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Review

TAM 3+, a New Approach to Attract Teachers Towards Technology

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Abstract: Technology Acceptance Model (TAM) is a widely acknowledged information system theory showcasing the motivational factors of how users come up and use technology. TAM 2 and TAM 3 are later extensions consuming and confirming more such factors responsible for technology adoption. Following this line of research, one latest study has proposed a further extension as TAM 3+. The current study is a brief critical review of this proposition. Why and how this has been reached? How far it could be merited to attract teachers towards better technology use? Taken together, this study will provide the readers with a solid understanding of users 'subjective self' considered a vital stimulus in TAM 3+, and thereby concludes whether to praise or criticize this extension as a tool for predicting end-users behavior concerning technology use.

Keywords: TAM, TAM3+, Technology Adoption, Subjective Self, School Teachers

Introduction

The reviewed article (Kundu *et al*., 2022) starts with a famous line from the great Indian poet and philosopher Nobel Laureate Kabiguru Rabindranath Tagore "amari chetonar ronge panna holo sobuj, chuni hoye uthlo ranga hoye" (Tagoreweb, 2021). The authors thereby explained the importance of *'ami'* or the human self in this universe. They further make their stand stronger quoting William James, the 'Father of American psychology' who also observed that there is but one cause of human failure and that is man's lack of faith in his true self (WJQ, 2021). The basic objective of their research as the authors pointed out was to investigate the importance of teachers' subjective self, comprising of their self-efficacy and self-concept in their ease of Information and Communication Technology (ICT) use. They convincingly stated that ICT, a ubiquitous aspect of modern human life, plagued with the latest developments relating to 'reification' and 'etherealization' has proved its immense potential in delivering education effectively, especially in the post-COVID-19 pandemic-affected world when its urgency is being felt more than ever across the globe every hour by every teacher (Kundu and Bej, 2021a). Considering the huge proliferation of ICT over the educational domain and limited infrastructure the authors tried to find out ways of how much may be achieved with what is having by leveraging the full potential of self. Since the basics of their investigation rest on attitude and motivation-related factors they have taken up Technology Acceptance Model (TAM) originally developed by Fred Davis in 1986 (Davis, 1989) as a theoretical framework, a much-discussed model exhibiting the man-machine interplay. It shows technology adoption does not merely depend on the available resources and infrastructure rather a large extent of it is dependent on users' attitudinal and motivational factors, behavioral intention, perceived usefulness, and ease of use. Few more factors have been added in its latest TAM 3 version like voluntariness, experience, subjective norms, image, job relevance, output quality, demonstrability, computer efficacy, anxiety, and enjoyment.

The authors of this reviewed literature found users' 'subjective self' needs to be explored further and took it as a research gap. Several other behavioral factors are there predicting users' motivation factors regarding technology use. They went on a detailed empirical analysis based on a quantitative correlational ex-post-facto methodology and found a strong effect of teachers' subjective self (made of self-efficacy and self-concept) on their perceived ease of ICT use. Based on their findings they have proposed an extension of TAM 3 towards TAM 3+ adding users' 'subjective self' as a new variable with said two components. This critical review is intended to analyze this proposed extension (TAM 3+) to provide an unbiased point of view for the reader regarding its merits and demerits. In this critical discussion the author objectively viewed the aims, scopes, and methods of the reviewed article and has made a subjective interpretation

of its potential implications by answering the following Research Questions (RQ):

RQ1: Why TAM is important?
RQ2: Why did the authors go for TAM 3+?
RQ3: How TAM 3+ has been reached?
RQ4: How far this new extension could be effective for better technology adoption?

