Master of Science in Information Systems – Digital Business Systems

Bridging the Gap: Understanding the Adoption of Gamification for Technical Debt Management in Agile Software Development

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Abstract

Most software companies have adopted agile methodologies for their software development projects. Due to its delivery-oriented nature, Agile Software Development (ASD) is more prone to Technical Debt (TD) than traditional project management methodologies, as developers tend to prioritise short-term gains over long-term code quality. This practice can lead to challenges in managing the TD incurred, ultimately affecting the long-term software quality. Therefore, TD prioritisation is essential when implementing new features in agile projects. Despite the importance of Technical Debt Management (TDM) in ASD, the area still lacks systematic processes. TD is associated with less progress and wasted time and software developers are assumed to spend approximately one day a week repaying TD. Prior research has attempted to implement game design elements into the software development process to develop high-quality codes. These studies indicates that Gamification can be useful as a motivational tool for developers to manage TD in ASD. This study utilises a complementary mixed-method approach, comprising a quantitative questionnaire and qualitative interviews to investigate what affects software companies' Behavioural Intention to adopt Gamification for TDM in ASD. The study develops five hypotheses based on a proposed UTAUT-TTF model and emphasises the significant effect of Social Influence and Task-Technology Fit in facilitating the adoption of Gamification. This study presents potential implementation challenges and factors affecting Norwegian software developers' adoption intention towards Gamification for managing TD in ASD. Qualitative interviews are conducted to understand the underlying reasons for the results obtained from the quantitative data analysis. The main finding implies that managers should be aware of software development teams and their unique preferences and approaches for ASD. Managers should consider the purpose, challenges, and potential when introducing game elements and features to the development process. Careful consideration is essential for the game elements to be effectively integrated into TDM in ASD and successfully adopted by team members.

Keywords: *Gamification, Technical debt, Agile Software Development, UTAUT, TTF*

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Abbreviations

APM = Agile Project Management

ASD = Agile Software Development

BI = Behavioural Intention

EE = Effort Expectancy

FC = Facilitating Conditions

IDT = Innovation Diffusion Theory

IS = Information Systems

PE = Performance Expectancy

SCT = Social Cognitive Theory

SI = Social Influence

TAM = The Technology Acceptance Model

TD = Technical Debt

TDM = Technical Debt Management

TPB = The Theory of Planned Behaviour

TRA = Theory of Reasoned Action

TTF = Task-Technology Fit

UTAUT = The Unified Theory of Technology Acceptance and Use

1.0 Introduction

As of today, most software companies have adopted agile methodologies for software development projects (Rios et al., 2019). Agile methodologies are an iterative approach breaking a project into smaller cycles, allowing quick delivery and responses (Dybå et al., 2014; Holvitie et al., 2018). The agile approach is helpful in dynamic resource-scarce environments, especially when dealing with short deadlines for delivery and unpredictable situations (Dingsøyr et al., 2012; Holvitie et al., 2018).

Due to its delivery-oriented nature, Agile Software Development (ASD) is recognised in literature as more prone to software quality issues (Holvitie et al., 2018; Rios et al., 2018). These software quality issues are also acknowledged as Technical Debt (TD), a metaphor first introduced by Cunningham in 1992 (Cunningham, 1993). The TD metaphor describe scenarios where developers make beneficial implementations to meet urgent requirements in the short term but can lead to future challenges (Brown et al., 2010; Cunningham, 1993). Although TD is acknowledged, its effect on software processes remains unknown (Holvitie et al., 2018). Agile practitioners must be aware of several TD implications in agile projects including its continuance, economic importance, and the strategies to repay it (Behutiye et al., 2017).

Effective Technical Debt Management (TDM) is fundamental to improve software quality in agile projects (de Lima et al., 2022; Lenarduzzi et al., 2021). As of today, it is assumed that software developers spend approximately one day a week repaying TD (Crespo et al., 2022). Accumulating TD can be an intentional or unintentional decision (Holvitie et al., 2014). If Unintentional TD is not managed, the debt can increase and result in high maintenance efforts to keep the system running. High maintenance efforts further affects the time available to incorporate new capabilities to the system (Behutiye et al., 2017). Understanding how TD should be prioritised is therefore essential when implementing new features in agile projects (Lenarduzzi et al., 2021).

TDM includes locating the sources of additional software maintenance costs and determining when improving the software system and adding new features is profitable and advantageous (Tom et al., 2013). TDM in ASD determines the long-term success of the software (Holvitie et al., 2014). Several tools and management techniques have been proposed to support the management of TD and one of the proposed techniques is Gamification (Haendler & Neumann, 2019). Gamification can be described as using game elements in a non-game context and is promising for improving software processes (Deterding et al., 2011; Foucault et al., 2018).

Perhaps the most valuable resource of a software organisation is its developers (Stol et al., 2022). One of the most critical factors that must be considered in a software project is therefore developer training, as the quality of the code can affect the project's success (Moser et al., 2021). The concept of gamifying software development involves integrating game elements into the development process, which aims to change developer behaviour (García et al., 2017; Marques et al., 2020). Gamification in software development processes has already proved beneficial as an effective mechanism to motivate, engage and encourage code review tasks in addition to improve agile processes (Porto et al., 2021; Stol et al., 2022). There are several studies introducing Gamification to the TD metaphor. Most of these studies have been conducted in learning environments to motivate students to write high-quality code in programming assignments (Dubois & Tamburrelli, 2013; Kasahara et al., 2019; Moser et al., 2021). Results from these studies have shown that Gamification techniques can be a strong motivational driver to remove code smells and students wrote significantly higher quality code under Gamification conditions (Dubois & Tamburrelli, 2013; Kasahara et al., 2019; Moser et al., 2021).

Despite the increased awareness and importance of TDM in ASD, the area still lacks systematic processes (Holvitie et al., 2018). Prior studies have attempted to capture the TD paths and previous research shows that Gamification can be used to manage TD in ASD (Haendler & Neumann, 2019; Holvitie et al., 2018; Stol et al., 2022). Gamification is mainly introduced for learning purposes, but has gained attention within software development research to improve the quality of software products in agile settings (Haendler & Neumann, 2019; Stol et al., 2022). Although Gamification is a recent topic of interest, several studies emphasise difficulties and challenges for its implementation in software companies. The main challenges reported are the lack of user engagement and performance (Porto et al., 2021). The implementation of Gamification lacks theoretical foundations to evaluate whether software companies are willing to adopt Gamification to manage TD in agile software projects. Given the current research gap in this area, we aim to respond to the following exploratory research question:

What affects Norwegian software companies' behavioural intention to adopt Gamification as a tool for managing technical debt in agile software development?

This research intends to enhance the existing knowledge on Gamification and its role in managing TD. Regardless of previous research on the opportunities and challenges with Gamification for managing TD, little is known about practitioners' behavioural intention to adopting it. This research aims to fill this gap and provide insights from the experiences of practitioners in Norwegian software companies and their adoption intention of Gamification for TDM in ASD. The Norwegian market is chosen to avoid any potential bias in work cultures from other countries. The findings of this research can shed light on the perceived value of Gamification as a tool for motivating developers to produce high-quality codes. They can further contribute to the literature on Gamification adoption by empirically testing adoption theories in the context of TDM in ASD projects.

1.1 Research Structure

The present research is structured as follows: chapter two provides an overview of the method employed to synthesise dimensions addressed in the relevant literature and presents the conceptual background on TD, TDM, ASD, TD in ASD, Gamification, and Gamification for overcoming TD in ASD. Chapter two further propose a conceptual research model and presents the hypotheses for this research. Chapter three explains the methodologies applied, while chapter four present the analysis results. Chapter five discusses the research findings. Chapter six present and this research implications for practice and research in addition to the research contributions, limitations, and recommendations for further research. The conclusion sums up this research and is presented in chapter seven. Lastly, the reference list and appendices are provided in chapter eight and nine.

2.0 Literature Review

A review of prior literature is essential for academic projects and creates a foundation for future research in areas where research is needed (Webster & Watson, 2002). This research employed a systematic approach for the literature review to determine the source material as suggested by Webster & Watson (2002). The search is conducted in the timeframe from September 2022 to April 2023.

When settling on key search terms, the researchers made multiple changes to encounter the best search result criteria. The leading information systems journal, MIS Quarterly, in addition to IEE, ACM and Oria was used to find relevant articles using similar terms. A supplementary search was conducted on Google Scholar to ensure complete coverage and prevent potential exclusion of relevant articles. A combination of the following keywords was used in the initial literature search: “Adoption,” “Agile,” “Agile project management,” “Agile software development,” “ASD,” “Gamification,” “Gamification elements,” “Gamification in software development,” “Game applications,” “Motivation,” “Norwegian,” “Software development,” “Technical debt,” “Technical debt management,” “Task-technology fit,” “TD,” “TTF,” “Unified theory of acceptance and use of technology,” “UTAUT,” and “UTAUT-TTF.”

A “backward/forward” search method was employed to minimise the risk of excluding relevant research, as proposed by Webster & Watson (2002). This search method aims to comprehensively analyse the reference list of the primary studies identified in the initial literature search for the potential inclusion of additional relevant research. The papers included in the conceptual background were screened based on thoroughly examining the article's title, abstract, discussion, and conclusion of the articles obtained during the literature search.

To ensure high-quality literature, specific inclusion criteria were established before the initial literature search. The review included articles written in English and with at least one author. Articles had to be either peer-reviewed or conference papers. Lastly, the articles had to available in full text and free of charge. The primary objective of this literature review is to investigate the degree to which software companies operating in the Norwegian market are receptive to implementing Gamification to manage TD in the context of ASD.

Agile methodologies was first introduced through the publication of the Agile Manifesto in 2001 and started to gain popularity in the software development industry in the early 2000s (Meyer, 2014). Further, Venkatesh et al. (2003) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) in 2003. Goodhue and Thomson developed the Task-Technology Fit model (TTF), which was inspired by the framework created by DeLone and McLean in 1992 (DeLone & McLean, 1992; Goodhue & Thompson, 1995). Given the rapid change in the information technology climate, more recent literature on the topic has been selected. The literature for the conceptual background in this research is based on the information above and articles published between 2003-2023 have therefore been prioritised for inclusion. In addition, the four articles regarding TTF published in 1992,1995 and 1999 have also been included as they are considered significant contributors to the conceptual background for this research.

Relevant articles included in this review will be presented in the conceptual background. This research proposes a research model by combining elements from UTAUT and TTF. The proposed theoretical model lays the ground for empirically investigating and testing the Behavioural Intention (BI) to adopt Gamification for TDM in agile projects and is explained in the next section.

2.1 Conceptual Background

This section presents definitions of the core concepts in this research. The topics introduced in this section will further lay the foundation for the upcoming analysis, discussion, and conclusion.

2.1.1 Technical Debt

The concept of TD was first explained by Ward Cunningham at the OOPSLA conference in 1992 (Cunningham, 1993). Cunningham defined the TD concept as a metaphor:

"[…] *...Although immature code may work fine and be completely acceptable to the customer, excess quantities will make a program unmasterable, leading to extreme specialization of programmers and finally an inflexible product. Shipping first time code is like going into debt. A little debt speeds development so long as it is paid back promptly with a rewrite. Objects make the cost of this transaction tolerable. The danger occurs when the debt is not repaid. Every minute spent on not-quite-right code counts as interest on that debt. Entire engineering organizations can be brought to a stand-still under the debt load of an unconsolidated implementation, object-oriented or otherwise..."* (Cunningham, 1993, p. 30).

Similar to financial debt, TD incurs interest payment in the form of future costs for repaying the debt from trading long-term code quality for a short-term gain that can lead to quality issues (Brown et al., ; Crespo et al., 2022; Foucault et al., 2018; Fraser et al., 2013; Kruchten et al., 2013). The metaphor describes a scenario in software development where developers make compromises (e.g., writing lower-quality code) to address an urgent requirement in the process (e.g., short deadlines) (Brown et al., 2010). TD was originally a metaphor for bad code in coding practices. Following its introduction, the TD metaphor has been expanded within research to include other phases of the software development lifecycle (Brown et al., 2010). A wide range of definitions has been suggested by other authors to simplify, clarify, and adapt the TD concept to various scenarios (Kruchten et al., 2012). Avgeriou et al. (2016) refined TD as "[…] *a collection of design or implementation constructs that are expedient in the short term but set up a technical context that can make future changes more costly or impossible.* […]" (Avgeriou et al., 2016, p. 112).

TD occurs in other phases of the software development process (Lim et al., 2012; Santos et al., 2022), such as design (Zazworka et al., 2011), architectural (Martini et al., 2014), requirements (Brown et al., 2010), people and documentation debt (Kruchten et al., 2013; Santos et al., 2022), illustrating the same effect of "cutting corners" at various stages. A study performed by Avgeriou et al. (2016), showed that the most discussed causes of TD were architecture, design, code, and testing. Architectural debt is caused by decisions that compromise the internal quality aspects. Shortcuts within the detailed design can cause design debt. Further, poorly written codes can lead to code debt (Avgeriou et al., 2016). Martini et al. (2014) specifically investigated architectural debt and highlighted eight factors causing TD for architectural debt, including time pressures, human factors, and reuse of legacy. Rios et al. (2019) highlighted causes of TD in ASD and observed deadlines as the most common cause of TD in these development processes. Additionally, low maintainability and delivery delays were common effects of TD in ASD. The authors further found that non-adoption of good practices, inappropriate planning, and lack of commitment can incur debt. Low-quality codes were found to be the most frequent effect of TD for ASD. Zazworka et al. (2011) explain that the issue of invisible debt represents a considerable challenge in software development, leading to an increased amount of TD. Although some team members may have recognized the negative effects of TD, others remained unaware or underestimated its impact. The lack of awareness or visibility of TD led to accumulation of invisible debt, which, instead of being promptly addressed, had to be repaid later.

2.1.2 Technical Debt Management Activities

Understanding how TD is accumulated and why, is essential to make appropriate decisions when managing it (Rios et al., 2019; Zazworka et al., 2011). Li et al. (2015) conducted a systematic mapping study on TDM. From 94 papers, the authors identified that the management process consists of eight activities, with TD repayment, TD identification, and TD measurement being the most common. The commonly discussed approaches for the three activities are code analysis, calculation models, and refactoring (Li et al., 2015). Holvitie et al. (2018) performed a multi-national survey. From 184 responses, they identified management activities, verifying, and maintaining the structure and clarity of implemented artifacts as the most used TDM activities in practice.

Existing research proposes several approaches for managing TD in ASD. The management approaches are often based on the developer's point of view (Santos et al., 2022). Santos et al. (2022) investigated how project managers manage and experience TD for ASD. Their results indicate that project leaders manage, and experience TD differently opposed to other roles in the ASD process (e.g., developers). Research by Besker et al. (2020) focused on the human aspect of TD accumulation. Their findings indicate that TD is associated with less progress and wasted time. TDM activities, therefore, positively influence developers' morale and productivity.

2.1.3 Agile Software Development

Recently, organisations have changed from traditional project management to APM. Agile has merged to be the most successful approach for software development and proposes changes for management and practice to increase reputation and profit margins (Azanha et al., 2017; Dybå et al., 2014; Naik & Jenkins, 2019). ASD refers to cooperative working based on ideas and principles, which has merged into the preferred approach for the software industry (Naik & Jenkins, 2019). Unlike traditional project management APM promotes shared decision-making, self-management, and learning within software teams to address software's fundamental aspects (Dybå et al., 2014). The method is frequently applied to address the challenges and unpredictability of project activities in software projects, e.g., requiring a tight timeframe between planning and delivery time (Dybå et al., 2014). APM is based on the same concepts from the Agile Manifesto, which focuses on individuals, interactions, functional software, customer collaboration, and responding to change in software development (Dybå et al., 2014).

Despite the benefits of ASD, existing research indicates challenges regarding management, prioritising, learning, and communication within effective teamwork (Strode et al., 2022). Strode et al. (2022) presented the agile teamwork effectiveness model for those involved in APM to predict teamwork effectiveness. To this date, Scrum, Crystal and Dynamic Systems Development Method, and eXtreme Programming are the most practiced agile methods among companies in different industries. Scrum and eXtreme programming have shown to be the most adopted methods within the software development industry (Holvitie et al., 2018; Naik & Jenkins, 2019).

2.1.4 Technical Debt in Agile Software Development

Existing research indicates that TD recently has gained popularity among practitioners in the software development industry (Behutiye et al., 2017; Holvitie et al., 2018). TD has proved to be understood by non-technical members (e.g., managers and customers), which can close the communication gap between technical and non-technical individuals in projects (Holvitie et al., 2018). Understanding TD and its causes in agile software projects is essential for identifying and making appropriate TD decisions at the right time (Behutiye et al., 2017; Rios et al., 2019; Zazworka et al., 2011). For instance, when ASD project groups are aware of TD and its consequences, agile developers can take advantage of it and plan how to handle and further use it to gain opportunities instead of taking paths that negatively affect the development (e.g., decrease the quality of a software product) (Behutiye et al., 2017).

Guo et al. (2016) explained that "*Agile development appears to be more prone to technical debt accumulation compared to traditional software development approaches due to its delivery-oriented focus*." (Guo et al., 2016, p. 163). Despite the increasing studies, TD and its management are not sufficiently understood in the context of ASD (Behutiye et al., 2017). Behutiye et al. (2017) identified in their literature review that APM is prone to TD due to quick delivery, architecture, and design issues. The authors found 31 papers addressing TDM activities that assist decisions in ASD, revealing that refactoring is the most popular TDM strategy. Further, the authors found that ASD focus on delivering functional software instead of prioritising the documentation process. Current TDM strategies are not helpful enough, resulting in a lack of specific strategies and recommendations to handle, manage and prioritise TD in ASD projects (Behutiye et al., 2017). Caires et al. (2018) performed a survey to allocate ASD practices and processes that are sensitive to TD. Findings indicate that most instances of

TD are related to agile software implementation and arise from architectural deficiencies. Further, the size of a debt item is proportionate to its impact on the project. Refactoring and iteration were indicated to have the most positive effect on TDM (Caires et al., 2018).

2.1.5 Gamification

Although the concepts of Gamification were first introduced in the digital media industry, little academic research and adoption were performed before 2010 (Deterding et al., 2011). Deterding et al. (2011) were among the first to define Gamification and defined it as "*the use of game design elements in non-game contexts*" (Deterding et al., 2011, p. 1). Gamification relates to the term "game" and needs to be distinguished from "play" or "playfulness." Gaming consists of explicit rules and competition amongst participants to reach a discrete goal or outcome instead of playfulness, which denotes more free form (Deterding et al., 2011). In practice, Gamification can lead to developing a playful mindset and behaviour when playing the game. The most elementary use of Gamification is motivational affordances. Moreover, awarding participants for accomplishing an encouraging challenges (Deterding et al., 2011; Dubois & Tamburrelli, 2013).

Gamification encourage and increase participants' motivation by applying game elements (Stol et al., 2022). Hamari et al. (2014) investigated beneficial effects of Gamification and found that it provides a positive effect and provokes behaviours. Sailer et al. (2017) built their paper on the basic assumption that game design elements can be deliberately used to modify non-game contexts and purposely address motivational mechanisms. The authors studied the effects of different game design elements, including points, badges, leader boards, performance graphs, meaningful stories, avatars, and teammates. The results show that certain game design elements can be a key solution to address motivational challenges in working contexts if the game design elements are implemented properly based on well-established models (Sailer et al., 2017).

