($p>0.05$).

Also, all the associations have positive signs that indicate the positive direction of associations among all the constructs tested. The Pearson correlation (r) between the independent variables Customer

Collaboration, Continuous Delivery, Human Centric and Technical Excellence and dependent variable Agile Maturity Level are 0.204 ($p<0.05$), 0.596 ($p<0.01$), 0.647 ($p<0.01$), and 0.768 ($p<0.01$), respectively. These values indicate a moderate to a high degree of correlation between independent variables and dependent variables.

Table 5. Correlation matrix

	CA	**CC**	**CD**	**HC**	**TE**	**AML**
CA	1					
CC	0.454**	1				
CD	0.146	0.200	1			
HC	-0.073	0.163	0.686**	1		
TE	0.165	0.098	0.632**	0.619**	1	
AML	0.137	0.204*	0.596**	0.647**	0.768**	1
** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed)						

Note: AML = Agile Maturity Level, CA = Customer Adaptive, CC = Customer Collaboration, CD = Continuous Delivery, HC = Human Centric, and TE = Technical Excellence

Impact of Agile Practices on Agile Maturity Level

The impact analysis was done with multiple regression analysis to predict the agile level by the set of agile practice variables. The results of multiple regression analysis are presented in Table 6. The equation in model 1 shows a positive relationship between the independent variables and the dependent variable. The result shows that Agile Maturity Level changes by 0.009 units for every 1-unit change in Customer Adaptive practices and the other independent variables remain the same. Similarly, Agile Maturity Level changes by 0.063 units for every 1-unit change in Customer Collaboration practices and the other independent variables remain the same. Moreover, Agile Maturity Level changes by 0.037 units for every 1-unit change in Continuous Delivery and all other independent variables remain unchanged. Also, the Agile Maturity Level changes by 0.257 units for every 1-unit change in Human Centric practices, and the other independent variables remain the same. Agile Maturity Level changes by 0.627 units for every 1-unit change in Technical Excellence and the other independent variables remain the same.

The result also indicates that Technical Excellence has the most powerful influence on the Agile Maturity Level at a coefficient value of 0.627. This is followed by Human Centric practices coefficient value of 0.257, Client Collaboration with a coefficient value of 0.063, Continuous Delivery with a coefficient value of 0.037, and Customer Adaptive practices with a coefficient value of 0.009. However, Technical Excellence and Human Centric practices are the only significant practices in determining the Agile Maturity Level (AML). Based on the model summary, the value of R^2 is 0.648 and the adjusted R^2 is 0.628, which indicates that 62.8% of the effect on AML is accounted for by Agile Practices.

Table 6. Results of regression analysis

Variables	B	Standard Error	T value	p value	R2/R2adjusted	VIF
CA	0.009	0.065	0.135	0.893	0.648/0.628	1.460
CC	0.063	0.049	1.297	0.198		1.358
CD	0.037	0.083	0.445	0.658		2.264
HC	0.257	0.102	2.516	0.014		2.420
TE	0.627	0.095	6.565	0.001		1.987

Note: Agile Maturity Level = 0.533 + 0.009CA + 0.063CC + 0.037CD + 0.257HC + 0.627TE
Model Summary, R^2 = 0. 648 and Adjusted R^2 = 0.628

Effect of Years of Agile Experience and Type of Organization on Agile Maturity Level

The results show that neither Agile Experience years nor Organization Type seems to have any direct significance on the Agile Maturity Level, as the p values are 0.075 and 0.571 respectively. The interaction of moderator Organization Type with independent variables does not seem to have a significant impact on the Agile Maturity level as all the p values are greater than 0.05. The interaction of moderator Years of Experience with agile with independent variables does not seem to have a significant impact on the Agile Maturity level as all the p values are greater than 0.05.