Findings Relating to RQ1

Background of TAM

When Davis (1989) introduced his notion of TAM, he leveraged one very popular psychological principle namely the Theory of Reasoned Action (TRA), first proposed in 1967 by Martin (Fishbein, 2008) that attention to a person's intention to behave in a particular way. It explains the paths in which attitudes influence human behavior in a certain action. Davis adopted this principle in an era already feeling the throbs of technology, especially the computer technologies to reach an understanding of the vital factors influencing technology adoption or abandonment by a certain user and his model has been in vivid use for the last three decades with many iterations. Before TAM was in the limelight the theory of reasoned action (one's pre-existing emotional state) was used to consider to predict human behavior, his engagement or avoidance of a particular action was the predestined outcome of his/her beliefs concerned with anticipated outcomes. Davis was exceptional to note that a deeper understanding of the motivational factors of an individual needs more attention to face the exponential growth of technology adoption irrespective of domains (Davis *et al.*, 1989). Catering to this need TAM has been a capable model for decades to come up with "an explanation of the determinants of computer acceptance that is general and capable of explaining user [attitudes] and behavior across a broad range of end-user computing technologies and user populations" (Davis *et al*., 1989, p. 985). It is noteworthy to mention here that the introduction of TAM (Fig. 1) has been epoch-making not only by divulging users' information system acceptance but also by bringing together and explaining the prominent determinants of technology adoption and use (Kundu *et al*., 2022). This illustration the authors have made conveys the importance of TAM in the educational technology domain.

Importance of Considering TAM

As revealed in Fig. 1, 'perceived Ease of Use' (PEU) and 'Perceived Usefulness(PU) are two essential components or factors of TAM irrespective of domains chosen for technology adoption. The authors defined these two terms since their study deserved this explanation. PEU is a user's degree of belief in using a system effort-free while PU defines his degree of belief that using a particular system will improve his or her performance. It needs to recall once again that TAM revolves around this single fundamental notion that a user's attitude to adopt a technology depends on his PEU and PU. Thus, it guaranteed the proposed hypothesis that the authors upheld for their investigation that the users' self-efficacy and self-concept jointly named as users' 'subjective self' might affect their PEU that eventually determine their technology adoption, making apposite attitude and mediating the relationship between technology and acting variables.

TAM3 as One of the Subsequent Modifications

This comprehensiveness, the authors mentioned, evident in TAM has been unique which made it widely accepted among subsequent researchers that only resulted in adding more thoroughness with further extensions. This comprehensiveness as Meerza (2017) noted brings external, cognitive, and affective components together and jointly influences technology use. The application of TAM is proposed to determine whether a population will be inclined to accept or reject the use of a technology (Davis, 1993). Davis *et al.* (1989) found TAM may assist researchers in identifying why particular "systems may be unacceptable [and] to pursue appropriate corrective steps" (p. 985). It has been studied across different user groups and across a range of contexts to clarify users' attitudes and actual technology use. A lot of studies have been successfully made in the contexts of education and ICT. There, TAM is used as a means of reaching conclusions about ICT use. Davis (1993) used it in the context of acceptance of Information Technology (IT) in the workplace, Li and Kirkup (2007) used it in the context of Internet use in universities, Sanchez and Hueros (2010) used it in the context of the acceptance of Moodle, while Edmunds *et al*. (2012) used it regarding ICT use in higher education.

Venkatesh and Davis (2000) further extended TAM to explain *'perceived usefulness'* and *'usage intentions'* in terms of 'social influence' and 'cognitive instrumental processes' (result demonstrability, output quality, Job Relevance, Image, and Subjective Norm) and proposed as the TAM2 (Fig. 2) but they missed 'attitude towards using'. To meet this gap Venkatesh and Bala (2008) developed TAM 3, a comprehensive nomological network of IT adoption and use by combining TAM-2 with the determinants of Perceived Ease of Use (PEU) like computer anxiety, perceptions of external control, computer playfulness, computer self-efficacy, perceived enjoyment, and objective usability. A comparative presentation of TAM, TAM 2, and TAM 3 (Fig. 2) has been made in Boughzala (2014).

TAM 3 has so far been the latest extension of TAM. But the authors of Kundu *et al.* (2022) have found a research gap in TAM 3 considering the ever-evolving nature of technological innovations and associated complexities. They found TAM 3 has limited explanation over technology-related self-efficacy and self-concept of the user and hypothesize an effect of self-efficacy and self-concept among users' PEU. Following this hypothesis, they went out to empirically test the effects of these two variables on the users' ICT adoption and use. They have termed these two variables jointly as the user's 'subjective self'.