2.1.6 Gamification for Managing Technical Debt in Agile Software Development

Previous scholars have identified Gamification as a helpful approach in software development as it seeks to encourage a particular behaviour (Stol et al., 2022). Examples of encouraged behaviour include writing more tests, better documentation, improved commitment messages, and increased productivity (Dubois & Tamburrelli, 2013; Stol et al., 2022). Gamification in experienced software development teams can engage, train, monitor, and motivate software developers to overcome technical challenges and improve software quality. From a managerial standpoint, Gamification could impact financial incentives and support the evaluation of teams and employees (Dubois & Tamburrelli, 2013).

Studies have introduced Gamification for software development in the educational system and reported several positive effects (Dal Sasso et al., 2017; Dubois & Tamburrelli, 2013; Moser et al., 2021). Dubois & Tamburrelli (2013) propose a general approach for understanding how to successfully apply Gamification principles to software development. The authors conducted a preliminary experiment showing how Gamification affects software development behaviour and performance. Participants were students involved in a software development project. The results showed a significant increase in the software quality for the students with the Gamification approach as opposed to the software quality produced by students without it. Moser et al. (2021) conducted a single-case study on students working in a computer project environment. The researchers found that Gamification techniques help motivate developers to resolve issues related to software quality and facilitate knowledge transfer.

Teaching TDM is more complex in industrial settings than in educational ones (Guzmán & López, 2019). However, Gamification has been successfully implemented in addition to being beneficial for training and teaching scrum in industrial settings (Guzmán & López, 2019). Ebert et al. (2022) aimed to explain the usage of Gamification for software and IT companies by performing an industry case study. The results indicate that Gamification makes teaching exciting and impacts the learning in projects. Technologies continuously change, requiring software teams to learn and maintain the right skills and knowledge. Gamification can contribute to handling these challenges through its benefits, e.g., boosting the team' s performance. Ebert et al. (2022) recommend that companies must define their process and consider the potential risks before adopting Gamification.

Porto et al. (2021) aimed to characterise how Gamification has been adopted in non-educational software development activities by systematically mapping 103 studies. Their mapping found points and leader boards as the most used Gamification elements in agile software engineering. Further, these Gamification elements were most used to support code review. The authors reported that Gamification encouraged developers to revise codes and increased motivation and engagement to improve the quality of their work (Porto et al., 2021). Dos Santos et al. (2013) observed that the introduction of Gamification elements to manage and visualise high-level TD, combined with tools to measure it at low-level, motivated teams to improve quality and pay debts. Gamification enabled monitoring of the group's progression as it became visible. The visibility of the progression contributed to maintaining the team's motivation to sustain the progress. Gamification elements also played a role in social commitment and were a powerful mechanism to monitor the accumulation of TD within the agile teams (Dos Santos et al., 2013).

Prause & Jarke (2015) conducted a series of experiments using Gamification techniques to improve the adherence to conventions among software teams in an academic setting. The results showed that these methods could help improve the team's performance. They used a reputation system and various Gamification elements such as personal scores and leader boards to determine the compliance of the conventions. According to their results, developers were most likely to embrace Gamification techniques for various reasons, such as improving readability, supporting self-organisation, and reducing business costs. After conducting an analysis of the related studies, they found that Gamification techniques could help improve software quality (Prause & Jarke, 2015). Crespo et al. (2022) found that Gamification increases developers´ awareness of TD in their case study. The authors stated that companies should invest in staff training through these tools to raise awareness of TD. Gamification is found to be an effective mechanism for developers actively seek to improve their software development skills (Crespo et al., 2022; Stol et al., 2022).

The process of deriving Gamification lacks substantial evidence, and several researchers emphasise the issue of the adoption of Gamification without evidence (Dal Sasso et al., 2017; Dubois & Tamburrelli, 2013; Porto et al., 2021; Sailer et al., 2017). Barreto & França (2021) reviewed 130 articles to classify how software engineering researchers understand Gamification, identify elements of games used to motivate software engineers, and map areas of software engineering that have been addressed so far. They found that Gamification is expected to produce positive results in both the behavioural and technical dimensions. However, there is a lack of evidence on what it can bring to industrial software development settings. Porto et al. (2021) pointed out 18 difficulties and challenges for Gamification implementation in software teams. Finding a fair assignment of points or reward was the main challenge. Further, Software teams and individuals have different needs. Finding ideal elements that motivate everyone is complicated, as a result, Gamification tools may lose their intended motivational effects.

2.2 Theoretical Frameworks

This chapter provides a detailed overview of the theoretical concepts and frameworks that underpin the intended research. This chapter includes a review of relevant literature that supports the research hypothesis to answer the research question and provide a clear explanation of the proposed theoretical model that guides this research.

2.2.1 The Unified Theory of Technology Acceptance and Use

Several theoretical models have been developed to understand the acceptance and use of information systems over the past four decades, which is an ongoing management challenge (Schwarz & Chin, 2007). To unify the literature on the adoption of new technologies, Venkatesh et al. (2003) created the Unified Theory of Technology Acceptance and Use (UTAUT). UTAUT combines diverse viewpoints on user and innovation acceptance, allowing researchers and practitioners to identify fundamental influencing factors on acceptance in any context. The UTAUT is based on eight prominent models in IS adoption research. The following eight theories are the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model, the Theory of Planned Behaviour (TPB), a combined TBP/TAM, the Model of PC Utilisation, Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT) (Venkatesh et al., 2003). The theory suggests that four primary constructs are direct determinants to determine a user's Behavioural Intention of using information technology, namely- Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC) (Venkatesh et al., 2003).

Performance Expectancy is the degree to which people believe using the system will help them improve their job performance. It refers to the perceived benefits achieved using innovations to improve job performance (Venkatesh et al., 2003). The PE construct is based on factors from the theories UTAUT is established on, perceived usefulness in TAM, and relative advantage in IDT (Venkatesh et al., 2003).

Effort Expectancy is referred as *“the degree of ease associated with the use of the system”* (Venkatesh et al., 2003, p. 450). This construct originates from the perceived ease of use in TAM and the complexity of IDT (Venkatesh et al., 2003). In UTAUT, EE positively affects PE (Venkatesh et al., 2003). EE is the essential factor influencing an individual's decision to use technology, as it indicates the user's perception of how easy a system is to use (Venkatesh et al., 2003).

Venkatesh et al. (2003) defined Social Influence as "*the degree to which an individual perceives that important others believe he or she should use the new system*" (Venkatesh et al., 2003, p. 451). SI is similar to the subjective norm of TRA and reveal how user's social environment, such as friends, colleagues, and superiors, affects the user's behaviour and intentions to use a technology (López-Nicolás et al., 2008; Venkatesh et al., 2003).

Facilitating conditions is *"the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system"* (Venkatesh et al., 2003, p. 453). FC originate from TPB's perceived behavioural control and uncover the effect of a user's knowledge, ability, and resources (Venkatesh et al., 2003).

These four constructs (PE, EE, SI, FC) collectively influence Behavioural Intention, which significantly influence the intention to adopt and use the studied technology. The constructs are moderated by individual differences, including age, gender, experience, and voluntariness of use (Venkatesh et al., 2003). Since its establishment in 2003, academics have actively applied the UTAUT model as a theoretical lens in over 800 papers to conduct empirical studies of user intention and behaviour in technology adoption and diffusion research (Venkatesh et al., 2003; Williams et al., 2015). Existing research has examined different perspectives of UTAUT, e.g., RFID-enabled services (Nysveen & Pedersen, 2016), e-learning in developing countries (Abbad, 2021), e-government technologies (AlHadid et al., 2022; Venkatesh et al., 2011), Artificial Intelligence tools (Venkatesh, 2022), Metaverse (Lee & Kim, 2022), and Machine learning-driven clinical decision support systems (Berge et al., 2023). There is a growing interest in Gamification in managerial environments. Previous scholars have applied the UTAUT model to explore students Behavioural Intention to adopt gamified learning (Ofosu-Ampong et al., 2020), the effect of gamification on users intention to adopt internet banking (Rahi & Abd. Ghani, 2018), and the impact of gamification adoption on brand awareness and loyalty in tourism (Abou-Shouk & Soliman, 2021).

Although UTAUT is commonly used within IS research, studies using UTAUT to investigate users' adoption and acceptance of Gamification in ASD to reduce TD are limited. Incorporating game design elements into non-game settings aids in improving organisational efficiency by encouraging and increasing participants' motivation (Stol et al., 2022). As a result, the UTAUT model is applicable as it provides an understanding from a user engagement perspective (Rahi & Ghani, 2018). Using constructs of UTAUT can predict and evaluate what affects users in Norwegian software companies to adopt Gamification to manage TD in agile software projects.

2.2.2 Task-Technology Fit

The TTF was developed by Goodhue and Thomson in 1995, consistent with the presented theoretical framework by DeLone and McLean in 1992 (DeLone & McLean, 1992; Goodhue & Thompson, 1995). The TTF model evaluate and predict the acceptance and use of new technology applied mainly at the organisational level (Aljukhadar et al., 2014; Goodhue & Thompson, 1995; Vanduhe et al., 2020). The TTF evaluates the suitability between an individual, features of the technology (e.g., software, hardware, and data), and task features (the specific action performed to achieve the desired output) (Goodhue & Thompson, 1995; Vanduhe et al., 2020). TTF consists of five concepts: task characteristics, technology characteristics, TTF, technology utilisation, and performance impact (Goodhue & Thompson, 1995). Task and technology characteristics reflect specific details of the technology and its application. The TTF construct reflects the individual´s perceptions of whether the technology suits the task (Goodhue, 1992; Goodhue & Thompson, 1995).

TTF can be divided into three propositions (P1, P2, and P3). P1 suggests task and technology characteristics affect how well a user evaluates TTF. Task characteristics refer to a specific function or attribute of the technology and the degree to which it supports an individual to perform their tasks. To determine how well the technology or system suits the users to complete their tasks is measured by eight components, namely, data quality, locatability of data, authorisation to access data, data combability, training and ease of use, production timeliness, system reliability, and IS relationships with users (Goodhue & Thompson, 1995). Technology characteristics are measured by non-routineness (inability to evaluate search Behaviour), interdependence with other organisations, and job title (Goodhue, 1992; Goodhue & Thompson, 1995). P2 assess how the utilisation of information systems influences the user´s evaluation of TTF (Goodhue & Thompson, 1995). P3 evaluates "*user evaluations of the task-*

technology fit will have additional explanatory power in predicting perceived performance impacts beyond that from utilization alone" (Goodhue & Thompson, 1995, p. 219).

The TTF model has been examined from different perspectives, e.g., for the adoption and functionality of e-books for teaching and research (D'Ambra et al., 2013), and the adoption of shopper-facing technologies under social distancing (Covid-19) Wang et al. (2021). Although there is increasing research on TTF, fewer studies have investigated Gamification (Vanduhe et al., 2020). Specifically, it is unclear if adopting game applications fits agile software development and if Gamification can be a suitable tool for affecting the developer's motivation to produce high-quality codes.

2.2.3 Unified Theory of Acceptance and Use of Technology and Task-Technology Fit

Dishaw & Strong (1999) discussed the TAM model combined with TTF, resulting in an extension of the TAM incorporating the TTF construct. This proposed model was subsequently tested through path analysis, and the results indicated that the model provides an increased explanation compared to TAM or TTF alone. Notably, the proposed TAM-TTF model highlights the impact of perceived usefulness and perceived ease of use while excluding the exploration of facilitating conditions and social influence. Findings by Al-Maatouk et al. (2020) supported the TAM-TTF theory by examining students' behavioural intention to use social media as a learning method to increase their Advanced Placement Program in higher education.

UTAUT is based on the assumption that Social Influence and Facilitating Conditions are crucial to predict adoption behaviour. UTAUT performs better than other technology acceptance theories (such as TAM) as it incorporates a variety of aspects that impacts users behaviour and intention to use a technology (Venkatesh et al., 2003; F. Wang et al., 2022). The UTAUT constructs PE, EE, SI, and FC is adopted in this research to explore whether these constructs influence users' intentions to apply Gamification to manage TD in ASD. The aim of testing these constructs is based on the idea that users' acceptance and application of Gamification is a process where users accept the new technology. UTAUTs Moderating variables age, gender, experience, and voluntariness of use are not included due to the scope of this research. The proposed theoretical model for this research model retains the four original

UTAUT constructs and introduces the “Task- technology fit” construct to improve and enhance the model.

A combination of TTF and UTAUT postulates that the perceived fit between a task and technology is the main factor influencing the adoption of a technology. In line with the TTF model, technology and task characteristics predict the fit between technology and tasks (Goodhue & Thompson, 1995). According to the TTF model, users are not likely to adopt new technology if there is a gap between the task's requirements and the device's functionality (Goodhue, 1992; Goodhue & Thompson, 1995). The UTAUT model states that the user's SI and PE the adoption of new technology (Venkatesh et al., 2003). Perceived fit influences PE (Zhou et al., 2010). In addition, prior studies confirm that TTF affects Perceived Usefulness (PU) , resulting in a correlation between TTF and PE (Dishaw & Strong, 1999). Both PU and PE are similar in measuring how technology is expected to impact the user's performance (Davis, 1989; Venkatesh et al., 2003). The relationship between technology functionality and PE suggests that when a technology can complete a task, individuals' expectations increase accordingly. The correlation between task characteristics and Effort Expectancy proposes that technologies with higher functionality require less effort (Zhou et al., 2010).

Previous research has used the combination of UTAUT and TTF to explain user adoption of technologies in various contexts including, mobile banking (T. Oliveira et al., 2014; Zhou et al., 2010), e-government (Amrouni et al., 2019), massive open online courses (Wan et al., 2020), healthcare wearable devices (H. Wang et al., 2020), human resource information system (Alkhwaldi et al., 2022), tablet computers as learning tools (F. Wang et al., 2022) and smart home health care services (Kang et al., 2022). The proposed UTAUT and TTF model build an optimized conceptual model for this research as it aims to identify factors that affect software developers' adoption intention to use Gamification to support TDM in ASD.

2.2.4 Hypothesis Development

The four constructs of UTAUT and TTF are hypothesised to have a significant role as direct determinants of user acceptance and adoption behaviour.

Performance Expectancy (PE)

In this research, PE refers to the degree to which users expect Gamification to improve the TDM process when developing software under agile development processes. Users may intend to adopt Gamification if they think it can improve the TDM process in ASD. Venkatesh et al. (2003) proved that PE is the strongest predictor and significant measurement of BI. Further, research by Ofosu-Ampong et al. (2020) indicated that PE significantly influences the intention to use gamified learning. Rahi & Ghani (2018) proved PE to significantly influence users' intention to adopt internet baking with help from gamified elements, whilst results by Abou-Shouk & Soliman (2021) display a significant relationship between PE and BI of Gamification's adoption for brand awareness and loyalty in tourism. Based on the findings in previous studies, hypothesis H1 is obtained:

H1: *Performance Expectancy significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.*

Effort Expectancy (EE)

In this research, EE refers to the degree of ease associated with the use of Gamification in ASD processes. This factor suggests that users intend to accept Gamification for TDM if a gamified application is perceived as easy to use. Previous studies indicate that EE significantly affects users BI to use a particular technology (Abou-Shouk & Soliman, 2021; Ofosu-Ampong et al., 2020; Rahi & Ghani, 2018). Based on the findings in previous studies, hypothesis H2 is obtained:

H2: *Effort Expectancy significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.*

Social influence (SI)

SI has been found to strongly support the acceptance of information technology (Abou-Shouk & Soliman, 2021; Khurana et al., 2019). In this research, SI refers to the degree to which an individual will be motivated to use Gamification for managing TD in ASD if the people surrounding their use and report benefit from it. SI therefore, contributes to drive users' attitudes towards the use of Gamification for managing TD in ASD (Khurana et al., 2019). Aebli (2019) found that the individuals' connection to others are one rational motivate behind gamer´s adoption of Gamification, specifically leader boards. SI positively influence the attitude directly towards the use of Gamification (Rahi & Ghani, 2018). SI appears in several empirical studies on the acceptance of information technology and has received strong support from user behaviour. For example, SI is proven to significantly affect the behavioural intention to adopt information technologies (Abou-Shouk & Soliman, 2021). Based on the findings in previous studies, hypothesis H3 is obtained:

H3: *Social Influence significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.*

Facilitating Conditions (FC)

In this research, FC refers to the degree to which users perceive knowledge and skills are available from an organisational level to support the use of Gamification to manage TD in ASD. It is assumed that users intend to accept gamified applications if they perceive that resources are available to support implementing a game application to manage in ASD. FC appear in several empirical studies on the acceptance of information technology and have been proven to significantly affect behavioural intention (Abou-Shouk & Soliman, 2021; Ofosu-Ampong et al., 2020). Based on the findings in previous studies, hypothesis H4 is obtained:

H4: *Facilitating Conditions significantly affects the Behavioural Intention adopt Gamification for Technical Debt Management in Agile Software Development.*

Task-Technology Fit (TTF)

TTF assesses the match between the task and the features of the technology (Aljukhadar et al., 2014). In this research, TTF refers to the degree to which the users perceive Gamification as a suited tool for managing TD in ASD. TTF has been proven to significantly affect end-users adoption of Massive Open Online Courses (Wu & Chen, 2017). Dishaw & Strong (1999) noted that TTF affects the consumer's utilisation of technology. (D'Ambra et al. (2013) found that TTF significantly affects academic e-books adoption behaviour. Based on the findings in previous studies, hypothesis H5 is obtained:

H5*: Task-Technology Fit significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.*

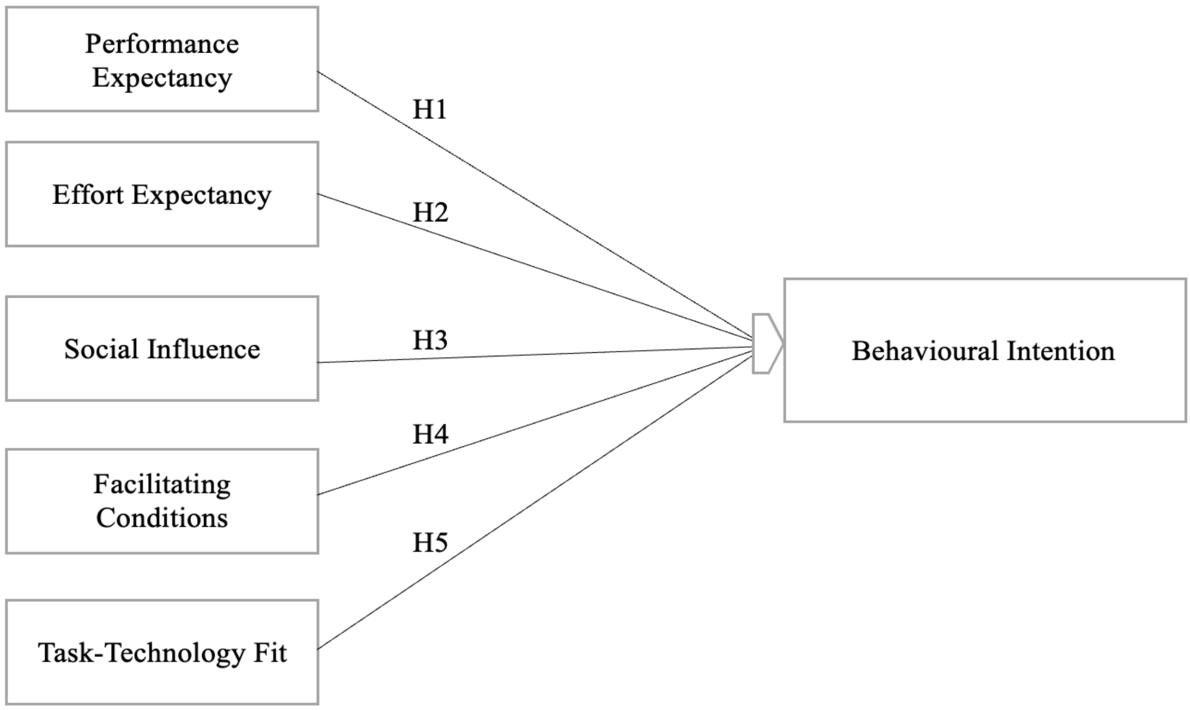

Figure 1: The proposed theoretical model combining UTAUT and TTF

This research utilises a proposed theoretical model, represented in Figure 1. Figure 1 illustrates the relationships between the independent and dependent variables and the corresponding hypotheses this research aims to explore. The following chapter will provide a detailed explanation of the methods employed for the data collection and hypothesis testing.