Table 7. Results of regression analysis with organization type as moderator

Variables	B	Standard Error	T value	p value
Intercept	-0.503	.913	-.551	.583
CA	-0.080	0.138	-0.576	0.566
CC	0.086	0.092	0.937	0.352
CD	0.244	0.170	1.434	0.155
HC	0.169	0.194	0.868	0.388
TE	0.644	0.196	3.280	0.002
CA*OT	0.034	0.055	0.609	0.544
CC*OT	-0.006	0.045	-0.124	0.901
CD*OT	-0.094	0.075	-1.257	0.212
HC*OT	0.028	0.086	0.325	0.746
TE*OT	0.003	0.093	0.033	0.974
OT	0.250	0.416	0.602	0.549

Note: OT = Organization type

Table 8. Results of regression analysis with Years of Agile Experience as a moderator

Variables	B	Standard Error	T value	p value
Intercept	1.226	1.078	1.138	0.258
CA	-0.091	0.15	-0.607	0.545
CC	0.180	0.118	1.52	0.132
CD	-0.028	0.184	-0.151	0.88
HC	0.206	0.201	1.022	0.310
TE	0.521	0.224	2.332	0.022
CA*AE	0.019	0.028	0.676	0.501
CC*AE	-0.022	0.022	-0.996	0.322
CD*AE	0.014	0.034	0.409	0.683
HC*AE	0.017	0.041	0.42	0.676
TE*AE	0.015	0.041	0.364	0.717
AE	-0.261	0.206	-1.266	0.209

Note: AE= Agile Experience

Hypothesis Testing Results

The result indicates that H4 and H5 are supported, and H1, H2, H3, H6, and H7 are not supported.

Table 9. Hypothesis testing result

Hypotheses	p-value	Result
H1: There is a significant effect of Customer Adaptive practices in determining the Agile Maturity Level of Software companies.	p>0.05	Not Supported
H2: There is a significant effect of Customer Collaboration practices in determining the Agile Maturity Level of Software companies.	p>0.05	Not Supported
H3: There is a significant effect of Continuous Delivery in determining the Agile Maturity Level of Software companies.	p>0.05	Not Supported
H4: There is a significant effect of Human Centric practices in determining the Agile Maturity Level of Software companies.	p<0.05	Supported
H5: There is a significant effect of Technical Excellence in determining the Agile Maturity Level of Software companies.	p<0.01	Supported
H6: Work experience with agile practices moderates the relationship of agile practices and the Agile Maturity Level.	p>0.05	Not Supported
H7: Software development organization type moderates the relationship between agile practices and the Agile Maturity Level.	p>0.05	Not Supported

DISCUSSION

The purpose of this research study was to analyze the elements that have an impact on the agile-based practices that are used in the Nepali software industry. The Agile Adoption Framework and the SAMI Index were used to compile the data that was used to establish and examine the factors and agile practices that need to be evaluated (Sidky et al., 2007).

First, it was believed that customer adaptive practices played a key role in establishing the level of agile maturity, but there was essentially no relevance of these practices in the context of the Nepali software sector. In the context of the Nepali software industry, though it correlates with very less influence, it is not one of the driving factors for Agile Maturity.

Likewise, even though Customer Collaboration is considered to be one of the most important components of the agile manifesto according to Batra et al. (2017), it does not appear to have a large relevance in the Agile Maturity Level in the firms that develop software in Nepal. Because most Nepali software companies are located offshore or provide services to outsourcing companies, there is a very slim chance of Nepali developers being able to interact with actual customers. This could be one of the reasons why the Nepali industry does not rely on Customer Adaptation and Collaboration as major factors of the Agile methodologies.

On the other side, continuous delivery has been found to have a substantial degree of correlation with the agile maturity level; however, it does not appear to be a significant predictor for the agile maturity level. According to Arachchi and Perera (2018), Continuous Delivery has the potential to make an agile process more effective.