Findings Relating to RQ2

Before coming to the central analysis of TAM and its subsequent extensions the authors have made an in-depth literature review which includes the following aspects that also served as the purpose statement:

i. Change in the global educational arena with technology, including India
ii. Role of ICT in Teaching
iii. Factors Affecting ICT
iv. Self-efficacy and Self-concept in human self-system

In the beginning, the authors rightly grasp the nuance of change in the educational arena with technology incorporation, especially after computer and information technologies. They quote R. Buckminster Fuller (Fuller, 1938) to point out today's e-generation where cutting-edge technology has been influencing almost every aspect of human life with potential computing power and simultaneous 'etherealization'. Education and teaching-learning are no exception when it has transcended themselves to the broadcast mode from earlier factory mode with a greater focus on individuality, creativity, and problem-solving. A visual of this futuristic change has been convincingly captured in Kundu and Bej (2021b) which depicts the problem-based learning which is the ability of learners to solve real-world problems; immersion which is real-time decision making; and simulation which is a safe environment for problem-solving which are going to take driving principles of future education as presented in the Venn diagram below (Fig. 3). In all three aspects technology, rather 'ephemeralzed' technology will serve a major role by transforming education from a pure knowledge transfer process to hands-on experience and knowledge creation by solving problems. And this is feasible by manipulating smarter arrangements for e-transfer of knowledge like a simulation of human minds through neural networks, deep learning, and artificial intelligence. Everywhere authors found ICTs are audibly predominant.

The context of this study reflects India and the authors have made the echo of the country's technology-integrated teaching-learning tune so far. Responding to the changing scenario Indian government has come up with a new policy framework that proposed a dramatic change from its earlier stands of techno-pedagogy in every domain-pedagogical, institutional, and human (Kundu and Bej, 2021b). This policy (NPE, 2020) has been exclusive in respect of its approach to ICT or Educational Technology (ET) from its predecessors with greater emphasis on the dematerialization and digitalization of content, hitherto remarkable in the conservative Indian education system (Fig. 4).

The authors found this policy intent is not a mutated one but rather a gradual continuation of a process that might have its nascent beginning in ancient India. Mukhopadhyay and Parhar (2004) in their book Encyclopaedia of Indian Education traced a detailed technological inheritance and noticed India long ago used a device like ink pens made of birds' features or of bamboo sticks where they rest roots of this prestigious inheritance. Besides Indian philosophy said '*Sa vidya ya vimuktaye'* (what liberates is education) which they found the secret of today's 'constructivist approach behind ET adoption'. Thus, they pointed out a strong Indian legacy of technology adoption buried in educational wisdom passed through the ages as reflected in the 'concept map' (Fig. 5).

Starting from the ink pens to specific innovations like Sidney L. Pressey's Mechanical Teaching Machines to the inventions like the computer, internet, or www have enhanced the role of ET in education. But technology is not a solution itself rather it helps the process only. It's a tool that facilitates innovation, not innovation itself. The authors pointed out the observation of on espoused theoretical characteristics of ET that illustrate the benefits of ET (Fig. 6).

ICT is a miracle of science combining the silent tune of both technology and unified communication allowing users to access, store, transmit, understand and manipulate information with blinks. This has virtually revolutionized education by making it free from its earlier limitation in all domains-access, quality, and equity. Several past studies have told highly of its blessings towards students, teachers, teaching, and learning. The authors have summed up these benefits of ICT to teaching carefully that if accumulated may form a diagram (Fig. 7).

Despite having the immense potential of ICT, limitations are obvious towards its adoption at all levels-material, cognitive and conative. This technology is in no way culpable. ICT use and ICT integration in pedagogy are two different things. The roots of these limitations as authors found lies in the difference between 'Espoused Theory' and 'Theory-in-Use' proposed in their book *Action Science* where they asserted 'Espoused theories' are those that individual claims to follow while 'Theories-in-Use' are those than can be inferred from practical action" (p. 82).

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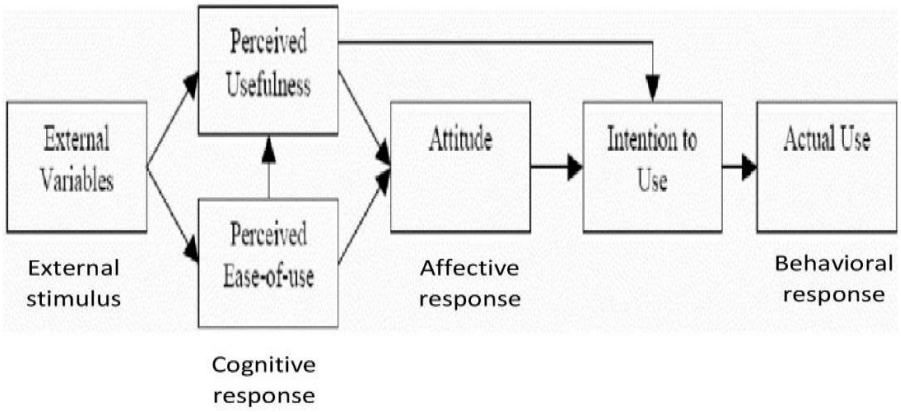