3.0 Research Methodology

As described in previous chapters, this research aims to identify what affects Norwegian software companies' Behavioural Intention to adopt Gamification for TDM in ASD. Five hypotheses are developed based on the proposed UTAUT and TTF model in the previous section. This research is based on empirical testing of theories and hypotheses, where findings from the empirical study result in support or reject through quantitative and qualitative data analysis, which can help strengthen or refine theory (Oates, 2006; Park et al., 2020). Hypotheses will be tested followed by semi-structured interviews to answer the research question and extend the current knowledge on the topic. The underlying philosophical view of this research is considered a positivism paradigm. Positivism is aligned with the hypothetical deductive model and grounded on the ontology that the world is assumed to be regular with universal laws and not random (Oates, 2006). The positivism paradigm is categorised as “the scientific method” which is an objective paradigm where research is conducted through measurements (Oates, 2006; Park et al., 2020). Research approaches and methods applied in this research will be further explained in the following subsections.

3.1 Research Approach

The objective of this research is to test the proposed UTAUT and TTF model to predict the behavioural intention to adopt Gamification to manage TD in ASD. This research uses a deductive approach by formulating hypotheses grounded in established theories, applies qualitative and quantitative methods, and therefore meets the requirements for mixed methods. Mixed methods research combines both quantitative and qualitative methods within a single study (Venkatesh et al., 2013). The mixed method research can enrich the understanding of the phenomenon and contribute complementary or contradictory conclusions from the quantitative analysis (Venkatesh et al., 2013). The mixed methods approach serve as a complementarity, as one method will clarify the results from another method (Ågerfalk, 2013; Fidel, 2008; Venkatesh et al., 2013). In this case, data is generated through a quantitative questionnaire and qualitative semi-structured interviews. These interviews are conducted based on the analysis of the quantitative data retrieved from the questionnaire. Collected data will be transformed, categorised in codes, and compared to find relevant similarities or differences (Oates, 2006; Pallant, 2020). The mixed methods approach including questionnaire and interviews, will be further addressed in the following sections.

3.2 Questionnaire

An online questionnaire was conducted to gather primary empirical data to explore the research question from a predefined population (Bryman et al., 2019; Oates, 2006). Online questionnaires allow respondents to take it at a time and location that is convenient to them (Oates, 2006). The questionnaire was developed to obtain standardised data from a large group of individuals in a time-efficient manner to generalise and arrive at a conclusion. The questionnaire included predefined and structured questions (Oates, 2006; Pallant, 2020). It is important to emphasise that questionnaire procedures do not always guarantee entirely accurate results. However the results grant more accurate conclusions as they eliminate errors that can occur in standard observational methods (Nardi, 2015).

The proposed UTAUT and TTF model assumes a relationship between variables exists based on the data obtained from a predefined sample population. These relationships are direct determinants of intention or usage (e.g., the relationships are either positive/negative) (Venkatesh et al., 2003). The questionnaire aims to test the proposed research model focusing on developers, who are potential users, and their Behavioural Intention to adopt Gamification for managing TD in the ASD. The following subsections include a detailed description of the questionnaire design.

3.2.1 Measurement Development

The questionnaire comprises two components, all consisting of closed questions, as closed questions make it easier for respondents to complete the questionnaire (Oates, 2006; Pallant, 2020). The first component contains general items of the participants related to their demographics: age, education, company size, TD, and Gamification experience. The age question was divided into groups (e.g., 23-29 and 51-57) to decrease implications for the statistical analysis as some respondents may not be comfortable sharing their exact age (Pallant, 2020).

The second component of the questionnaire consists of items measuring the basic constructs of the research model. They are arranged to test respondents' PE (four items), EE (four items), SI (three items), FC (four items), TTF (four items), and BI (three items) to adopt gamification for TDM in ASD. Items used in the second part of the research, derived from findings of typical studies investigating the UTAUT and TTF models to guarantee valid constructs (Abou-Shouk & Soliman, 2021; et al., 2013; Ofosu-Ampong et al., 2020b; T. Oliveira et al., 2014; Venkatesh et al., 2003; Wan et al., 2020; Yang et al., 2017; Zhou et al., 2010). Previous research states that the six constructs used in the questionnaire are essential for evaluating users' acceptance and willingness to adopt the technology (Goodhue, 1992; Goodhue & Thompson, 1995; Venkatesh et al., 2003). Adjustments were made to ensure the items are still valid to measure users' behavioural intention to adopt Gamification for managing TD in agile projects. The items' comprehensiveness and representativeness in creating the scale measure have also been considered. An overview of the items, along with their source, is included in Appendix 1**.**

To collect the required data, the second component of the questionnaire adopts a 7-point Likert-type scale from 1 (strongly disagree) to 7 (strongly agree). The Likert scale is among the most widely used measuring instruments in the information system field and is considered a part of attitude scaling techniques (Taherdoost, 2019). A Likert scale indicates the degree of agreement and disagreement toward various statements about a phenomenon and is likely to produce a highly reliable scale (Taherdoost, 2019). This scaling is chosen as it is easier to read and complete from the participant's perspective. However, weaknesses such as central tendency bias caused by participants avoiding the extremes or acquiescence bias has been considered when choosing the proper scale for this research (Taherdoost, 2019). 7-point scales are the most preferred rating scales and are included in this research as reliability increases when including more response options (Taherdoost, 2019). The Likert scale improves the statistical analyses and allows neutral responses (Pallant, 2020). Previous studies on TTF and UTAUT have used 5-point or 7-point Likert-scare for their questionnaire (Alkhowaiter, 2020; T. Oliveira et al., 2014; H. Wang et al., 2020; Zhou et al., 2010). A seven point Likert-scale has higher convergent validity, and including a midpoint will facilitate the collection of more valuable data (Preston & Colman, 2000).

3.2.2 Pre-test and Pilot Study

A pre-test was conducted to refine and improve the questionnaire, followed by a pilot study. The purpose of the pilot study was to check the quality of the content to indicate the appropriate language for each item in the questionnaire and ensure that the definitions provided were appropriate and applicable to the questions followed (Oates, 2006; Pallant, 2020).

The pilot study was emitted on 30 participants, of which 27 responded. It was sent to acquaintances within the domain to ensure the items were tested on the right target groups, and people lacking knowledge of the topic to secure an understandable language. Three participants contributed with detailed feedback through an interview after taking the questionnaire. The questionnaire was refined based on participants' feedback regarding the clarity and objectivity of the questions. Finally, a thorough review of the refined questionnaire was executed before it was finalised and ready to be sent out.

3.2.3 Participants and Settings

The population of the present research contains different groups of individuals in companies utilising ASD approaches. Potential respondents for the questionnaire were primarily developers in Norwegian software development companies, but other relevant parties and stakeholders involved in the software development process were also included. A non-probabilistic, purposive sampling in conjunction with snowballing sampling was applied. Snowball sampling offers suggestions from the target population about other people relevant to the research topic (Bryman et al., 2019; Oates, 2006). Purposive sampling can potentially offer valuable data from a wide variety of respondents. These sampling methods were chosen to avoid delimiting or excluding possible respondents.

E-mail addresses for companies that fit the population criteria were acquired from publicly available lists of technological companies, their websites, LinkedIn, and personal acquaintances with a connection to people within suitable companies. To avoid a convenience selection from participants on LinkedIn, the post specified criteria for the potential respondents needed. In contrast to general-purpose social media platforms such as Facebook, LinkedIn is a specialised networking site to connect professionals across various fields. This specificity of LinkedIn enables the targeting of data collection efforts towards an appropriate social network, thereby offering a better ability to concentrate potential participants (Dusek et al., 2015).

Each e-mail address found was saved in an Excel worksheet to maintain a system and avoid duplicates. The questionnaire was distributed to every e-mail in the spreadsheet via Nettskjema. General contact forms and managers' e-mails were available on some web pages. In this case, e-mails were sent individually requesting to share the questionnaire link with relevant colleagues that fit the population criteria. The contact person had to confirm before they received the link.

3.2.4 Response Rate

In total, 976 individual e-mails were sent out. To increase the response rate, two reminders were sent after the initial e-mail. The reminder excluded individuals who already responded to the questionnaire, confirmed they would not participate, or confirmed they were not the right person to ask. The common feedback was that the company either outsourced its software development services, lacked time or interest, or needed more acquired prerequisite knowledge.

150 responses were collected from the questionnaire resulting in a response rate of 15.4%. The initial response rate was 33 respondents (3.4%). To increase this number, a reminder was sent out. The reminder increased the total responses by 59% (from 33 to 88). The e-mail collection was responsible for approximately 59% of the responses, individual e-mails asking to share the link were responsible for 37%, and responses from LinkedIn were responsible for 4%.

3.2.5 Procedure

This research began with a thorough literature review of existing research on the topic. The literature review lays the foundation for the research question and purpose of this research (Webster & Watson, 2002). A theoretical model has been proposed to structure and plan the appropriate research methods to extract data for this research. Further, a research-appropriate questionnaire was developed based on previous research and the proposed UTAUT and TTF model.

Before conducting the questionnaire, an application was sent to Sikt to ensure appropriate data collection. The application was approved after one day and the questionnaire was sent out the same week. Invitations containing a link to the questionnaire was sent through Nettskjema in addition to posting the link on LinkedIn. The terms and condition for participation were elaborated in the introductory part of the questionnaire (attached in Appendix 2). Respondents receiving the questionnaire had to accept the terms and conditions before being able to answer the questionnaire. Additionally, the introduction contained the researchers' contact information followed by instructions on how to withdraw answers at any time. Respondents were assured that all data will be deleted when the project ends, which according to the plan, is by the end of July 2023. By proceeding from the introductory part to answer any questions, participants consented to partake in the research by clicking the "next" button.

After agreeing to the terms and conditions of the questionnaire, participants were transmitted to the first component. When proceeding to the second component, a glossary was included at the beginning. The glossary in the second component was included to define and exemplify terms and acronyms of how Gamification could be used to manage TD in ASD. Respondents were asked to rate 22 items based on the extent they agreed or disagreed with them from an agile perspective. After completing the questionnaire, participants received a confirmation that the form had been delivered, followed by an option to get the receipt by e-mail.

3.2.6 Data Analysis

3.2.6.1 Coding

The initial step in the data analysis process involved extracting the raw data from the online questionnaire platform Nettskjema.no to Excel. All subsequent statistical analyses were performed using IBM SPSS® Statistics version 27. Before importing the data from Excel to SPSS, variable names and coding instructions were established in a codebook (Appendix 3). The source data were then verified and inspected for errors, paying particular attention to ensure that categorical and continuous variables were correctly identified and labelled (Pallant, 2020). Values for the variables were reviewed to confirm that the minimum and maximum values were accurately represented and that there were no missing data or cases.

3.2.6.2 Descriptive analysis and normal distribution

Descriptive statistics were analysed, followed by normality and continuous data assessment to determine the appropriate application of parametric or nonparametric statistical methods. Parametric tests assume that the data is normally distributed, while nonparametric tests do not make this assumption. A normal distribution refers to a symmetrical, bell-shaped curve with most scores clustering around the mean and fewer scores at the extremes (Pallant, 2020). The skewness and kurtosis values were evaluated to determine if the data were normally distributed. Skewness measures the symmetry of the distribution, while kurtosis indicates the degree of peakiness of the distribution. A perfect normal distribution has skewness and kurtosis values of 0, although this is rare in social science research (Pallant, 2020). The detrenched Normal Q-Q plots are generated by plotting the actual deviations of the straight line. The plots should not cluster, and most of them should gather around the zero line (Pallant, 2020). The original and trimmed mean in a normal distribution should not differ significantly. Standard deviation, theoretical range, and actual range were also considered. A Kolmogorov-Smirnov (Sig.) value confirms normality when the p-value is non-significant ($p \geq .05$). Histograms, normal and detrended Q-Q plots, and boxplots must be inspected to identify potential outliers, which are values lying an unusual distance from other values and can introduce bias (Field, 2018; Pallant, 2020). Outliers can be excluded from appropriate statistical analyses to strengthen the dataset (Field, 2018).

3.2.6.3 Reliability and Validity

To ensure the accuracy of the data collected through the questionnaire, two aspects were evaluated: validity and reliability. Evaluating validity and reliability are important and interrelated means of reducing or evaluating measurement errors. Validity refers to the extent to which the data accurately represents what it is supposed to measure (Hair et al., 2014). Content validity and construct validity are two types of validities that are related to questionnaires (Oates, 2006). In this research, content validity was ensured by pre-validating the scales and pilot-testing the items included in the questionnaire.

Construct validity involves two types of validity: convergent and discriminant validity (Pallant, 2020). Convergent validity is related to the degree to which the items of a scale correlate and measure the common underlying construct, while discriminant validity is concerned with the distinctiveness of the items from different scales and does not correlates (Campbell & Fiske, 1959; Venkatesh et al., 2003). Pearson correlation coefficient is used to assess construct validity through a multi-trait monomethod (Pallant, 2020). Pearson correlation coefficient measures the strength and direction of the linear relationship between two variables. This research followed the guidelines proposed by Cohen (1988). These guidelines suggest that a correlation coefficient of 0.10 to 0.29 represents a small effect size, a correlation coefficient of 0.30 to 0.49 represents a medium effect size, and a correlation coefficient of 0.50 to 1.00 represents a large effect size (Cohen, 1988). A factor analysis could also be recommended to explore and test the validity of the relationships for the constructs. However, few earlier research with a combination of UTAUT and TTF has conducted factor analysis, and it would not fit this research as factor analysis mainly allows to condense of a large set of variables or scale items down to a smaller number of dimensions or constructs (Hair, 2014; Pallant, 2020). A factor analysis is therefore considered beyond the scope and purpose of this research.

Internal consistency is the degree to which the items that make up a scale measure the same underlying construct and is used to evaluate the reliability of the measurements. The reliability of the measurements and internal consistency were assessed through Cronbach's alpha coefficient, the most used indicator of internal consistency, indicating the average correlation among the items (Pallant, 2020). Cronbach's alpha measures the degree to which the sets of questions that measure one construct achieve reliable outcomes (Lakshmi and Mohideen 2013). These evaluations were conducted to ensure that the collected survey data are valid, reliable, and accurately represents the research question (Hair et al., 2014).

3.2.6.4 Multiple regression analysis

The hypotheses (illustrated in Figure 1) were tested through multiple regression analysis. This method is appropriate when the research problem with a single dependent variable is presumed related to two or more independent variables (Hair et al., 2014). The analysis aims to indicate the Behavioural Intention to adopt Gamification as a tool to manage TD in agile software processes. The underlying assumptions of the method were evaluated to ensure a dataset suitable for regression analysis. First, the sample size was addressed to ensure a large enough sample size that adds scientific value and generalises to other samples, as insufficient sample sizes may result in non-generalizable findings (Pallant, 2020). Tabachnick & Fidell gave a formula that was used to evaluate the cases required for the multiple regression. This formula is $n > 50 + 8m$ (where m represents the number of independent variables) (Tabachnick & Fidell, 2013, p. 123). The multiple regression analysis beta coefficient, t-value, and p-value were examined to reject or confirm the hypothesis. If the beta coefficient is positive, and the t-value and p-value are both significant, it suggests a positive and significant relationship between the predictor variable and the outcome variable. The t-value is significant when it is greater than two, and the p-value is considered significant if $p \leq 0.05$ (Pallant, 2020).

The unstandardised regression coefficient represents how much the dependent variable (Y) changes when the independent variable (X) increases by one unit if all other variables in the model remain constant. Unstandardised regression coefficient B is utilised to prepare a prediction equation, enabling other researchers to predict an outcome based on the independent variable (Pallant, 2020).

Pallant (2020) states that the residuals ought to show a linear association with the predicted dependent variable scores. The second assumption was evaluated by checking the scatterplot for each independent and dependent variable to assess linearity. The last assumption was evaluated by assessing the multicollinearity, which occurs when independent variables are highly correlated ($r \geq 0.7$), and singularity, which occurs when one independent variable is a blend of other independent variables, by examining the correlation matrix. Variables with high intercorrelations should not be included in the same model for multiple regression as it can be difficult to distinguish the unique contribution of each predictor, and they might report as not statistically significant (Pallant, 2020).

R-square represents the proportion of variance in the dependent variable that the independent variables in the model can explain. A higher R-square value indicates a better fit between the model and the data. The adjusted R-squared provides a more accurate estimate of the actual population value by adjusting for the number of variables in the model. Adjusted R-square corrects additional variables that the R-square doesn't account for. The adjusted R-square further accounts for the possibility of overfitting and improves the model's reliability. The adjusted R-squared is a suitable approach for analysing data from small samples and provides a more robust measure of the relationship between variables (Pallant, 2020). Therefore, the adjusted R-square was prioritised over the normal R-value in this research, as the collected data only represents a small sample size. Interviews has been chosen as a method to further explain the analysis result from the quantitative research results. The following subsections explain the participants and procedure used to conduct and analyse the interview findings.

3.3 Interviews

The results obtained from the questionnaire and its items' interdependence laid the groundwork for results requiring an in-depth explanation to answer the proposed research question. Semi-structured interviews were conducted to expound upon the questionnaire findings and discover the reasons behind software companies' adoption or resistance to Gamification for TDM in ASD. These interviews were conducted to gain more in-depth information and a better understanding of the findings from the analysis. An interview is a planned conversation between two people to gather information about the other person(s) (Oates, 2006). The interviews followed a semi-structured approach, formed with predefined questions. The interviews consisted of open questions to initiate a conversation and allowed the interviewer to change or add follow-up questions as the conversation unfolded (Hammarberg et al., 2016; Pallant, 2020). An overview of the interview guide is included in Appendix 4.

3.3.1 Participants

Participants were selected based on their expertise on the subject matter, with the main criterion for interview participation being their experience with TDM. Potential participants were identified through published literature, feedback from the questionnaire, and recommendations.