However, the results of a study conducted on Nepali software companies show that it does not play a significant role in influencing the Agile Maturity Level as a predictor, even though it is highly correlated. According to Pope (2021), "human" aspects play a significantly more important role in the formation of agile organizations — specifically, firms that are able to demonstrate organizational agility in a seamless chain that begins in the stockroom and continues all the way up to the boardroom. This may be shown clearly in the research that was done on the Nepalese software sector. In the context of Nepal, human-centered practices have a very high level of correlation, which plays a vital role as a major predictor in predicting the agile maturity level.

Technical Excellence is the variable that has the highest level of association with the Agile Maturity Level, making it the most significant predictor of this quality. The quality of the code and the design of the program should be the primary concerns of developers; this appears to be the case in the Nepalese software sector as well (Alami & Paasivaara, 2021). The impact analysis reveals that the strong impact on the dependent variable is accounted for by the independent variable. This is because Technical Excellence has such a significant impact. Finally, the current research was unable to draw any conclusions regarding the influence of moderators on the Agile Maturity Level, such as the number of years spent working with agile methods or the type of organization. Julian et al. (2019) hold the idea that more experienced teams often value autonomy in their work, flexibility in their approaches, and a desire to assess and adapt them over time. Julian et al. (2019) believe that it may be because agile has not been around for a long enough time to have accumulated enough data for research, or maybe it is because the number of people that use agile has not grown to a significant enough level yet. In the current climate of the Nepali software business, these moderators do not appear to be of that much significance in terms of determining the Agile Maturity Level of the various organizations.

CONCLUSION

The current study aimed to evaluate the Agile Maturity Level of software companies in Nepal and the impact of agile techniques on the level. The apparent problem that prompted this study was that Nepal's software sector is growing rapidly and many organizations are utilizing agile approaches for

software development, but the major components like Customer Collaboration, Adaptiveness, and Evolutionary approaches, which can determine the maturity level of agile adoption, remain unknown. The average Agile Maturity Level of the Nepalese software industry is slightly above "effective", driven by the acceptance of changes and client values, frequent delivery of practical software, the importance of people in the business, and technology and knowledge.

Nepali software companies have reached the Adaptive Level of Agile Maturity, which involves adjusting to process change and detecting and responding to feedback. Nepali software companies' agile techniques are collaborative, evolutionary, and effective. As most software firms in Nepal are offshored or outsourcing organizations, employees or development teams do not have appropriate exposure to their customers, hence Customer Adaptive practices and Customer Collaboration are not properly related to the Agile Maturity Level of the Nepali software industry. Continuous Delivery is correlated with Agile Maturity Level but is not a predictor.

From this, we can conclude that the most basic idea of implementing agile is iterative software development, and iterations are done to deliver a PSI in each iteration, which is called continuous delivery. It can be strongly linked with how agile practices are in place, but it cannot be considered an independent variable that can predict agile maturity. Agile maturity affects continuous delivery, stronger agile techniques, and better software delivery.

In Nepal's software sector, Technical Excellence and Human Centric practices determine Agile Maturity Level. Nepal's software sector is doing well thanks to high levels of technological competence and human-centric methods. Foreign companies are prepared to receive services and goods from Nepali software companies, where technological competency is a priority. All processes that indicate the value of people must be in place for highly trained people to work together. The Nepali software industry emphasizes these practices to remain nimble.

IMPLICATIONS

Concerning the topic of agile implementation in software companies in Nepal, the main goal of this study is to find out if there is a relationship between its basic principles, how it is used, and how mature it is. There has not been any research like this done in Nepal before, so this is important. This subject would be about the most important thing that determines how agile a software company is. The study is important for business owners and managers, in particular. This study looks at the effects of different agile practices to find out what works best in Nepal to reach a high level of agile maturity and make sure projects turn out well. There has not been any research like this done in Nepal that anyone could use to get a good look at their organization's worries about agile strategies and plans.