Fig. 1: Technology acceptance model (Davis, 1989)

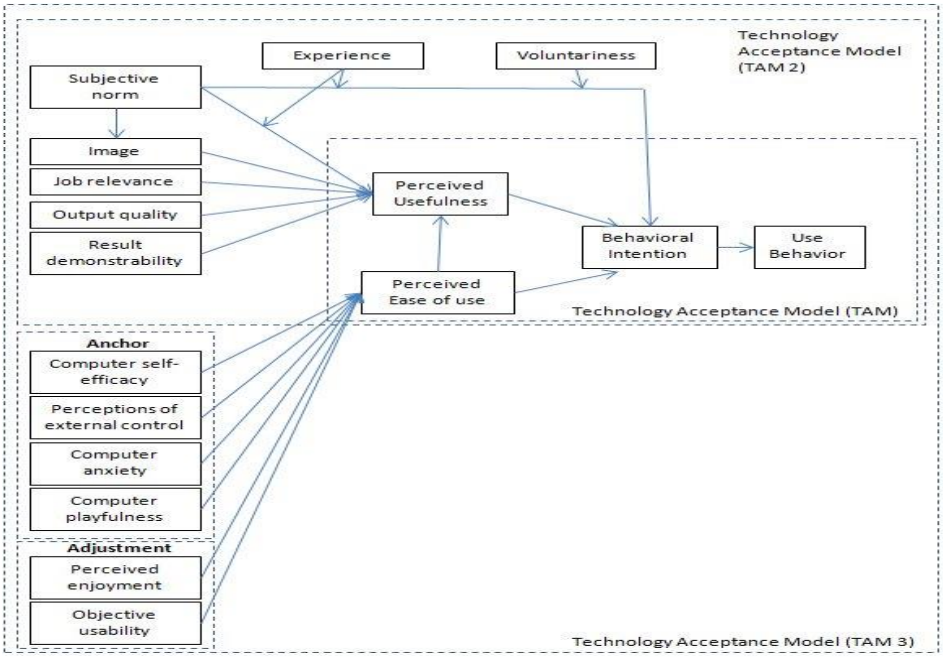

Fig. 2: Comparisons among TAM, TAM 2, and TAM 3 (Boughzala, 2014)

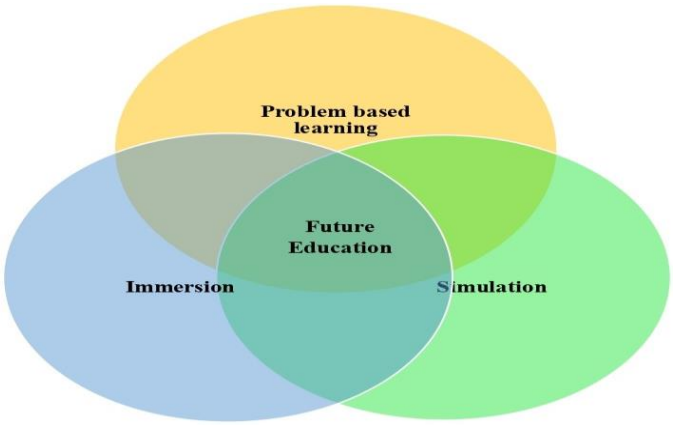

Fig. 3: Venn diagram capturing future education (Kundu and Bej, 2021b)

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Fig. 4: Positive policy intents (NPE, 2020)