Ultimately, four individuals agreed to participate, each being interviewed individually. To ensure participants anonymity, personal information, names, gender, and company name will not be disclosed. They will be identified as R1, R2, R3, and R4, each with their respective backgrounds as follows:

R1: A researcher in the field of AI for a large Norwegian company.

R2: Has a range of experience with TD, both from research and practice.

R3: Work in an agile team for a large Norwegian software company.

R4: Serve as a scrum master in a large Norwegian company.

3.3.2 Procedure

An application to conduct the interviews was submitted along with the questionnaire to Sikt. Collecting interviewees started along with the questionnaire invitations to ensure that the most representative objects had the opportunity to participate. The interviews were performed after the questionnaire results were analysed. A short introduction and a recap of the questionnaire results were given as an introductory part of the interview. During the interview, the interviewee was allowed to ask questions regarding the topic, imprecise questions, or concerns.

3.3.3 Data Analysis

The interview analysis summarises the data retrieved from the four interviews conducted for this research. Results were transcribed directly after the interviews were conducted to prepare for the analysis. Transcripts were thoroughly cleaned, then systematically analysed to identify key patterns and themes related to the research topic (Oates, 2006). The analysis was further summarised into common themes across the separate interviews.

3.4 Ethical Considerations

This research is conducted in compliance with the ethical research guidelines at Kristiania University College, subject to The Norwegian Act on Ethics and Integrity in Research, along with associated regulations that follow the national and European research ethical guidelines (*Research Ethics*, n.d.). These guidelines ensure integrity of the research process and data collection and protect participants. Data collected in this research underwent processing. They were safeguarded per the established guidelines for research data processing at Kristiania University College, which adhere to the FAIR principles (Findable, Accessible, Interoperable, and Reusable). Furthermore, the research adhered to the principle that research data should be as open as feasible, but as closed as necessary. These guidelines were followed in accordance with the signed contract between the researchers, supervisor, and the school department, as of 19th October 2022. Researchers are recognised through adherence to the APA 7th standard, which acknowledges the authors of their work and research whilst mitigating the occurrence of plagiarism.

The online questionnaire was created in Nettskjema to ensure respondents' anonymity with encrypted data delivery to TSD (Tjenester for sensitiv data). Nettskjema meets the highest security requirements for the personal information process and treats all information confidential and according to the GDPR. The e-mail invitation and LinkedIn post ensured participants' anonymity. Furthermore, respondents' answers do not reveal any personal details (*Hva lagres når du svarer på et nettskjema?*, n.d.; *Nettskjema*, n.d.)

The interviews were conducted over teams and an oral consent were given before the interview started to ensure participants understood the terms and conditions and that their answers would remain anonymous throughout the research. To avoid conflicting with GDPR, interviews were not recorded but transcribed directly during the interview. The data obtained from the methods explained above, are analysed, and presented in the next chapter.

4.0 Analysis and Results

This chapter involves a detailed analysis of the questionnaire data and present the interview results. The key objective of this chapter is to provide a robust and comprehensive analysis of the collected data, enabling the researchers to draw meaningful conclusions and offer valuable insights into the research questions and hypotheses.

4.1 Questionnaire Results

The following subsections will present the results of the statistical analysis of the questionnaire data, which include demographic data, reliability, validity, and hypothesis testing using multiple regression analysis.

4.1.1 Preliminary Analysis: Assessment for Normality

150 respondents completed the questionnaire, resulting in a response rate of 15.4%. According to Oates (2006), a typical response rate at 10% is common for online questionnaires. A response rate of 15.4% is therefore considered above average. The data was further examined to ensure the distribution of scores was normal. Several variables, especially PE, showed high skewness and kurtosis values. Therefore, these outliers were removed, resulting in improved values for PE, which initially had skewness values of -828 and kurtosis values of .548. Normality assessments results for the continuous variables are presented in Table 1. The final histograms, normal, detrenched normal Q-Q plots, and boxplots for PE are included in Appendix 5. The original mean and trimmed mean were relatively similar. The standard deviation was below five for all variables, indicating that the distribution of scores was not far from the mean. Six respondents were considered as outliers by screening the histograms and boxplots in SPSS. Due to the relatively small sample size, these respondents were removed as they potentially can represent bias that could compromise the analysis (Pallant, 2020). The final sample consisted of 144 respondents, which is still considered adequate for the research, as reported by Oates (2006).

Variables	Theoretical Score range (min. -max.)	Actual Score Range (min. - max.)	Mean Total Score	5% Trimmed mean	Standard Deviation	Skewness	Kurtosis	Kolmogorov-Smirnov (p-value)
Performance Expectancy	1.00-7.00	2.00-7.00	4.7691	4.8187	1.08513	-596	.116	<.001
Effort Expectancy	1.00-7.00	2.00-6.75	4.5243	4.5228	.97491	.089	-.177	.001
Social influence	1.00-7.00	2.67-7.00	4.5394	4.5201	.96319	.110	-.399	.001
Facilitating Conditions	1.00-7.00	1.50-7.00	4.3681	4.3754	1.15758	-.095	-.173	.038
Task - Technology Fit	1.00-7.00	1.75-7.00	4.2274	4.2407	1.14961	-.150	-.340	.003
Behavioural Intention	1.00-7.00	1.00-7.00	3.2199	3.1708	1.48401	.356	-.575	<.001
Score range was the respondents' lowest (min.) and highest (max.) sum of total scores for the questionnaire. Theoretical score range was the lowest (min.) and highest (max.) sum of total scores possible for the construct.								

Table 1: Assessment of the normal distribution of variables (total scores) in the questionnaire (n=144).

4.1.2 Descriptive Data

Descriptive statistics were conducted to get a sense of the data distribution. The geographical focus of the selected population was employees in software companies based in Norway, and the demographical data in Table 2 shows the general characteristics of the sample and their experiences. Most respondents were between the ages of 23-50, with a bachelor's or master's degree. Position titles within the population varied, and 19.4% had a position title not listed in the pre-defined answers. The definition of small and medium-sized enterprises in Norway is defined as 1-99 employees (Iversen, 2003). 56.9% of respondents are employees in small or medium enterprises, while remaining participants are employed in large companies. When asked about their experience of TD and Gamification, 88.9% indicated they had experienced TD, while 67.4% had experience with Gamification. 31.3% of the respondents have experienced Gamification in an ASD process. However, 5.6% of respondents have experience with Gamification for managing TD in ASD processes.

Variable	Items	Frequency (n)	Relative Frequency (%)
Age	18 - 22	4	2.8
	23 - 29	40	27.8
	30 - 36	25	17.4
	37 - 43	32	22.2
	44 - 50	29	20.1
	51 - 57	7	4.9
	58 - 64	6	4.2
	65 - 71	1	0.7
Educaion	Vidregående	7	4.9
	Yrkesfag	3	2.1
	Årsstudium	0	0
	Bachelor	58	40.3
	Master	70	48.6
	Ph.D.	3	2.1
	Other	3	2.1
Position title	Software developer	25	17.4
	Software Engineer	14	9.7
	Project manager	14	9.7
	Product owner	5	3.5
	IT-consultant	47	32.6
	Software Architect	9	6.3
	Researcher	2	1.4
	Other	28	19.4
Employees currently working in the Norwegian location of the company	Less than 50	49	34
	50 - 100	33	22.9
	100 - 150	18	12.5
	150 - 250	10	6.9
	250 - 350	9	6.3
	More than 350	25	17.4

Experienced Technical debt	Yes	128	88.9
	No	9	6.3
	I don't know	7	4.9
Experience with Gamification	Yes	97	67.4
	No	43	29.9
	I don't know	4	2.8
Experience with Gamification for managing technical debt	Yes	8	5.6
	No	132	91.7
	I don't know	4	2.8
Experience with Gamification in an agile software development process	Yes	45	31.3
	No	93	64.6
	I don't know	6	4.2

Table 2: General characteristics of respondents and their experiences (n=144)

4.1.3 Validity and Reliability

The relationship between all 22 items of the five constructs was investigated using a Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality and linearity. There was a small effect size for all relationships with SI2, specifically between SI2-PE2 with a negative correlation, R=-.027, n= 144, p=.745 (Appendix 6). There was a large effect size between BI2 and BI3 with R=.906, n=144, p=<.001. A new analysis was performed to get an overview of the correlations between the total of the five constructs without SI2 (Appendix 7). The correlation between PE-EE, PE-TTF, EE-TTF, and FC- TTF has a large effect size. The rest of the constructs have a medium effect size, except the correlation between PE and BI with medium effect size R=.444, n=144, p=<.001.

Correlations						
	Performance Expectancy	**Effort Expectancy**	**Social Influence**	**Facilitating conditions**	**Task-Technology Fit**	**Behavioural Intention**
Performance Expectancy	1					
Effort Expectancy	.721**	1				
Social influence	.509**	.570**	1			
Facilitating Conditions	.656**	.643**	.619**	1		
Task -Technology Fit	.747**	.707**	.604**	.712**	1	
Behavioural Intention	.444*	.505**	.572**	.562**	.602**	1

Table 3: Pearson product-moment correlation coefficient with the total of the constructs.

The most common method to measure the reliability of Likert scales is Cronbach's Alpha (Dong Cheng et al., 2008). The initial reliability analysis represented the constructs of SI with Cronbach´s alpha of .500. Question SI2 had a corrected-item total of .158 and a mean inter-item correlation of .250. These results led to deleting SI2, and the final reliability analysis measured with Cronbach's alpha represented mostly adequate reliability levels with PE (.865), EE (.823), SI (.565), FC (.785), TTF (.897), and BI (.957). A Cronbach's alpha value should be >.7. However, the Cronbach alpha can be quite low when there are fewer than 10 items in the scale, and it may be more appropriate to report the mean inter-item correlation, which at an optimal range shows a correlation of 0.2 to 0.4 (Briggs & Cheek, 1986; Cronbach, 1951; DeVellis, 2012; Pallant, 2020). Cronbach's alpha for SI was .565, however, the mean inter-item of .397 was reported and SI was therefore considered to have adequate internal consistency (Pallant, 2020). After removing SI2 Cronbach´s alpha of the items improved from .944 to .948 which indicates that the questions are more reliable and accepting without SI2.

Cronbach´s Alpha	**Cronbach´s Alpha Based on Standardised Items**	**N of Items**
.948	.949	21

Table 4: Item-Total statistics and Cronbach´s Alpha

Constructs	Item	Corrected item-Total correlation	Cronbach's Alpha if item deleted	Cronbach´s Alpha
Performance Expectancy	PE1	.660	.945	.865
	PE3	.675	.945	
	PE3	.731	.944	
	PE4	.624	.946	
Effort Expectancy	EE1	.707	.945	.823
	EE2	.683	.945	
	EE3	.513	.947	
	EE4	.670	.945	
Social Influence	SI1	.584	.946	.565
	SI3	.571	.946	
Facilitating Conditions	FC1	.524	.948	.785
	FC2	.758	.944	
	FC3	.485	.948	
	FC4	.768	.943	
Task-Technology Fit	TTF1	.696	.945	.897
	TTF2	.787	.943	
	TTF3	.806	.933	
	TTF4	.736	.944	
Behavioural Intention	BI1	.675	.945	.957
	BI2	.699	.945	
	BI3	.667	.945	

Table 5: Representing the reliability of scale.

4.1.4 Multiple Regression Analysis

In assessing the underlying assumptions for regression analysis, the sample size is considered adequate if 144>50+8(5). This research has five independent variables and therefore requires a sample size of 90, which is well within the number recruited. Since SI2 was deleted in the reliability analysis, the multiple regression analysis was performed without SI2.

Examining R-square and adjusted R-squared values is essential to assess how well the UTAUT and TTF fit the collected data. The reported R2 value of 0.45 suggests that the proposed UTAUT and TTF model explains approximately 45% of the variance in the dependent variable. It is additionally essential to consider the adjusted R-squared value, which considers the number of independent variables in the model. If the adjusted R-squared value is relatively similar to the R-squared value, it suggests that the model contains only a few explanatory variables which is the case for this research (Gripsrud et al., 2016; Pallant, 2020). The reported adjusted R-squared value of 0.43 suggests that combining UTAUT and TTF can explain 43% of the variation for BI. It is worth noting that the model does not account for the remaining 57% of the variance, indicating the presence of other factors that are not captured by the included variables. This highlights the need for further investigation and the potential for additional variables to improve the model's explanatory power (Gripsrud et al., 2016; Pallant, 2020).

Independent variable	**Unstandardised B**	**T-value**	**P-Value**	**Part Correlation**	**Results**
Performance Expectancy	-.137	-1.266	.208	-0.80	**Not supported**
Effort Expectancy	.094	.814	.417	.051	**Not supported**
Social Influence	.506	3.136	.002	.198	**Supported**
Facilitating conditions	.171	1.790	.076	.113	**Not supported**
Task - Technology fit	.344	3.177	.002	.201	**Supported**
a. Dependent variable: Behavioural Intention					

Table 6: Collinearity Diagnostics (a) without SI2

Model	Adjusted R square	P-value
1	.430	<.001
a. Dependent variable: TotalBI		

Table 7: Model Summary and ANOVA (a)

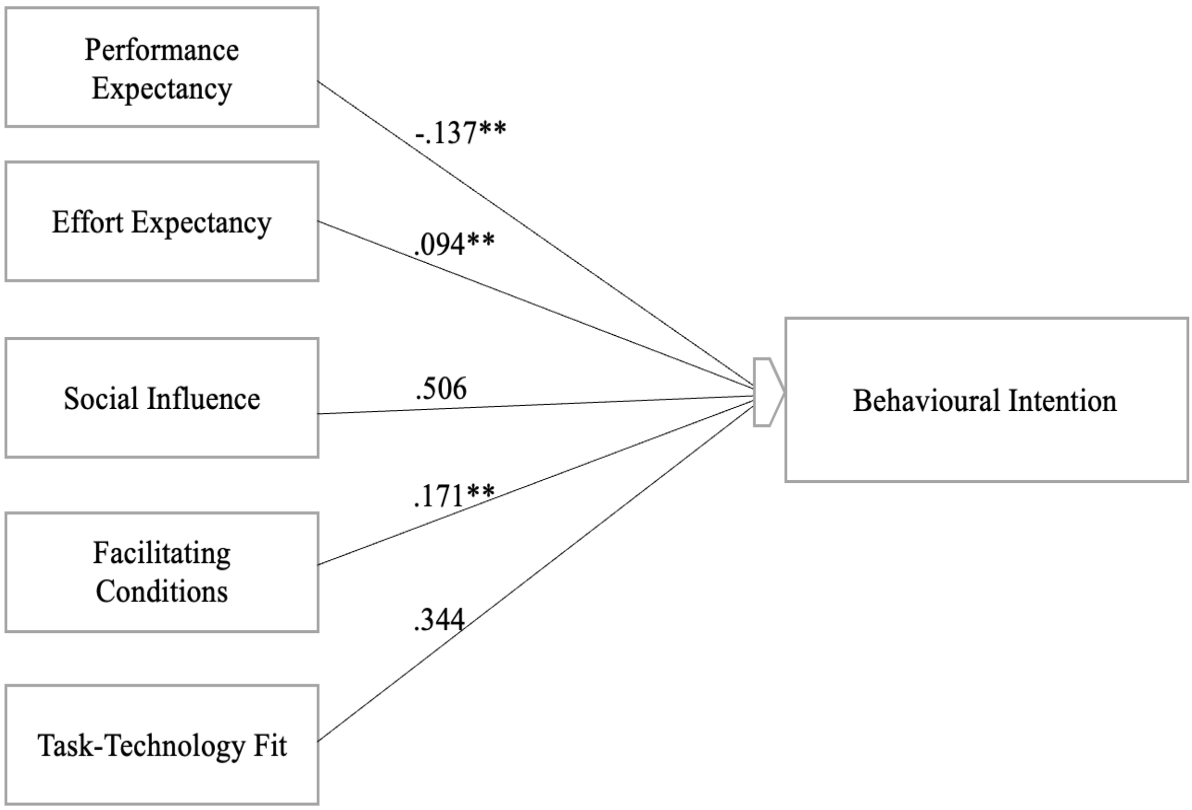

Figure 2: Structural model of evaluation UTAUT and TTF (**p. < 0.05).

Hypothesis 1: **Performance Expectancy significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.** The multiple regression analysis results revealed that PE has a negative beta coefficient of b = -.137 and a non-significant t-value of t = -1.266 with a p-value of p = .208. These findings were supported by measures of acceptable reliability and validity. Results suggest that PE may not significantly affect the BI to adopt of Gamification for TDM. Therefore, hypothesis 1 is **Not supported.**

Hypothesis 2: **Effort Expectancy significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.** The multiple regression analysis results revealed that EE has a beta coefficient of b = .094 and a t-value of t= .814 with a p-value of p= .417. This indicates that the relationship between EE and BI to adopt Gamification for TDM is not statistically significant**.** These findings were supported by acceptable reliability and validity measures, which confirms that hypothesis 2 is **Not supported.**

Hypothesis 3: **Social Influence significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.** The results of the multiple regression analysis revealed that SI has a positive beta coefficient of b = .506 and a statistically significant t-value of t = 3.136 with a p-value of p = .002. The reliability and validity were acceptable after deleting SI2, suggesting that SI significantly affects the BI to adopt Gamification for TDM. Hypothesis 3 is therefore **Supported**.

Hypothesis 4: **Facilitating Conditions significantly affect the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.** The results from the multiple regression analysis reveals that FC has a positive beta coefficient of b = .171 and a non-significant t-value of t = 1.790 with a p-value of p = .076. The results, therefore, suggest that FC may not have a significant effect on the BI to adopt Gamification for TDM. The reliability and validity were acceptable, which confirms that hypothesis 4 is **Not supported.**

Hypothesis 5: **Task-Technology Fit significantly affects the Behavioural Intention to adopt Gamification for Technical Debt Management in Agile Software Development.** The results revealed that TTF has a positive beta coefficient of b = .344, a significant t-value of t = 3.177, and a significant p-value of p = .002 and suggesting that TTF does have a significant effect on the BI to adopt Gamification for TDM. The reliability and validity were acceptable, confirming that hypothesis 5 is **Supported.**

4.2 Interviews

The following subsection present the interview analysis. This analysis intends to provide a comprehensive understanding of the interview findings. The data will be summarised, and themes and trends will be identified and organised accordingly.