The strength of Nepali software industries to deliver products and services using agile is their technical excellence and human-centered practices. However, companies should now focus on client collaborations and adaptation-related practices so that they can reach the maturity level defined by the Adaptive Level in the SAMI index. The Nepali software industry could then reach an all-around level of Agile maturity, with a focus on making a lively environment to keep and improve agility everywhere.

Due to the limitations of this research, the idea can be looked at and studied in more depth in the future by taking into account other factors that affect the level of agile maturity. Even though we can all agree that practices can get better over time, the fact that years of experience with agile do not act as a balancing factor for both agile practices and the Agile Maturity Level is something that could be looked into further.

Furthermore, agile is used in offices where foreign stakeholders are involved, but the type of organization did not seem to have any effect on figuring out how mature agile is, which still needs to be looked into more. This study looks at the agile practices that lead to better agile maturity. Some of

the findings are the same as those in the literature, but others are different in the context of Nepal. This research is important for managers and business owners in the software industry because it shows how the situation in Nepal is different from that in other countries. This study also shows that more research needs to be done on Agile practices, their level of maturity, and the factors that affect them in Nepal.

REFERENCES

Alami, A., & Paasivaara, M. (2021). How do agile practitioners interpret and foster "technical excellence"? In R. Chitchyan, & J. Li (Eds.), *Evaluation and assessment in software engineering* (pp. 10–19). Norwegian University of Science and Technology. https://doi.org/10.1145/3463274.3463322

Arachchi, S. A. I. B. S., & Perera, I. (2018, May). Continuous integration and continuous delivery pipeline automation for agile software project management. *Proceedings of the Moratuwa Engineering Research Conference, Moratuwa, Sri Lanka,* 156–161. https://doi.org/10.1109/MERCon.2018.8421965

Batra, D., Xia, W., & Zhang, M. (2017). Collaboration in agile software development: Concept and dimensions. *Communications of the Association for Information Systems*, *41*(1), 429–449. https://doi.org/10.17705/1CAIS.04120

Beck, K., Beedle, M., Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). *Manifesto for agile software development.* https://agilemanifesto.org/principles.html

Boehm, B. (2002). Get ready for agile methods, with care. *Computer*, *35*(1), 64–69. https://doi.org/10.1109/2.976920

Campanelli, A. S., & Parreiras, F. S. (2015). Agile methods tailoring – A systematic literature review. *Journal of Systems and Software*, *110*, 85–100. https://doi.org/10.1016/j.jss.2015.08.035

Dixit, K. M., & Lohani, R. D. (2017). *Computerization in Nepal: State of hardware and software business.* Institute for Social and Environmental Transition – Nepal. http://isetnepal.org.np/wp-content/uploads/2019/02/ISET-Computerization-in-Nepal-final-.pdf

Duka, D. (2013, May). Adoption of agile methodology in software development. *Proceedings of International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO),* 426–430.

Elssamadisy, A. (2008). *Agile adoption patterns: A roadmap to organizational success.* Addison-Wesley.

Herbsleb, J. D., & Moitra, D. (2001). Global software development. *IEEE Software*, *18*(2), 16–20. https://doi.org/10.1109/52.914732

Jain, R., & Suman, U. (2016). Effectiveness of agile practices in global software development. *International Journal of Grid and Distributed Computing*, *9*(10), 231–248. https://doi.org/10.14257/ijgdc.2016.9.10.21

Julian, B., Noble, J., & Anslow, C. (2019). Agile practices in practice: Towards a theory of agile adoption and process evolution. In P. Kruchten, S. Fraser, & F. Coallier (Eds.), *Agile processes in software engineering and extreme programming* (pp. 3-18). Springer. https://doi.org/10.1007/978-3-030-19034-7_1

Khan, S. U., & Niazi, M. (2012, June). Critical challenges in offshore software development outsourcing: An empirical study. *IASTED International Conference on Software Engineering, Greece.* https://doi.org/10.2316/P.2012.780-019