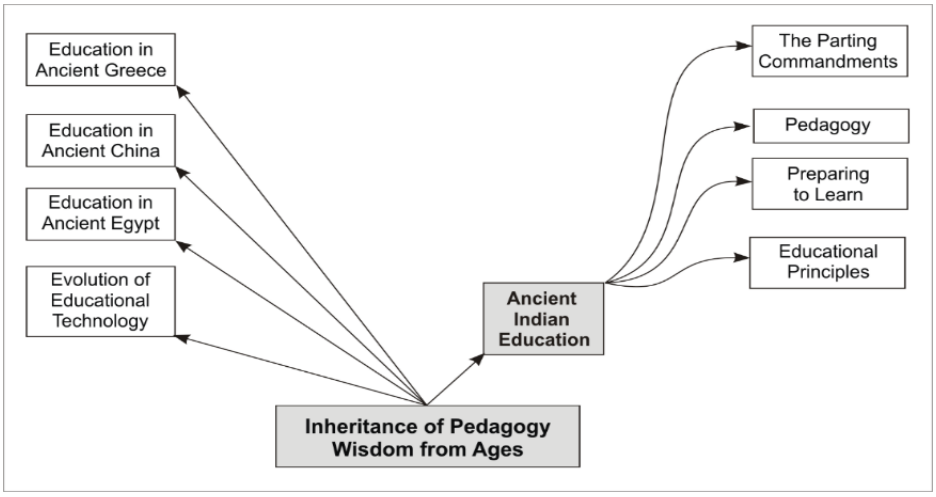

Fig. 5: The concept Map (Mukhopadhyay and Parhar, 2004)