4.2.1 Interview Results

All interviewees had managed TD in each of the agile projects they have been involved in. Further, R1 and R3 work in teams where TD is intentionally incurred. This is explained by the respondents as the debt will always be there. Achieving a totally flawless system or product is unattainable. R2 brings a diverse range of experiences and perspectives to the subject of TD. *"From a researcher perspective, I have a substantial understanding of TD from a TDM perspective, I have implemented a significant amount of technical debt while searching for effective tools to manage it, and from a Software developer perspective where I accumulated TD."*

The interviewees highlighted the importance of TD prioritisation. R1 and R4 emphasised that TD prioritisation is important to improve a product, fix features, produce quality products, and remain a relevant competitor in the market. As stated by R3, when working agile, *"it is easy to think you can go back and fix some of the features, but that is how technical debt often accumulates because you think it's good enough and don't consider taking care of it again."* An essential part of the prioritisation process is according to R1 and R4 the decision on which debt to fix as not all debts being harmful, dangerous, or necessary to prioritise. Factors affecting the prioritisation process are, according to R3, time, money, and how quickly one wants to add some value. The importance of the prioritisation process was further reasoned by R2: *"Because TD is not equal but requires different prioritisation for different types of TD(...) when you have a large number of features but no proper maintenance, it can result in a substantial amount of technical debt that might be harmful to the product. Thus, prioritisation is crucial to avoid technical debt and its associated negative consequences."*

The interviews revealed that managing TD is commonly viewed as a boring process leading to neglect of the process. It was stated in the interviews, that identifying motivational factors to facilitate TDM is crucial. R1, R2, and R4 view Gamification as a promising approach to address the challenge where TD is considered a boring process. For R1, R2, and R4, game elements are perceived as exciting tools that can increase team collaboration, engage, promote enjoyment, and motivate developers in the TDM process. The promising approach was further emphasised by R2: "*Because Gamification is fun, it is not just doing work. It makes TDM more fun and even more understandable."*

Findings from the interviews indicate that Gamification comprises several concerns from a potential user point of view. Firstly, according to the perspective of TDM, R2 indicated that an unintentional shift of attention could be a potential challenge. The shift of attention occurs when an individual becomes too focused on playing the game *("e.g., optimise for a badge or rank high on the leader board"*) rather than effectively managing TD. When the game is not adequately designed, there is a risk of failing to manage TD (R2). Similarly, R1, R3, and R4 mentioned the same disadvantage from their perspective as developers. They identify Gamification as an inefficient process, contributing to the accumulation of more TD. R1 attributed this negative outcome to a misplaced focus on the wrong aspects of Gamification. R3 raised concerns: *"If Gamification is about being efficient, then if you do not take the time to do it well, you will end up with worse code reviews and let through bad code with lower quality. (...) Point systems often result in quicker job completion, leading to lower-quality output and contributing to more TD."* Another concern raised by R1 and R4 was the potential for Gamification to foster a competitive environment within the team, which affects collaboration and further lead to the production of code smells.

Second, defining the purpose of Gamification is crucial for its success, according to R2. Gamification should be implemented with clear goals and a specific problem that needs to be solved. By defining the purpose of Gamification, organisations can ensure that their resources are being utilised in the right way and that they are achieving their desired outcomes (R2). R3 confirms this statement and adds that the management needs to be involved to ensure the implementation of Gamification adds value to the job the developers are already performing: *"There is a lot of resistance to new things; it must have value and be tailored to our process. There must be onboarding that convinces the team to believe in it and understand that it provides value. If it doesn't provide value, it's thrown away next week."*

Considering the feedback provided by R2 and R3, it has been noted that constant measurements are an inherent aspect of gamifying a process. R2 emphasised the need for a clear understanding of what metrics to measure before implementing Gamification within an agile development process. It is essential to acknowledge that finding the proper measures can be a complex process. One must consider the potential apprehension individuals may experience from being measured via badges or other similar mechanisms (R2). R3 explained that Gamification "*creates a controlled environmen*t," adding to this statement: *"Gamification in the development process is not effective. It adds elements of stress. Constant measurement can be stressful and* *may cause some participants to drop out due to the pressure. My final thought is that Gamification is not inclusive. Those who are not competitive may feel monitored, which can be demotivating*."

The interview results provide insight into the potential acceptance of Gamification within an agile project. Respondents expressed interest in exploring Gamification to enhance engagement and enjoyment but also identified limitations as a long-term strategy. R3 noted that Gamification introduces an additional layer of complexity to project management: *"We talk all the time and every week about what works and provides value, then we stop with what does not provide value to the project."* R2 further explained that *"Gamification should be refined and developed into an engaging game that can help address the knowledge gap among developers when it comes to fixing TD."* Moreover, R1, R2, and R4 added that Gamification, in its current state, is not ready to be implemented in non-educational settings, and in practice, it is challenging to implement. R4 also emphasised that employees have less confidence in utilising Gamification to handle TD in agile projects *"Because Gamification is a relatively new term, and people need to see it succeed in practice before they even think about implementing it."*

According to R3, Gamification for TDM in ASD serves a purpose comparable to existing practices *"where metrics are reported to management, who, based on the metrics, decide how to motivate the team to reach their goals"*. Furthermore, R3 emphasised the significance of intrinsic motivation, stating that it is more important than extrinsic motivation.

R1 and R3 opined that incorporating Gamification into the development process would add unnecessary complexity, potentially hindering the current workflow. According to R3s experience, software developers tend to hate implementing new processes, resulting in significant resistance to new initiatives within the team. R3 additionally expressed concerns about the responsibility allocation Gamification brings. Stating that as a developer, the responsibility to prioritise TD ultimately lies with them, *"But where in the prioritisation process will Gamification take place, and who is responsible for ensuring that TD is prioritised correctly?"* R1 works in a team focused on TD, and Gamification would not be perceived as a valuable tool to manage TD for the team. However, R1 added that Gamification *"could work in a team where the process and culture for prioritising TD are already bad."*

R3 also stated that the potential of Gamification as a management strategy might be more promising in project management and leadership than in software development teams. R3 confirmed this statement with an example: *"A singular implementation of Gamification within the development team will not be effective unless there is significant support and promotion of such a program by project and organisational leadership."* R3 further explained that instead of implementing Gamification in the development process, *"I believe it would be more beneficial to implement it within the decision-making leadership roles."* Leaders in these roles typically prioritise key performance indicators and use metrics to inform their decision-making without negatively affecting the development team's work quality (R3).

R2 had earlier created a tool to assess and track TD and suggested that having a tool to help visualise TD can be a powerful way to manage it. R2 express that implementing new technologies can be challenging, as people must learn how to use them effectively. Therefore, it is crucial to incorporate TD tracking in code reviews and make it easy for developers to signal that they are tracking TD. R2 mentioned that *"Developers would like to track debt without the effort, so a tool that helps developers to track TD with least possible effort would be a good solution."* R2 further stated, *"A tool that visualises and shows that the developers need to intervene at one point is one of the most exciting technologies one can use for TD."*

R3 emphasised the importance of prioritisation in handling TD, particularly in security. According to R3, developers good at security do not necessarily write secure systems but have control over what they prioritise. Risk analysis is performed in the case of security, creating an overview that includes a classification of different risks. Supporting documents indicate where and what risk developers are willing to take. Some developed systems can handle more risks as they have less to lose. This system is not very critical, so developers can avoid prioritising the TD in these systems. In this case, developers have made a controlled choice to ignore the management of TD in that system. R3 further suggested that risk analysis can be a valuable tool for prioritising TD. If a developer chooses not to prioritise TD, they are taking a risk. In such cases, risk analysis can be a good tool for TDM.

5.0 Discussion

This chapter presents the analysis results and their correlation with the relevant literature presented in this research. The discussion is organised into two subsections where the first section examines the questionnaire analysis and the second focus on the interview findings. Each subsection is structured according to the constructs from the proposed theoretical model.

5.1 Questionnaire Discussion

This research aims to investigate the Behavioural Intention towards adopting Gamification as a tool for managing TD in ASD. A proposed UTAUT and TTF model has been used to test the relationship between the constructs in this model to answer the research question. The following subsections interpret the findings based on the hypothesised relationships tested using multiple linear regression analysis. Social Influence and Task-Technology Fit were found to be the most significant constructs in the analysis, primarily driving the BI to adopt Gamification. Conversely, PE, EE, and FC were found to not have a significant relationship to BI.

5.1.1 Performance Expectancy

According to Venkatesh et al. (2003), PE is the strongest predictor and a significant measurement for BI. In the context of this research, it was hypothesised that PE significantly impact the BI to utilise Gamification for TDM in ASD. This hypothesis derived from previous Gamification studies where PE was observed to have a significant effect on the BI to adopt Gamification for purposes (Abou-Shouk & Soliman, 2021; Ofosu-Ampong et al., 2020; Rahi & Ghani, 2018). The analysis results in this research, however, indicate that PE does not have a significant impact on BI ($b= -.137$, $t= -1.266$, $p = .208$). This result suggests that users do not expect Gamification to improve their TDM process in ASD.

APM processes includes planning and delivery within tight timeframes (Behutiye et al., 2017; Dybå et al., 2014). The tight timeframes lead to scenarios where developers tend to make compromises to address urgent requirements (Brown et al., 2010). Regardless of the benefits of ASD, it presents challenges in terms of management, prioritising, learning, and communication within effective teamwork (Behutiye et al., 2017; Stol et al., 2022; Strode et al., 2022). In projects where time is a critical factor, developers may not have the luxury of incorporating Gamification as an additional process due to the pressure and constraints of agile methodologies. A potential explanation for the non-significant result of PE may be that other TDM tools are perceived more effective and useful than Gamification.

It is important to acknowledge the potential benefits of Gamification in enhancing engagement and motivation among developers which could ultimately optimise TDM practices (Deterding et al., 2011; Dubois & Tamburrelli, 2013; Porto et al., 2021; Stol et al., 2022). Management of TD is more complex in industrial settings than in educational ones (Guzmán & López, 2019). This complexity can be another explanation for the rejection of H1.

5.1.2 Effort Expectancy

The analysis results shows that EE does not have a significant effect on BI (b= .094, t= .814, p= .417), indicating that users do not perceive Gamification for TDM as easy to use in ASD. EE has been found significant for measurement of BI only during the initial period before it becomes non-significant during extended periods and sustained usage (Venkatesh et al., 2003). Incorporating game design elements such as points, badges, leader boards, performance graphs, meaningful stories, avatars, and teammates has been found to be effective in addressing motivational challenges in working contexts (Sailer et al., 2017). However, it is important to implement these elements properly based on well-established models to ensure success (Sailer et al., 2017). It is also worth noting that incorporating game elements in the software development process to manage TD is a complex process, especially in industrial settings (Guzmán & López, 2019). The process of incorporating game elements in the software development process to manage TD lacks substantial evidence and several researchers emphasise the issue of adoption of Gamification without evidence (Dal Sasso et al., 2017; Dubois & Tamburrelli, 2013; Guzmán & López, 2019; Porto et al., 2021; Sailer et al., 2017).

These findings from previous literature may explain the rejection of H2, as it is difficult to envision how Gamification would be effectively incorporated for TDM in the software development process. Overall, it can be argued that for users to adopt Gamification, its implementation process needs to be considered to ensure that users perceive the game elements as effective and easy to use for ASD.

5.1.3 Social Influence

SI was the strongest predictor of BI (b= .506, t = 3.136, p = .002) in this research. This finding indicates that people surrounding affects users' acceptance of Gamification as a TDM tool in ASD. SI has been found to strongly support the acceptance of information technology in previous studies. This is supported by Abou-Shouk & Soliman (2021) who found SI to significantly affect tourism organisations' intention to adopt Gamification websites and applications. Likewise, Aebli (2019) revealed that individual's connection to others is a significant effect on gamers for adopting Gamification.

Similarly, Gamification has been identified as a useful tool for TDM in ASD. Gamification engages, trains, monitors, and motivates software developers to overcome technical challenges and improve software quality, leading to positive outcomes (Dubois & Tamburrelli, 2013). In this research, the questionnaire results indicate that if more Norwegian software companies start to report a successful implementation of Gamification as a TDM tool and its perceived benefits in ASD, it is likely that other users in the industry would adopt this technique as well.

On the other hand, Porto et al. (2021) express that teams and individuals may have different needs, and finding the appropriate game elements can be a complex activity. Suppose an increased proportion of competing companies invest significant amounts of time, financial resources, and effort toward implementing Gamification techniques for TDM in ASD. However, if these efforts do not report any benefits, it is likely that other companies do not intend to adopt Gamification practices for TDM. It can therefore be argued that SI will only have a significant impact Norwegian companies' BI to adopt Gamification if it is proven to be an effective TDM tool in ASD. SI will not necessarily significantly affect the BI to adopt Gamification if competitors do not derive any noticeable advantages from the implementation.

5.1.4 Facilitating Conditions

The multiple regression analysis results indicate that FC has does not significantly affect BI to adopt Gamification for TDM in ASD. Furthermore, the FC factor is ranked as the second lowest (b = .171, t = 1.790, p = .076). This result indicates that users in general perceive that their organisation do not have the resources available to support the implementation of a game application to manage TD in ASD. This conflicts with prior research, which shows that FC has a significant effect on the user´s BI to adopt other technologies (Abou-Shouk & Soliman, 2021; Ofosu-Ampong et al., 2020; T. Oliveira et al., 2014).

Understanding the needs and motivations of developers is crucial as developers are valuable resources in software organisations (Stol et al., 2022). Previous research has shown that teams and individuals have different needs (Porto et al., 2021). Thus, identifying the ideal elements that motivate everyone is a complex task, and Gamification tools may not always achieve the intended motivational effects (Porto et al., 2021). This research suggests that the adoption of Gamification for TDM in ASD is influenced by the availability of resources to support implementation. Both the management and individual perspectives play critical roles in creating the intention to adopt Gamification as a tool for managing TD.

TD is proved to be understood by managers, closing a communication gap between the management and software developers in agile project (Holvitie et al., 2014). However, project managers experience TD differently than other team members and the managerial level often lacks an understanding of the ASD process on an individual level (Santos et al., 2022). Further, the TDM process currently lacks specific strategies (Behutiye et al., 2017). The analysis findings suggest that software developers believe that organisations lack the necessary resources to implement Gamification practices for managing TD within the software development process. Among these resources, effective management is particularly crucial for the successful implementation of Gamification. One potential resource deficiency that could hinder Gamification implementation is a lack of managerial level understanding of the software development process. Based on reported successes in other companies, a new process may be perceived as beneficial from a managerial perspective. Without a proper understanding of the development process, managers may unintentionally introduce an ineffective solution for software developers. The decision to implement Gamification for managing TD from a managerial level may therefore not be well-supported by individual members of ASD teams if managers do not understand the current ASD processes.

5.1.5 Task- Technology Fit

The results of the analysis strongly support hypothesis H5, as evidenced by a significant positive effect (b= .344, t=3.177, p= .002). This result indicates that users perceive that Gamification can be an appropriate method for managing TD in ASD. The analysis results are consistent with prior research that has demonstrated the positive impact of TTF on technology utilisation and adoption behaviours across different contexts, such as e-books and online courses (D'Ambra et al., 2013; Dishaw & Strong, 1999; Wu & Chen, 2017).

Gamification has been found to encourage behaviours such as writing more tests, better documentation, and increased productivity, and can be an effective approach to improving software development skills (Dubois & Tamburrelli, 2013; Stol et al., 2022; Porto et al., 2021). Points and leader boards are the most popular game elements used in ASD, which can be useful in an academic setting to improve software quality by enhancing readability and supporting self-organisation (Prause & Jarke, 2015). Gamification elements can also aid in managing and visualising the accumulation of TD within agile teams, as visibility of the progression has been shown to maintain the team's motivation to sustain the TDM progress (Dos Santos et al., 2013).

Despite the reported benefits of Gamification as a TDM tool, most findings are from educational settings, and there is limited substantial evidence of its effectiveness in non-educational settings for producing high-quality code (Dal Sasso et al., 2017; Dubois & Tamburrelli, 2013; Porto et al., 2021; Sailer et al., 2017). Today, practitioners have limited information on the effectiveness of Gamification as a tool to manage TD in agile projects. Other technologies are currently considered more suitable for managing TD in such projects. It can therefore be argued that Gamification for TDM in ASD should be evaluated to ensure that users perceive the technology to fit the task and understand its intended purpose.

5.2 Interview Discussion

Interviews were included to emphasise reasons why and identify current challenges that require resolution before a potential implementation of gamification for TDM in ASD a non-educational setting. The interviews aimed to investigate the analysis results that identified constructs affecting Behavioural Intention.

The interviews conducted with four respondents provided a diverse range of experiences and perspectives on the implementation of Gamification for TDM in ASD. APM is prone to TD, and TD occurs due to requirements for planning quick design and architecture delivery within a tight timeframe (Dybå et al., 2014; Behutiye et al., 2017). Low-quality codes are identified by Santos et al. (2022) as one of the most common causes of TD in ASD. TD occurrence is associated with less progress and waste of time (Crespo et al., 2022). As stated by all respondents', TDM is often viewed as uninteresting, leading to neglect of the process. This neglect can result in the accumulation of more TD, which can lead to low quality code, harm the product and potentially impair the company's competitiveness. Thus, it is crucial to identify motivational factors that can facilitate TDM in ASD.

5.2.1 Performance Expectancy

The analysis result suggests that users do not expect Gamification to improve the TDM process in agile development, as discussed previously in this chapter. A potential explanation for the outcome above was that developers could perceive the application of Gamification for TDM as an unnecessary step in the TDM process and potentially disturbing its intended efficacy. The interviews further confirmed this assumption and expressed that developers often dislike implementing new layers in the process. Interview findings also identified limitations for Gamification as a long-term strategy addressing that Gamification in a non-educational context can work against its intended purpose and result in competition among project participants. An environment where members are too focused on the game can foster a competitive environment within the team, as mentioned by R1. This contradicts the purpose of Gamification techniques in ASD, which is to resolve issues related to software quality and facilitate knowledge transfer among team members (Moser et al., 2021). R4 and R1 support this claim as they both expressed their concerns about competing against each other if game elements are implemented to reduce TD. However, one can argue that this perception of Gamification did not come as a surprise since Gamification relates to the term “Game”, which is according to Deterding et al. (2011) about competing among participants to achieve one goal or one outcome. Deterding et al. (2011) further emphasises that Gamification should be separated from playfulness. In ASD playfulness behaviour may be the desired outcome as opposed to competition amongst participants and may explain the rejection of H1 in this research.

5.2.2 Effort Expectancy

Users do not expect Gamification to be easy to use for TDM in ASD as found from the questionnaire analysis. Gamification is a relatively new term and little academic research, and adoption were done before 2010 (Deterding et al., 2011). A potential explanation for this outcome is a that the implementation currently lacks reports of successful implementation of Gamification for TDM (Dal Sasso et al., 2017; Dubois & Tamburrelli, 2013; Porto et al., 2021; Sailer et al., 2017). The lack of effective examples to demonstrate the efficacy of implementation in non-educational contexts poses a challenge in terms of comprehending its potential benefits and ease of use. As a result, developers may find it difficult to understand how this implementation could be effective. This assumption is supported by R4 who emphasised that people need to see it succeed in practice before implementing it, as Gamification is a relatively new term.

As revealed by the interviewees, Gamification can contribute to making TDM more fun and understandable. This finding aligns with literature where the elementary use of Gamification is to promote motivational affordances, identify and improve developing skills (Crespo et al., 2022; Deterding et al., 2011; Dubois & Tamburrelli, 2013). One can argue that developers like to track TD with least possible effort and that adding a tool that visualises TD could be a good solution. On the other hand, adding Gamification could add more complexity to the ASD process. R2 stated that Gamification should be implemented with clear goals and a specific problem that needs to be solved. In addition, R3 expressed much resistance to new things and that onboarding is essential for the team to believe and understand that it adds more value to the teams current ASD process. The incorporation of Gamification in TDM arguably needs to be considered carefully to avoid negative impacts on the existing processes. The complexity of Gamification and lack of understanding of how this would be easier to use than the current systems may be another explanation for why the results reject H2.