Mishra, A., Abdalhamid, S., Mishra, D., & Ostrovska, S. (2021). Organizational issues in embracing agile methods: An empirical assessment. *International Journal of System Assurance Engineering and Management*, *12*(6), 1420–1433. https://doi.org/10.1007/s13198-021-01350-1

Nerur, S., & Balijepally, V. (2007). Theoretical reflections on agile development methodologies. *Communications of the ACM*, *50*(3), 79–83. https://doi.org/10.1145/1226736.1226739

Ozcan-Top, O., & Demirörs, O. (2013). Assessment of agile maturity models: a multiple case study. In T. Woronowicz, T. Rout, R. V. O'Connor, & A. Dorling (Eds.), *Software process improvement and capability determination* (pp. 130–141). Springer. https://doi.org/10.1007/978-3-642-38833-0_12

Pirlea, C. (2019). *AGILE – The art of adapting to change and innovation.* https://a-connect.com/knowledge/agile-the-art-of-adapting-to-change-and-innovation/

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879. https://doi.org/10.1037/0021-9010.88.5.879

Pope, C. (2021, February 16). *Why human-centric metrics are essential to business agility.* https://www.service-now.com/uk/blogs/2021/why-human-centric-metrics-are-essential-to-business-agility.html

Sidky, A. (2007). *A structured approach to adopting agile practices: The agile adoption framework* [Doctoral dissertation, Virginia Tech]. https://vtechworks.lib.vt.edu/bitstream/handle/10919/27889/asidky_Dissertation.pdf?sequ

Sidky, A., Arthur, J., & Bohner, S. (2007). A disciplined approach to adopting agile practices: The agile adoption framework. *Innovations in Systems and Software Engineering*, *3*(3), 203–216. https://doi.org/10.1007/s11334-007-0026-z

Taylor, P. S., Greer, D., Sage, P., Coleman, G., McDaid, K., & Keenan, F. (2006, May). Do agile GSD experience reports help the practitioner? *Proceedings of the 2006 International Workshop on Global Software Development for the Practitioner, Shanghai, China,* 87–93. https://doi.org/10.1145/1138506.1138526

Turetken, O., Stojanov, I., & Trienekens, J. J. (2017). Assessing the adoption level of scaled agile development: A maturity model for Scaled Agile Framework. *Journal of Software: Evolution and Process*, *29*(6), e1796. https://doi.org/10.1002/smr.1796

Xiaohu, Y., Bin, X., Zhijun, H., & Maddineni, S. R. (2004, May). Extreme programming in global software development. *Canadian Conference on Electrical and Computer Engineering, Niagara Falls, ON, Canada,* 1845–1848. IEEE. https://doi.org/10.1109/CCECE.2004.1347565

Zaitsev, A., Gal, U., & Tan, B. (2020). Coordination artifacts in agile software development. *Information and Organization*, *30*(2), 100288. https://doi.org/10.1016/j.infoandorg.2020.100288

AUTHORS

Gangaram Biswakarma is currently working as Assistant Professor in the Central Department of Management and Deputy Director in the School of Management, Faculty of Management, Tribhuvan University, Nepal. He earned his Ph.D. in Management (OB/HR) from JJT University, India. He has completed his M.Phil., MBA, MTM, and PGDHSM from various universities in India. He has also competed FDP from IIM Shillong, India. He is currently a Post-Doctoral Fellow at Srinivas University, India. His research interests include OH/HR, sustainability, tourism management, and IT management.

Poojan Bhandari is a Software Architect at Ghimire Group Private Limited, in Kathmandu, Nepal. He has a B.E. in Computers from the Purbanchal University of Nepal and has completed an MBA in Information Technology from the School of Management at Tribhuvan University, Nepal. His research interests include applying a metrics-based approach to determining better software development practices. Being a certified scrum master and scrum developer, his expertise lies in web application developments and the processes followed in the course of those product development.