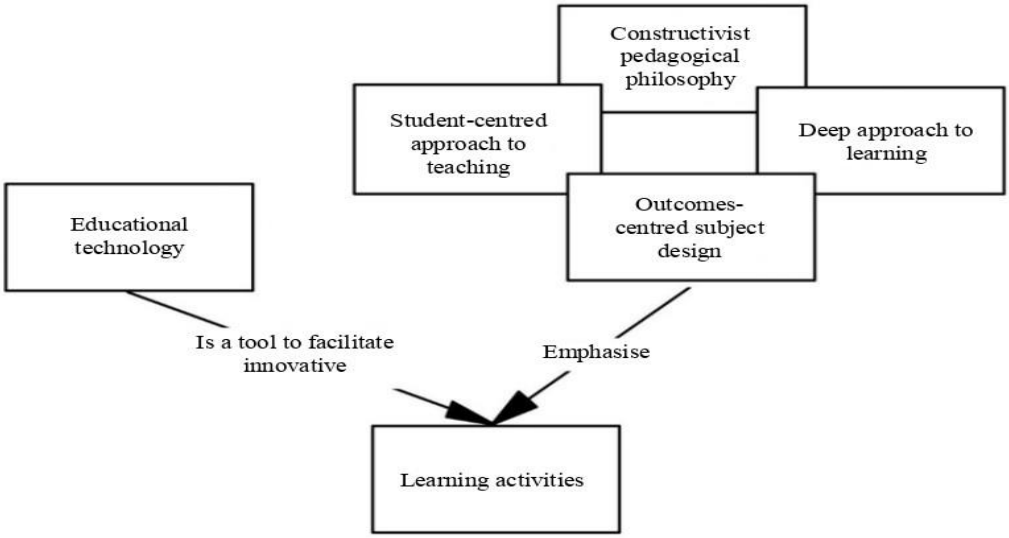

Fig. 6: Role of ET in facilitating learning activities

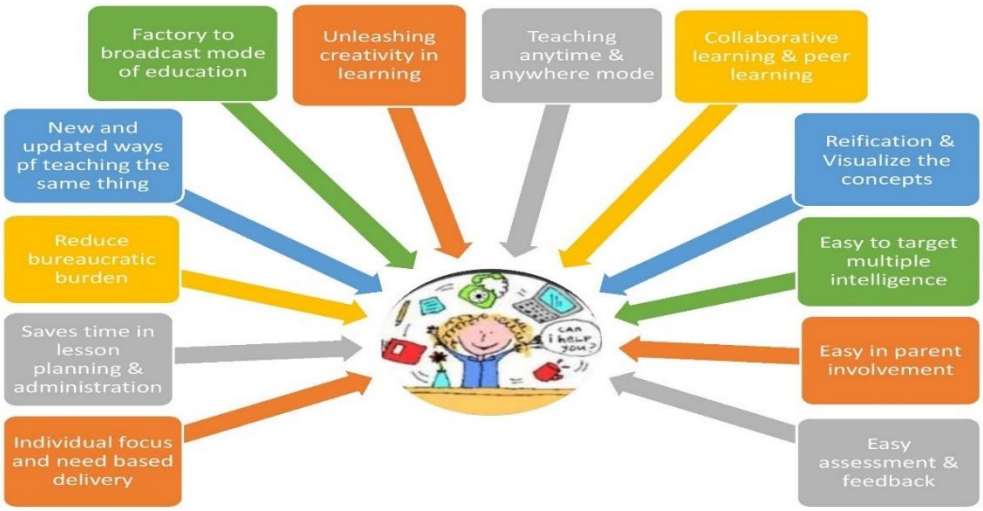

Fig. 7: ICT services in teaching

Thus, technology integration in pedagogy is a complex task that needs several factors to work together as evident in TPACK Framework (Mishra and Koehler (2006). Have reported a comprehensive diagram stating these factors affecting ICT integration making an exclusive focus on internal or attitudinal factors. Mukhopadhyay (2004) in Educational Technology: Knowledge Assessment diagnosed three main factors needed for technology adoption and these are complementary to each other-attitude, skill, and device. Eagly and Chaiken (1993a, b) have presented a multi-component model of attitude and it is a summary evaluation of affective, cognitive, and behavioral components regarding an object or person.

Referring to Peiffer *et al*. (2020) the authors asserted both self-concept and self-efficacy form overall as self-perceptions affecting academic success and failure. Proposed a diagram that shows the relationship between the human self-system and motivational currents (Fig. 8). It indicates the vital role of the chosen variables (subjective self) in backing an individual with motivation for certain work.

Besides, the authors made a detailed literature survey searching for the importance of self-efficacy and self-concept in the academic arena, especially in ICT integrated education. They went through studies like Sam *et al.* (2005); Lai and Pratt (2004); Teo *et al*. (2008); Hammond *et al*. (2011); Fanni *et al*. (2013); Krumsvik (2014); Scherer and Siddiq (2015); Hatlevik (2017); Hatlevik and Hatlevik (2018); Kundu (2020); Wu *et al*. (2020); Kundu *et al*. (2021a); Cheung *et al*. (2020) and conclude that self-efficacy has a dominant role in ICT use. They also mentioned a series of studies like Christoph *et al*. (2015); Janneck *et al*. (2013); Langheinrich and Bogner (2015); Langheinrich *et al*. (2016) found users' self-concept as an important determinant of their ICT adoption. Bong and Skaalvik (2003) have established a detailed difference between these two concepts and the authors made a pithy jotting reporting of this difference as presented in Table 1.

Being backed by these theoretical propositions the authors engaged in empirically investigating the effects of ICT-related self-efficacy and self-concept on users' perceived ease of ICT use. These and with a series of other references the authors summed up their point of view that the human self might be an important predictor of ICT adoption that supports further research on TAM. The hypothesized relationship, if proved, would help make TAM3 more comprehensive and extensive so far as the man-machine interface is concerned.

Findings Relating to RQ3

To reach their research objective the authors conducted an empirical quantitative correlational survey among 300 Indian secondary school teachers following a stratified random sampling technique. Three statistical hypotheses were formed to investigate the hypothesized relationships among three variables following the path diagram in Fig. 9.

The authors (Kundu *et al*., 2022) developed and standardized three psychometric scales to measure three variables following a unique scale development model as Comprehensive Model of Scale Development (CMSD). They reported getting a response rate of 75%. The Statistical Package for the Social Sciences (SPSS-22) software was used for data processing and the main statistical tool used was Multiple Regression Analysis to investigate the interrelationship among three variables-self-efficacy (IV) and self-concept (IV) and PEU (DV). Based on empirical findings they rejected all three hypotheses and statistically significant relationships have

been found between self-efficacy and PEU, self-concept and PEU, and eventually, subjective self (comprising of self-efficacy and self-concept) and PEU. The results of multiple regression analysis report the main finding regarding 3rd hypothesis based on the following regression equation:

$$\left[\textit{Perceived ICT usability} = 31.96 + (0.19)\ \textit{self}-\textit{efficacy} + (.76)\ \textit{self}-\textit{concept}\right]$$

From the above equation, it was evident that for every 1 standard unit increase in self-efficacy and self-concept (each), the perceived ease of ICT use will increase by 0.95 standard units which are further supported in the scatter plot analysis (Fig. 10).