5.2.3 Social Influence

The analysis indicates that users expect SI to significantly affect the intention to adopt Gamification for TDM in ASD. Specifically, users are more likely to adopt Gamification when others influence them. The adoption of APM in software development has emerged as a successful approach, replacing traditional project management methodologies (Azanha et al., 2017; Dybå et al., 2014; Naik & Jenkins, 2019). Today, APM is widely preferred in the software industry, with most software companies embracing agile methodologies for their projects (Naik & Jenkins, 2019; Rios et al., 2019). This trend can be attributed to SI, where organisations realise the effectiveness of APM and the increased adoption by their competitors. The importance of SI for adopting agile methodologies reflects that SI may be a crucial factor in the perception of Gamification. If more companies report successful implementations and gain competitive advantages, other companies may also be influenced to adopt Gamification.

An important aspect of SI is the organisational culture and existing processes related to TD prioritisation. As emphasised by R1, the culture of TD prioritisation serves as a strong predictor of whether Gamification can be an effective tool for managing TD in ASD. To successfully onboard Gamification, users need to understand how it adds value to the process, and the organisational culture plays a significant role in this process. If the organisational culture values TD prioritisation but does not perceive Gamification as adding value, then it is unlikely to be adopted by project members.

5.2.4 Facilitating Conditions

The analysis result suggests that users do not expect that their organisation has the resources available to support the implementation of game applications for TDM in ASD. The managerial level often lacks an understanding of the ASD process from a developer perspective (Santos et al., 2022). Gamification implemented as a managerial decision without a proper understanding of the processes and dynamics in software development teams may not be well-supported by individuals in these teams. The interviews reveal that successful implementation of Gamification for TDM requires involvement from management to ensure the process adds value.

Overall, Gamification can have some benefits in an agile context, but its implementation requires careful consideration of its potential impact on project dynamics. From R3's perspective, users will only accept the implementation of Gamification from a managerial level if the management understands its purpose and how it adds value to a project. The analysis and interviews suggest that users believe their organisations require more knowledge and resources to implement Gamification to manage TD in ASD. Implementing Gamification in such projects is a demanding process that requires essential resources from management, which is currently lacking in Norwegian software companies. Although Gamification may not have the potential for ASD, it could be helpful in project management and leadership, as suggested by R3.

5.4.5 Task-Technology Fit

Analysis result indicates that users perceive gamification as a potential method for managing TD in ASD. As revealed in the interviews, TDM is often viewed as a "boring" process, and not all developers are motivated to manage TD. Developers sometimes prioritise other, more exciting tasks, even though these may not be as important as TD management. The existing literature and interview findings support H5, by suggesting that game elements can promote the enjoyment and motivate developers, making the management process more engaging and understandable. These findings are consistent with the statement expressed by R2, which believed that Gamification would be a valuable tool for TDM where motivation is necessary to prioritise TD.

Gamification consists of explicit rules and competition amongst participants to reach a discrete goal, and intends to initiate a playful mindset (Deterding et al., 2011). Findings from the interview revealed that developers might unintentionally shift their attention to the game, leading to a lack of focus on prioritising quality codes and contributing to the accumulation of more TD. One can argue that Gamification can be perceived as a fun solution for those who are competitive, but as R3 emphasised, Gamification may cause stressful situations for those who are not competitive. Defining proper measuring metrics is an important yet complex aspect for a successful implementation of Gamification for TDM in ASD. R3 raised a concern towards the constant measurement arising from a gamified process and the apprehension individuals may experience from being measured via game elements. Gamification may therefore not be an inclusive solution, as it for some can result in TDM being considered a constant monitored process in ASD. Arguably, Norwegian software companies needs to consider the importance of user's motivation and distinguish whether it is intrinsic motivation or extrinsic motivation that needs to be enhanced for their current TDM processes.

Interviewees generally did not consider Gamification as an appropriate method for TDM in ASD. People need to experience and understand how Gamification could help and add value to TDM in ASD before they consider it worthwhile. In addition, the interviewees noted that adding Gamification introduces an additional layer of complexity to the project management and process. It is not ready to be implemented in a non-educational setting. R1 expressed that adding Gamification could work in a team where the prioritisation process already lacks quality. The previous chapter argues that new strategies for TDM should be carefully evaluated and tested before implementation, as many software developer teams already have good processes or routines for TDM in ASD.

The aim of this research was to test the influence of the five constructs PE, EE, SI, FC and TTF on BI by proposing a theoretical UTAUT-TTF model. Interviews provided valuable insights regarding the potential adoption of Gamification for TDM in Agile projects that do not fall under these constructs. The implications, contributions, limitations, and potential areas for further research for both sections are discussed in Chapter below. Finally, Chapter Seven combines the main findings from both subsections and provide a conclusive summary.

6.0 Implications, Contribution, and Suggestions for Future Research

This chapter aims to highlight the research implications, contribution, and present suggestions for future research.

6.1 Theoretical Implications

This research contributes to the limited existing body of research in the area of Gamification adoption in ASD and has several theoretical implications. First, this research made an important step to integrate some constructs from UTAUT and TTF to explain user adoption of Gamification to manage TD in ASD. While a limited of studies have used a combination of UTAUT and TTF to examine user adoption of technologies, relatively little research has been performed to address user's adoption intention of Gamification for TDM in ASD. The proposed theoretical model in this research explained the users in Norwegian software companies' acceptance and adoption intention of Gamification for TDM with 43%, indicating that there are 57% that are not captured by the included variables. The analyses revealed that this proposed theoretical model did not perform better than the basic UTAUT or TTF model alone.

By providing empirical evidence, this research contributes to literature on user acceptance of Gamification for TDM in ASD. The increasing adoption of agile methodologies by software companies has led to a higher occurrence of TD, and TDM in ASD still lacks systematic processes (Behutiye et al., 2017; Holvitie et al., 2018; Rios et al., 2019). Previous research has explored the use of Gamification for TDM in ASD (Haendler & Neumann, 2019). However, it lacks theoretical foundations to assess whether users in software companies are willing to adopt Gamification to manage TD in ASD. This research addresses this gap by gathering data from a large sample of potential users and conducting in-depth interviews to understand their BI better. By including explanatory interviews this research offers a theoretical contribution by incorporating complementary perspectives to the quantitative analysis results. Interviewees revealed new challenges that would not have been uncovered through the quantitative analysis. The interview findings provide a fresh perspective to the topic and fill gaps in areas that need more theoretical insights, thus contributing to advancing research on the topic as practitioners in the field have limited information regarding the effectiveness of Gamification as a tool to manage TD in ASD.

6.2 Practical Implications

PE, EE, and FC do not significantly influence the Behavioural Intention of Gamification adoption in Norwegian software development companies. TTF and SI were proven to have a significant effect on the BI of Gamification adoption. A significant support of SI emphasizes the benefits of promoting successful use of gamification for TDM by software development practitioners. The research results imply the necessity to develop game applications that meet developers' needs for managing TD and improves their current TDM processes. Managers and developers should ensure that a game application will motivate the team to identify and manage TD. These research results can impact Norwegian software companies wanting to implement Gamification for TDM to make informed decisions.

The interviews contribute to understand the underlying factors that influence the adoption of Gamification and is relevant for practitioners seeking to leverage Gamification in various contexts. This research study suggests that creating a culture of Gamification and TDM can be influenced by both managers and individuals. For example, management could provide training and resources to promote the adoption of Gamification as a tool for managing TD, while individuals could be encouraged to share their experiences and knowledge with others in the company.

Previous research has shown that Gamification can be successfully used to manage TD in ASD (Dos Santos et al., 2013; Ebert et al., 2022; Porto et al., 2021). Gamification has additionally been proven effective in both educational and non-educational settings (Crespo et al., 2022; Dal Sasso et al., 2017; Dos Santos et al., 2013; Dubois & Tamburrelli, 2013; Moser et al., 2021; Stol et al., 2022). Conversely, few studies have focused on the implementation of Gamification from a user perspective and their adoption intention towards it. The interviews highlight the importance of considering users and emphasises the importance of understanding their' perspectives. Specifically, this research implies that, from a user perspective in non-educational settings, Gamification is not perceived as an effective tool and may not encourage TDM in an agile context. This finding implicates the managerial need to consider the user perspective before implementing Gamification in software development.

6.3 Contributions

This research applied a proposed UTAUT and TTF model to develop and test the hypothesis on whether PE, EE, SI, FC, and TTF significantly affect the BI to adopt Gamification for TDM in ASD. The research results show that SI and TTF significantly affect Norwegian software companies' behavioural intention to adopt gamification for TDM in ASD. These results contribute to research by providing a good foundation for understanding the most important factors affecting BI on this topic. Further, this research study provides scholars with a deeper understanding of Gamification in relation to ASD.

The research identified a literature gap on whether software companies are willing to adopt Gamification to manage TD in ASD. This research contributes to the Gamification and ASD literature by empirically considering potential users in Norwegian software companies and their BI to adopt Gamification for managing TD in ASD. The complimentary mixed methods approach contributes with an overview of factors affecting the BI to adopt Gamification in Norwegian software companies and further presents an overview of potential challenges and opinions software developers in these organisations have on the potential solution for TDM. The implications provide insights and recommendations that can inform the decisions and actions of managers and practitioners in the field and suggest that Norwegian software companies may need to consider alternative strategies for managing TD to improve software quality. These contributions contradict findings from previous literature where Gamification is a promising for improving software processes (Deterding et al., 2011; Foucault et al., 2018).

6.4 Limitations and Suggestions for Future Research

In this research, data was collected from potential users of a gamified TDM solution in ASD in Norwegian software companies. Individuals with TDM experience in ASD have been interviewed to identify potential opportunities and challenges of the implementation from their perspective. There are several limitations to this research affecting its findings and how the results are interpreted. These limitations open avenues for further research.

The questionnaire was conducted solely online, and participants were not monitored or supervised in any way. Conducting an online questionnaire may have led to a sampling bias as this sample did not include those who cannot access a computer for the online questionnaire (Bryman et al., 2019). Nettskjema allows participants to be held anonymous and treat their data accordingly. A limitation is the researchers' inability to regulate how participants responded to the questionnaire, which could affect the research's internal validity. As a result, the researchers have had less control of recipients and who have participated in the questionnaire. The data collected can be considered less reliable as the researchers chose to post a link to the questionnaire on LinkedIn and asked people to forward the questionnaire link. However, participants recruited from LinkedIn and the shared link constituted a small number of the total number of participants, and most participants were found by the researchers themselves.

One limitation of the questionnaire is its demographic questions, which consisted only four items. These items were not prioritised for the analysis in the present research due to time limitations and the scope. Including these items lengthened the questionnaire beyond what was necessary. It is possible that this may have prevented some participants from responding due to the additional time required. A shorter questionnaire with fewer questions could have increased the response rate and contributed to a larger sample size. In addition, it is necessary to address the limitation associated with selecting closed questions in the questionnaire. Closed questions facilitate easier completion of the questionnaire as open questions can be time-consuming to answer. Still, closed questions also have certain disadvantages (Oates, 2006; Pallant, 2020). Closed questions can result in respondents providing answers without much consideration which can influence their responses and lead to imprecise data (Oates, 2006). Pre-defined answer options may not match the respondent's views or opinions, causing frustration. To overcome these limitations, future research should incorporate open-ended questions in the questionnaire to obtain a broader range of viewpoints and perspectives that closed questions may have ignored.

The questionnaire was published and distributed within a limited timeframe. The time constraints resulted in a relatively small but representable dataset to test the hypotheses. It is important to emphasise that the answers may not represent all users in Norwegian software companies. Therefore, the removal of the six outliers could possibly have impacted the results. Further research should be conducted on a larger sample size as it could have been beneficial to collect responses from a larger population. The current research used an online questionnaire to collect data from target respondents in Norwegian software development companies. Hence, future research could conduct a similar study in another country or employ a comparative study between two countries to see if the results are similar or different with different cultures.

The proposed theoretical model in this research did not include the moderating variables from the original UTAUT model. Task Characteristics, Technology Characteristics, Utilisation, and Performance Impact from the original TTF model were also excluded. The moderating variables were excluded based on the exclusion of these variables in similar studies combining UTAUT and TTF, in addition to being outside the research scope. Task and Technology Characteristics were included in some previous research studies. However, they were excluded from this research due to the scope limitations and their non-significant effect on TTF in some previous studies (Wan et al., 2020; H. Wang et al., 2020). Future research should consider including the moderating variables gender, age, experience, voluntariness of use, use behaviour and the task and technology characteristics as they can be important contributors for the results.

The selected analysis in SPSS did not include the demographic and experience variables despite their inclusion in the online questionnaire. Pallant (2020) explained that crosstabs analysis could be conducted to explore the relationship between two categorical variables. It can be argued that this analysis could provide deeper insights into developers' decision-making processes for adopting Gamification but is not within the scope and purpose of this research. For example, a crosstabs analysis examining the relationship between the age group of 44-50 and developers with experience in Gamification in ASD could potentially yield valuable insights into the factors that influence technology adoption. Nonetheless, this analysis was not conducted in this research due to the research scope. A multi-group analysis, depending on a socio-demographic feature (e.g., gender, education level, type of firm, region, etc) is therefore recommended for future research.

The interviews conducted, can be seen as a limitation to the research as opinions from executives were not included due to time limitations. Including executive interviews could enrich the findings by identifying more diverse views on the topic in addition to necessary and sufficient conditions that needs to be present in an organisation for them to adopt the technology. Further research can examine the adoption of Gamification for TDM in agile projects from managers perspective, both quantitatively and qualitatively. Such research can help in providing clear outlines regarding the relationship between the opinions from both user and managerial perspectives.

Drawing on the insights gained from interviews with industry practitioners, the researchers highlight the significance of user group considerations and agile development processes in determining the need for Gamification in software development. The findings in this research provide a foundation for future research to explore the potential benefits of Gamification in different work environments and to investigate the design and integration of game elements in varied contexts to effectively address the needs of users in these settings. Overall, this research offers valuable insights into the effective implementation of Gamification in ASD and opens new avenues for further research in this area.

7.0 Conclusion

Despite recent interest in the research area on Gamification as a means for managing TD related challenges, the implementation process still needs improvement. A research gap was identified from the literature review on whether software companies are willing to adopt Gamification to manage TD in ASD. Researchers have raised concerns about the adoption of Gamification without adequate empirical support. Further, the effect Gamification has on developers to produce high-quality codes in ASD lacks substantial evidence. The primary objective of this research was therefore to fill this research gap by investigating what affects Norwegian software companies' behavioural intention to adopt or resist Gamification for TDM in ASD. Thus, this research enhances existing knowledge regarding users' adoption intention and perceptions of Gamification's usefulness for managing TD.

Based on the findings, it can be concluded that the perception of Gamification as a valuable tool for managing TD in Norwegian software companies is influenced by various factors. From the online questionnaire, 144 valid responses were collected and analysed. The results of the quantitative analysis using the proposed theoretical model support H3 and H5, which shows that Social Influence and Task-Technology Fit significantly affect the behavioural intention to use Gamification for TDM in ASD.

The qualitative data gathered through semi-structured interviews provided insights to further support the quantitative analysis. The interviews showed that users' perception of Gamification, the company's culture, and the company's current TDM process affect users' behavioural intention to adopt or resist it. This research contributes to a better understanding of the behavioural intention to adopt Gamification as a tool for TDM in ASD. The findings provide valuable insights and present factors that significantly affect the adoption or resistance of Gamification from a user perspective. These findings provide Norwegian software companies with valuable insights which can help them make informed decisions when considering Gamification as a TDM tool.

The research emphasises the significance of SI and TTF in facilitating the adoption of Gamification. The qualitative data clarifies the underlying reasons for the support or rejection of the tested hypotheses. To our knowledge, this is the first research to test the proposed UTAUT and TTF in the context of Gamification for TDM in ASD, contributing to the existing literature on this topic.

Further research can build on these findings to develop best practices for Gamification implementation of TDM in ASD. Both practitioners and researchers need to acknowledge that each ASD team and the TD prioritisation process is unique, and factors affecting the intention to adopt Gamification may vary. Therefore, the need for TDM tools should be considered individually for each team. To be a valuable tool, Gamification requires a thorough evaluation, and users need to comprehend its purpose before implementing it to manage TD in agile teams. While this research was a small-scale study, we believe that our results contribute towards closing the knowledge gap in this field, and further research should verify these findings through more extensive studies.

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9.0 Appendices

Appendix 1 – Measurement scale

Constructs	Items	Source
Performance Expectancy	Utilising gamification in software development processes could enable my company to improve the quality of software products	(Abou-Shouk & Soliman, 2021; Venkatesh et al., 2003)
	Using gamification could help me accomplish code review tasks more efficiently.	
	Using gamification could significantly help increase the productivity of my company's software development.	
	Gamification would engage and encourage and motivate interactive learning with my colleagues to improve the quality of software products	
Effort Expectancy	It would be easier for me to become skillful at producing high-quality code with the help of gamification to support the management of TD during the software development process.	(Ofosu-Ampong et al., 2020; Venkatesh et al., 2003, 2012)
	I believe that a game application in software development processes is easy to use.	
	I would find gamification easy to use	
	Learning to operate gamification to become more skillful at code review tasks and improvements would be clear and understandable	
Social Influence	In general, my organisation has supported gamification for software development	(Abou-Shouk & Soliman, 2021; Yang et al., 2017)
	The management encourages using new innovative technologies for managing and producing quality code	
	My company could use a game application to support the management of TD if an increased proportion of competitors use it	
Facilitating Conditions	My company has resources available to use a game application to manage and support the management of TD	(Abou-Shouk & Soliman, 2021; Oliveira et al., 2019; Venkatesh et al., 2003)
	It is believed that other colleagues will find a game application helpful in improving the quality of software products.	

	My company has the skilled human resources to use game application and encourage employee engagement to reduce technical debt.	
	Using a game application would fit well with how my company develops software products in agile projects settings.	
Task-Technology fit	Gamification is an appropriate tool for faster, better decision-making for managing TD in my software organisation.	(Wan et al., 2020; Zhou et al., 2010; D'Ambra & Wilson, 2004; Tam & Oliveira, 2016)
	In general, a game application's functions could help me manage and reduce TD when developing software in an agile project.	
	Using a game application is appropriate in helping me manage TD in my software organisation.	
	Gamification techniques can support the requirement to manage technical debt in my software organisation.	
Behavioural Intention	I expect my company to use a game application in the near future to support the management of TD.	(Abou-Shouk & Soliman, 2021)
	My company will use gamification in the near future to support the management of TD agile software development.	
	My company is likely planning to use gamification in the near future to support the management of TD.	

Appendix 2 - Questionnaire consent form

The estimated time to complete this survey is 10 minutes.
Thank you for participating in our research by taking this survey.
The following page provides information about this research's goals and what participation means for you. The results and answers will be handled confidentially and anonymised.

Purpose of the study:
You will help us to complete our master's Thesis at Kristiania University College. This survey aims to understand employees in software companies' behavioural intention to adopt Gamification to manage Technical Debt in agile software projects. We are therefore interested in your opinions about the phenomenon.

What participation means to you:
By participating in this survey, you will be of tremendous help in our research project, and we would like to express our deepest gratitude for your contribution. All questions must be answered, but we do not collect sensitive data, and participation is voluntary. You cannot be recognised or identified in our project. We treat the information about you confidentially and following the GDPR. All data will be deleted when the project ends and the assignment is approved, which according to the plan, is 31.06.2023.

Who is responsible?
Responsible for this project are Eline Fidje and Ane Emely Dalberg (students at Kristiania University College). The names mentioned above will be the only ones to access and process the data collected.

Disclaimer and declaration of consent
You are free to decide whether you want to participate in this research. If you choose not to participate, you may withdraw at any time without negative consequences. Please close this window if you want to withdraw from participating in the survey. By proceeding, you confirm that your participation is voluntary and at your discretion. By clicking the "next" button below, you agree that you have read and understood this information and give consent to take part in this research.

If you have any questions, do not hesitate to contact us:
anda031@student.kristiania.no or elfi007@student.kristiania.no

Appendix 3 – Code book

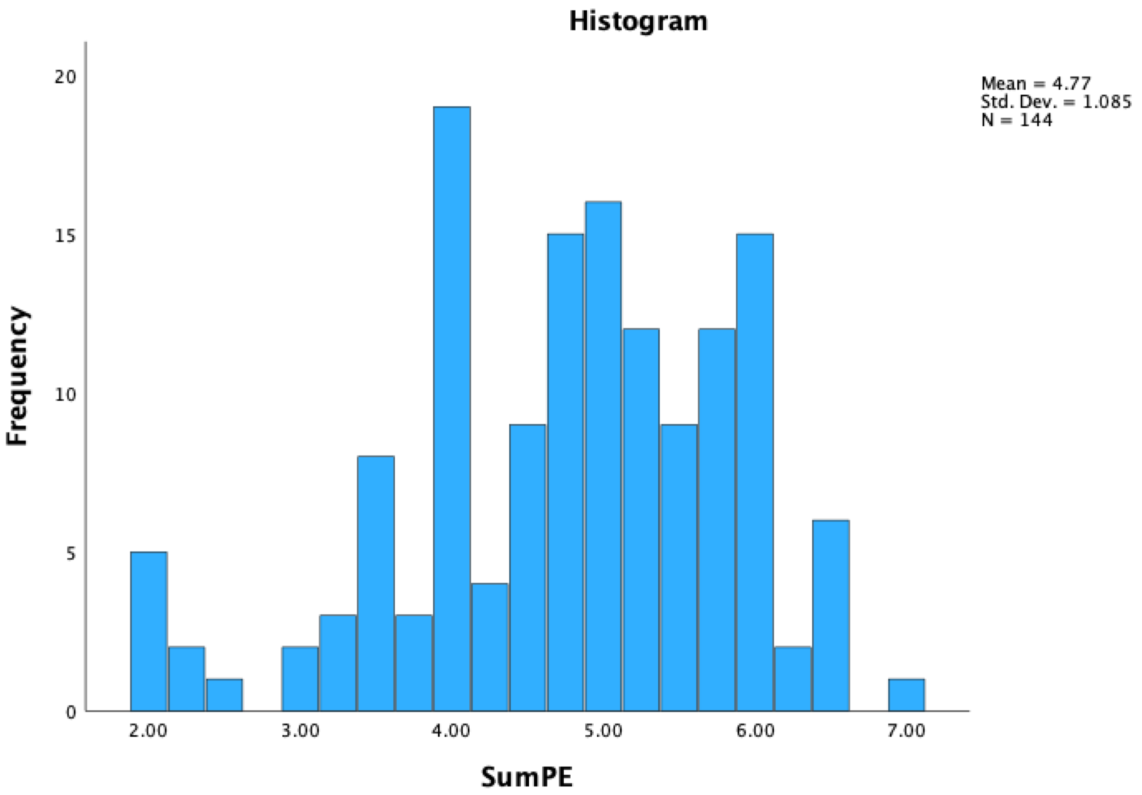
SPSS variable name	Full variable name	Coding instructions	Measurement scale
ID	Identification number	Identification number	Scale
Age	Age	1 18 - 22 years old 2 23 - 29 years old 3 30 - 36 years old 4 37 - 43 years old 5 44 - 50 years old 6 51 - 57 years old 7 58 - 64 years old 8 65 - 72 years old 9 Over 71 years old	Ordinal
Education	Education	1 Videregående 2 Yrkesfag 3 Årsstudium 4 Bachelor 5 Master 6 PhD 7 Other	Ordinal
Position title	Position Title	1 Software developer 2 Software engineer 3 Project manager 4 Product owner 5 IT-consultant 6 Software architect 7 Researcher 8 Other	Ordinal
Employees	Employees	1 Less than 50 2 50 - 100 3 100 - 150 4 150 - 250 5 250 - 350 6 More than 350	Ordinal
TD	Technical Debt	1 Yes 2 No 0 I dont know	Ordinal
Gamification	Gamification	1 Yes 2 No 0 I dont know	Ordinal
GamificationMTD	Gamification for Technical Debt Management	1 Yes 2 No 0 I dont know	Ordinal
GamificationASD	Gamifciation for Agile software development	1 Yes 2 No 0 I dont know	Ordinal
PE1 to PE4	Performance Expectancy	1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree	Ordinal

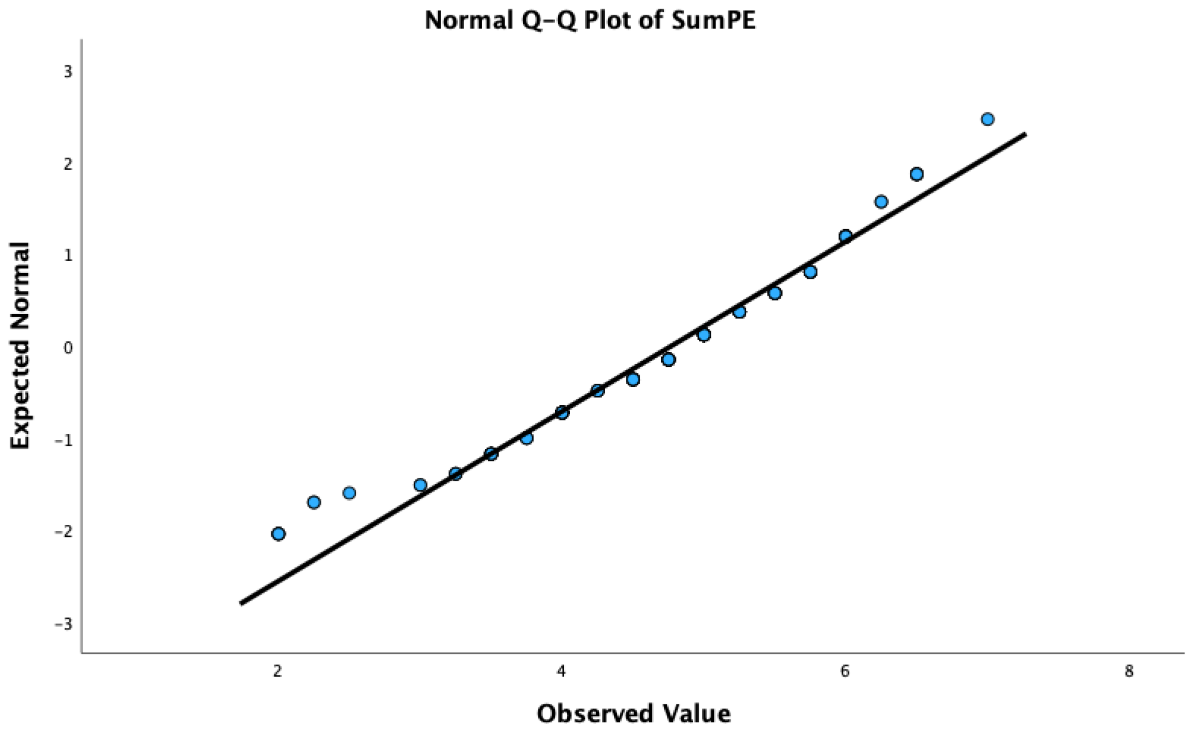
EE1 to EE4	Effort Expectancy	1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree	Ordinal
SI1 to SI3	Social Influence	1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree	Ordinal
FC1 to FC4	Facilitating Conditions	1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree	Ordinal
TTF1 to TTF 4	Task-Technology Fit	1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree	Ordinal
BI1 to BI3	Behavioural intention	1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree	Ordinal

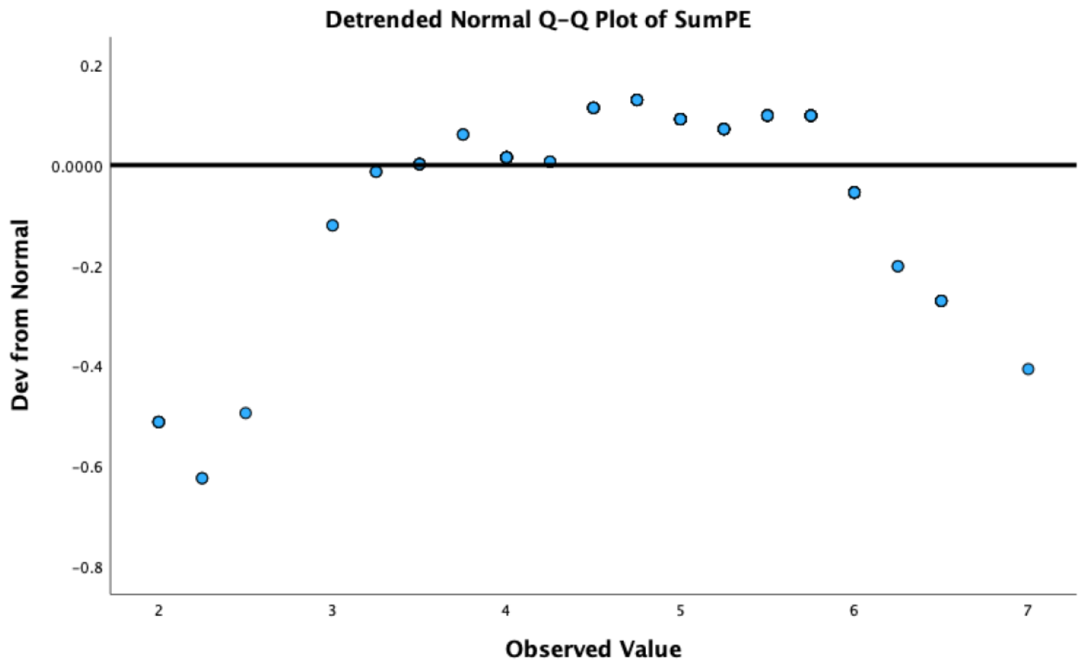
Appendix 4 - Interview guide

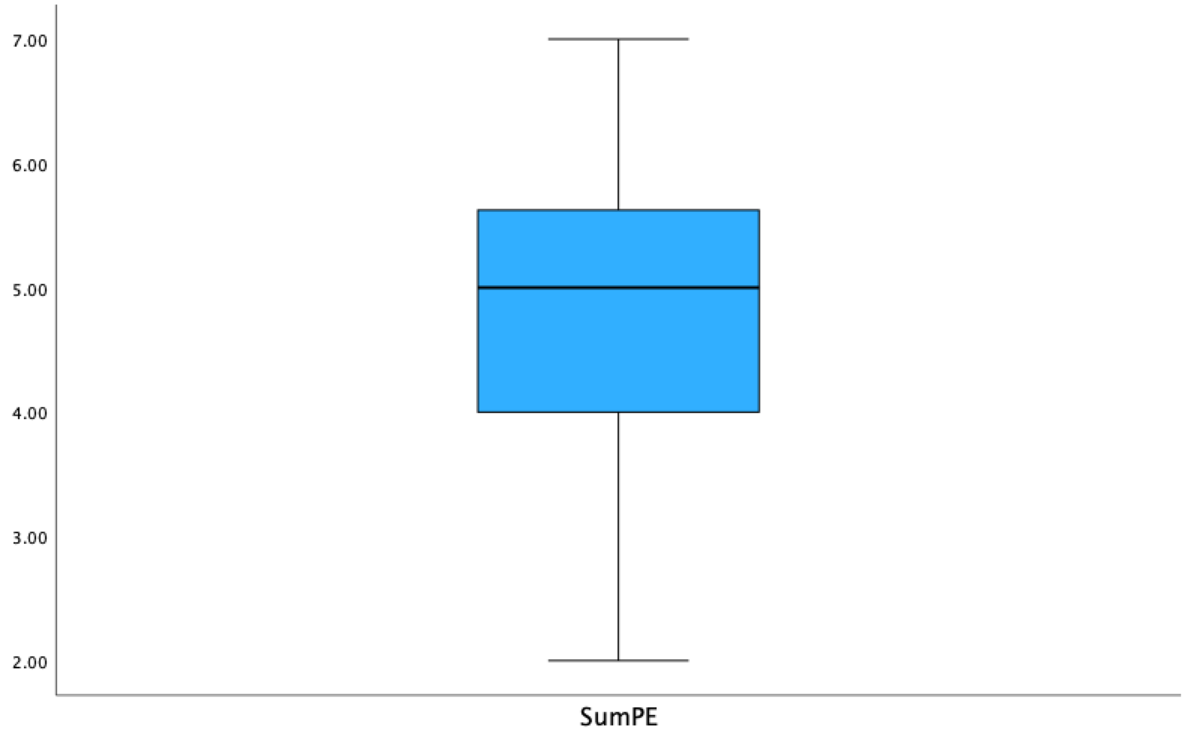
1. What is your experience with technical debt? What is your experience with technical debt in agile projects you have worked on?
2. Why do you think technical debt prioritisation is/is not important?
3. Does your team incur debt intentionally? If yes, why? What are the benefits of doing so?
4. Do you believe gamification would be a useful tool to prevent technical debt in agile projects? If yes/no, why?
5. If gamification would have been implemented in your project, how do you think it would have been accepted?
6. Based on the results of our survey, we found that people generally agree with the statements and that gamification could be a good solution. Why do you think this is the result? Can you elaborate more on what disadvantages/advantages you think can arise from using gamification in a development team?
7. The results also indicate that employees have less confidence in utilising gamification to handle technical debt in agile projects. Why do you think this is the case?
8. The result of our survey shows that the majority agree that management encourages the use of new technology to produce better code. Do you have any suggestions for other methods to handle technical debt in agile projects? (Other tools)
9. Do you have any additional thoughts on the topic or anything else you would like to add?

Appendix 5 – Histogram, Normal, Detrenched Normal QQ-plots, and boxplots for Performance Expectancy (SumPE)




Normal Q-Q Plot of SumPE
Expected Normal
Observed Value
3
2
1
0
-1
-2
-3
2
4
6
8


Detrended Normal Q-Q Plot of SumPE
Dev from Normal
Observed Value
0.2
0.0000
-0.2
-0.4
-0.6
-0.8
2
3
4
5
6
7


7.00
6.00
5.00
4.00
3.00
2.00
SumPE

Appendix 6 – Pearson product-moment correlation Matrix of each subcategory

Correlations

		PE1	PE2	PE3	PE4	EE1	EE2	EE3	EE4	SI1	SI2	SI3	FC1	FC2	FC3	FC4	TTF1	TTF2	TTF3	TTF4	BI1	BI2	BI3
PE1	Pearson Correlation	1	.664**	.652**	.586**	.630**	.435**	.405**	.577**	.335**	.122	.392**	.267**	.614**	.270**	.568**	.510**	.600**	.517**	.517**	.335**	.296**	.297**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.145	<.001	.001	<.001	.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
PE2	Pearson Correlation	.664**	1	.641**	.522**	.579**	.476**	.301**	.528**	.365**	-.027	.383**	.301**	.556**	.318**	.583**	.513**	.586**	.590**	.568**	.440**	.355**	.348**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	.746	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
PE3	Pearson Correlation	.652**	.641**	1	.650**	.648**	.481**	.318**	.550**	.284**	.074	.440**	.305**	.653**	.354**	.628**	.534**	.640**	.653**	.561**	.451**	.454**	.458**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	.379	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
PE4	Pearson Correlation	.586**	.522**	.650**	1	.599**	.518**	.317**	.511**	.224**	.187*	.488**	.257**	.674**	.280**	.462**	.404**	.557**	.507**	.577**	.290**	.306**	.287**
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001	<.001	.007	.025	<.001	.002	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EE1	Pearson Correlation	.630**	.579**	.648**	.599**	1	.549**	.355**	.613**	.356**	.137	.367**	.230**	.644**	.138	.553**	.570**	.626**	.617**	.643**	.452**	.471**	.456**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	.101	<.001	.006	<.001	.099	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EE2	Pearson Correlation	.435**	.476**	.481**	.518**	.549**	1	.663**	.521**	.420**	.181*	.414**	.444**	.616**	.345**	.561**	.435**	.502**	.550**	.501**	.383**	.447**	.416**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	.030	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
EE3	Pearson Correlation	.405**	.301**	.318**	.317**	.355**	.663**	1	.529**	.366**	.219**	.345**	.338**	.402**	.353**	.412**	.242**	.457**	.403**	.368**	.242**	.300**	.276**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	.008	<.001	<.001	<.001	<.001	<.001	.003	<.001	<.001	<.001	.003	<.001	<.001
EE4	Pearson Correlation	.577**	.528**	.550**	.511**	.613**	.521**	.529**	1	.407**	.062	.412**	.290**	.511**	.253**	.522**	.474**	.582**	.541**	.470**	.427**	.446**	.385**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	.462	<.001	<.001	<.001	.002	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
SI1	Pearson Correlation	.335**	.365**	.284**	.224**	.356**	.420**	.366**	.407**	1	.102	.397**	.448**	.400**	.375**	.492**	.429**	.345**	.433**	.384**	.580**	.557**	.553**
	Sig. (2-tailed)	<.001	<.001	<.001	.007	<.001	<.001	<.001	<.001		.224	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
SI2	Pearson Correlation	.122	-.027	.074	.187*	.137	.181*	.219**	.062	.102	1	.249**	.260**	.134	.174*	.100	.065	.072	.131	.235**	.052	.152	.105
	Sig. (2-tailed)	.145	.746	.379	.025	.101	.030	.008	.462	.224		.003	.002	.110	.037	.232	.436	.394	.118	.005	.537	.069	.212
SI3	Pearson Correlation	.392**	.383**	.440**	.488**	.367**	.414**	.345**	.412**	.397**	.249**	1	.343**	.450**	.331**	.394**	.341**	.517**	.579**	.524**	.330**	.370**	.324**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.003		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
FC1	Pearson Correlation	.267**	.301**	.305**	.257**	.230**	.444**	.338**	.290**	.448**	.260**	.343**	1	.414**	.586**	.392**	.358**	.413**	.421**	.423**	.376**	.412**	.371**
	Sig. (2-tailed)	.001	<.001	<.001	.002	.006	<.001	<.001	<.001	<.001	.002	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
FC2	Pearson Correlation	.614**	.556**	.653**	.674**	.644**	.616**	.402**	.511**	.400**	.134	.450**	.414**	1	.329**	.665**	.572**	.660**	.662**	.629**	.405**	.446**	.431**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.110	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
FC3	Pearson Correlation	.270**	.318**	.354**	.280**	.138	.345**	.353**	.253**	.375**	.174*	.331**	.586**	.329**	1	.498**	.311**	.352**	.312**	.327**	.367**	.352**	.353**
	Sig. (2-tailed)	.001	<.001	<.001	<.001	.099	<.001	<.001	.002	<.001	.037	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
FC4	Pearson Correlation	.568**	.583**	.628**	.462**	.553**	.561**	.412**	.522**	.492**	.100	.394**	.392**	.665**	.498**	1	.645**	.596**	.649**	.577**	.509**	.546**	.520**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.232	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001
TTF1	Pearson Correlation	.510**	.513**	.534**	.404**	.570**	.435**	.242**	.474**	.429**	.065	.341**	.358**	.572**	.311**	.645**	1	.613**	.682**	.610**	.523**	.520**	.498**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	.003	<.001	<.001	.436	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001
TTF2	Pearson Correlation	.600**	.586**	.640**	.557**	.626**	.502**	.457**	.582**	.345**	.072	.517**	.413**	.660**	.352**	.596**	.613**	1	.767**	.679**	.512**	.539**	.530**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.394	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001
TTF3	Pearson Correlation	.517**	.590**	.653**	.507**	.617**	.550**	.403**	.541**	.433**	.131	.579**	.421**	.662**	.312**	.649**	.682**	.767**	1	.763**	.542**	.577**	.542**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.118	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001
TTF4	Pearson Correlation	.517**	.568**	.561**	.577**	.643**	.501**	.368**	.470**	.384**	.235**	.524**	.423**	.629**	.327**	.577**	.610**	.679**	.763**	1	.429**	.433**	.411**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.005	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001
BI1	Pearson Correlation	.335**	.440**	.451**	.290**	.452**	.383**	.242**	.427**	.580**	.052	.330**	.376**	.405**	.367**	.509**	.523**	.512**	.542**	.429**	1	.890**	.855**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	.003	<.001	<.001	.537	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001
BI2	Pearson Correlation	.296**	.355**	.454**	.306**	.471**	.447**	.300**	.446**	.557**	.152	.370**	.412**	.446**	.352**	.546**	.520**	.539**	.577**	.433**	.890**	1	.906**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.069	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001
BI3	Pearson Correlation	.297**	.348**	.458**	.287**	.456**	.416**	.276**	.385**	.553**	.105	.324**	.371**	.431**	.353**	.520**	.498**	.530**	.542**	.411**	.855**	.906**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.212	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix 7 – Pearson product-moment correlation Matrix of the total variables

Correlations

		TotalPE	TotalEE	TotalSI	TotalFC	TotalTTF	TotalBI
TotalPE	Pearson Correlation	1	.721**	.509**	.656**	.747**	.444**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001
	N	144	144	144	144	144	144
TotalEE	Pearson Correlation	.721**	1	.570**	.643**	.707**	.505**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001
	N	144	144	144	144	144	144
TotalSI	Pearson Correlation	.509**	.570**	1	.619**	.604**	.572**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001
	N	144	144	144	144	144	144
TotalFC	Pearson Correlation	.656**	.643**	.619**	1	.712**	.562**
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001
	N	144	144	144	144	144	144
TotalTTF	Pearson Correlation	.747**	.707**	.604**	.712**	1	.602**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001
	N	144	144	144	144	144	144
TotalBI	Pearson Correlation	.444**	.505**	.572**	.562**	.602**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	
	N	144	144	144	144	144	144

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 8 – Reliability analysis including all subconstructs.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.944	.945	22

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
PE1	89.90	382.458	.659	.657	.942
PE2	90.19	378.172	.663	.627	.941
PE3	90.30	377.554	.725	.686	.941
PE4	89.87	380.241	.628	.644	.942
EE1	90.65	378.788	.706	.690	.941
EE2	90.35	381.489	.685	.673	.941
EE3	89.94	388.361	.520	.607	.943
EE4	90.28	382.765	.664	.583	.942
SI1	91.19	378.507	.582	.533	.943
SI2	89.48	403.608	.189	.257	.948
SI3	90.21	382.977	.580	.483	.943
FC1	90.67	378.221	.534	.522	.944
FC2	90.35	374.426	.756	.699	.940
FC3	90.31	383.486	.489	.532	.944
FC4	90.53	369.440	.763	.686	.940
TTF1	90.71	377.215	.690	.605	.941
TTF2	90.55	374.347	.780	.731	.940
TTF3	90.78	369.988	.803	.787	.939
TTF4	90.38	376.979	.741	.702	.940
BI1	91.52	370.433	.668	.843	.941
BI2	91.69	372.398	.699	.894	.941
BI3	91.63	373.059	.664	.845	.941

Appendix 9 – Reliability analysis without the subcategory SI2

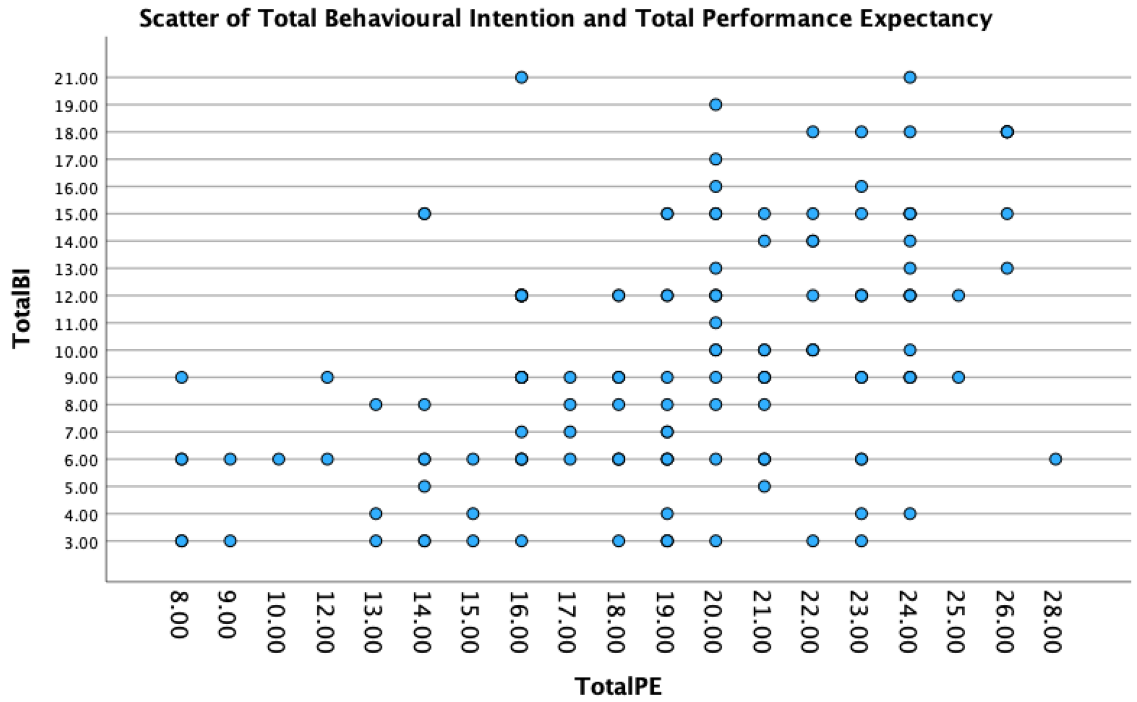
Reliability Statistics

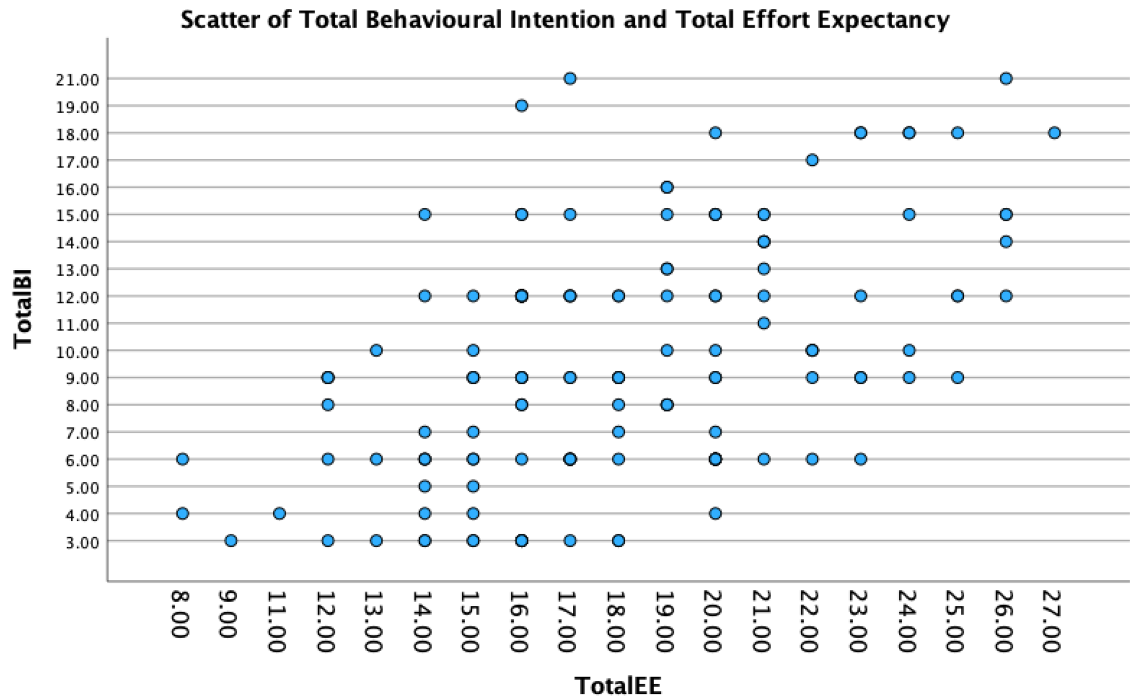
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.948	.949	21

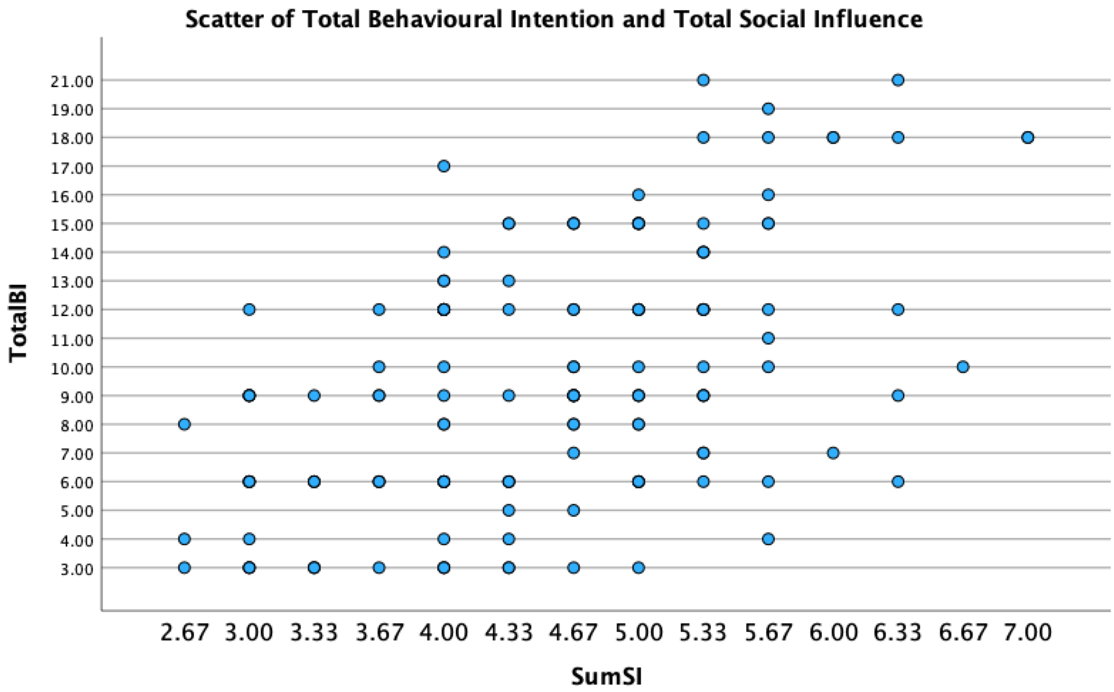
Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
PE1	84.54	371.733	.660	.652	.945
PE2	84.84	366.988	.675	.618	.945
PE3	84.94	366.696	.731	.685	.944
PE4	84.51	369.776	.624	.641	.946
EE1	85.30	368.127	.707	.687	.945
EE2	85.00	370.937	.683	.673	.945
EE3	84.59	377.936	.513	.599	.947
EE4	84.93	371.855	.670	.577	.945
SI1	85.84	367.799	.584	.531	.946
SI3	84.85	372.713	.571	.471	.946
FC1	85.32	368.191	.524	.508	.948
FC2	85.00	363.776	.758	.698	.944
FC3	84.95	373.054	.485	.531	.948
FC4	85.17	358.718	.768	.686	.943
TTF1	85.35	366.342	.696	.605	.945
TTF2	85.19	363.486	.787	.722	.943
TTF3	85.43	359.352	.806	.787	.943
TTF4	85.03	366.629	.736	.694	.944
BI1	86.17	359.552	.675	.840	.945
BI2	86.33	361.874	.699	.891	.945
BI3	86.28	362.370	.667	.845	.945

Appendix 10 - Scatterplots






Scatter of Total Behavioural Intention and Total Social Influence
TotalBI
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19.00
18.00
17.00
16.00
15.00
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13.00
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11.00
10.00
9.00
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7.00
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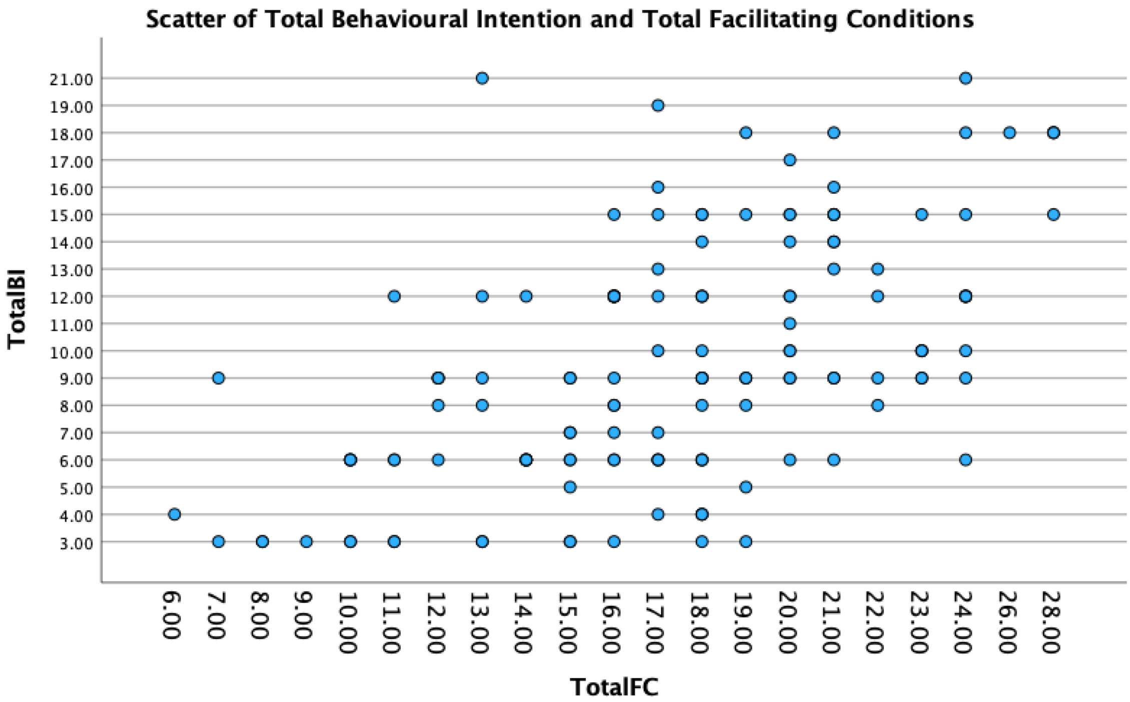
6.67
7.00
SumSI


Scatter of Total Behavioural Intention and Total Facilitating Conditions
TotalBI
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19.00
18.00
17.00
16.00
15.00
14.00
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11.00
10.00
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26.00
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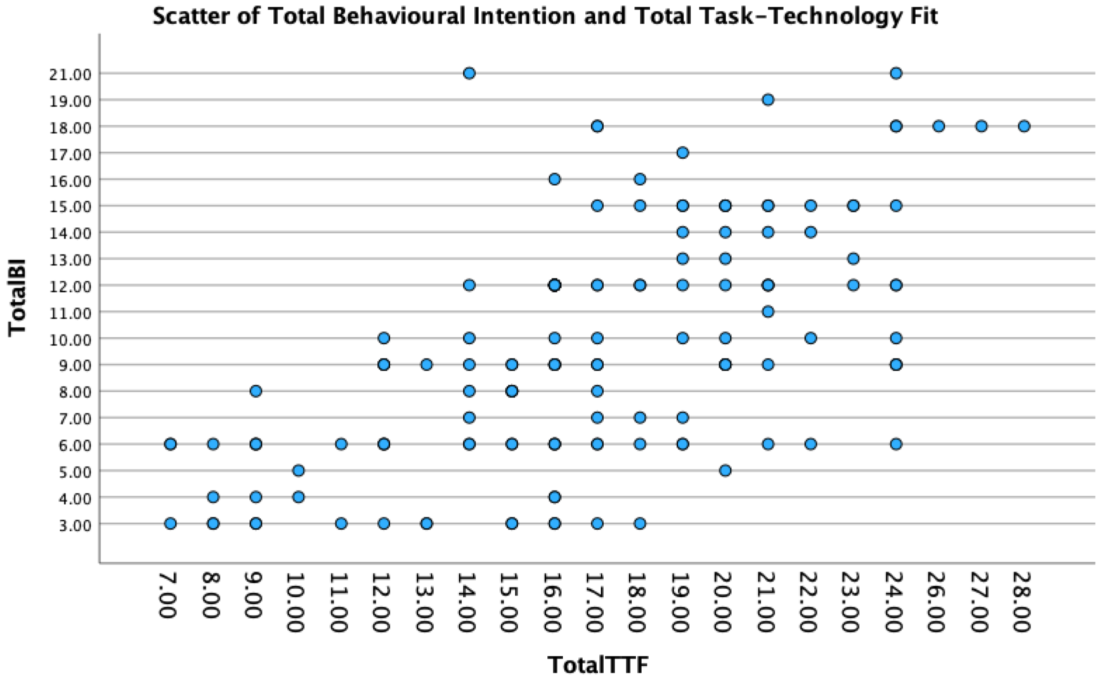
TotalFC



Appendix 11 – The final standard Multiple regression analysis (without SI2)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.671[a]	.450	.430	3.36171

a. Predictors: (Constant), TotalTTF, TotalSI, TotalEE, TotalFC, TotalPE

b. Dependent Variable: TotalBI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-2.417	1.428		-1.692	.093	-5.241	.407			
	TotalPE	-.137	.108	-.134	-1.266	.208	-.352	.077	.444	-.107	-.080
	TotalEE	.094	.116	.083	.814	.417	-.135	.323	.505	.069	.051
	TotalSI	.506	.161	.268	3.136	.002	.187	.826	.572	.258	.198
	TotalFC	.171	.096	.178	1.790	.076	-.018	.360	.562	.151	.113
	TotalTTF	.344	.108	.355	3.177	.002	.130	.558	.602	.261	.201

a. Dependent Variable: TotalBI