Results showed both the Independent Variables (IV) had a significant effect on the Dependent Variable (DV) and expectedly, their combined effect is more effective than their individual effects. Self-efficacy and self-concept jointly predict 79% of the dependent variable, while individually self-efficacy predicts 47% and self-concept does over 77% variability. Besides, authors reported self-concept put deeper statistically significant individual contribution to this mutual prediction on the teachers' PEU of ICT ($\beta = .76$, $t = 21.7$, $p<.05$) than self-efficacy ($\beta = .19$, $t = 5.4$, $p<.05$). Means self-concept was found a stronger predictor than self-efficacy in enhancing teachers' perceived ease of ICT use through many lees in degree than its singular influence on PEU. This finding also upholds the theoretical proposition that human self-efficacy is a part of the overall self-concept naturally the influence of the latter is ordained to be deeper than the earlier. Based on the consequences of the proposed structural equation (Fig. 8) it stands out as evident in Fig. 11.

The above output path diagram connotes the main finding and demonstrates that teachers' 'subjective self' significantly affects their perceived ease of ICT use and there is a high positive correlation between the two variables. The authors now following their research plan proposed a further extension of the TAM3 by adding a tested domain as the user's ICT-related 'subjective self' having two confirmed cognitive constructs-self-efficacy and self-concept. The new domain was found to have a statistically significant effect on the users' perceived ease of ICT use, wherefrom the authors claimed TAM3+ (Fig. 12).

Findings Relating to RQ4

The 4th research question *"*How far this new extension could be effective for better technology adoption*"* becomes vital for this critical analysis. Goodhue (2007) points out a limitation of TAM and said "TAM has left us with some significant blind spots" (p. 220), believing that TAM is limited in the questions it poses, such as: "What causes users to utilize a technology?" when the important question should be, "By what means do technologies affect performance?" Meerza (2017) found this blurred line between intent and actuality may ultimately harm academic fields. Thus, modification of TAM is required to make it more suitable for constantly changing IT scenarios across the globe and TAN 3+ is a step towards illumination. The authors observed we can't keep silent about the fact that technology adoption and integration is a complex and ever-challenging task because of the added technological complexities and associated cognitive preparations. Subject to micro evolutionary changes today's technology becomes irrelevant tomorrow. Naturally, a positive and strong 'self' will help users to survive and sustain amidst these incremental technology transferences. It demands an incremental change in preparation as well.

Another important aspect upheld by Boughzala (2014) who observed a massive change that has already been taken place in the minds of today's net generation (named Generation Y) in comparison to the past generations (named Generation X or Baby boomers). He said today's employees are very self-assertive, self-directed, instinctive, spontaneous, tireless in their constant search for new technology to get new information within the shortest time by using any device and no more to be intimidated by classical organizational hierarchy or conformist knowledge complexities. This Generation Y is already disturbed by the orthodox organization system and traditionalism in their professional spheres (Kowske *et al*., 2010). They are adaptive to the new work culture-Culture 2.0-as rightly sounded in Chesbrough and Appleyard (2007) which is a culture of a new attitude, growth mindset, grit, immense awareness, knowledge sharing, technology usage, mass collaboration, and open innovation.

A sound cognitive preparation of self will help technology users to sustain this change and remain adaptive to slow incremental growth. Carol S. Dweck in her book Mindset: The New Psychology of Success also asserted this growth mindset when she said becoming is better than being (Dweck, 2006). Kabiguru Rabindranath Tagore also talked about a self-relative universe (Tagoreweb, 2021) that nothing illuminates without self-illumination. Howard Gardener in his book "Extraordinary Minds" advocated for a special talent of introspection among exceptional individuals for identifying their strengths and weakness (Dweck, 2006). Thus, the new approach to observing technology adoption in pedagogy in the light of preparing the *'*subjective self' that this analysis upholds hints at immense potential. The above philosophical propositions have been proved empirically. Considering the huge technological affiliation of the upcoming educational sphere subsumed in problem-based learning, immersion, and simulation with technology having the leading role in knowledge transmission, comprehensive teacher preparation is inevitable. Here preparation following TAM 3+ with a renewed focus on making a strong subjective self makes sense.

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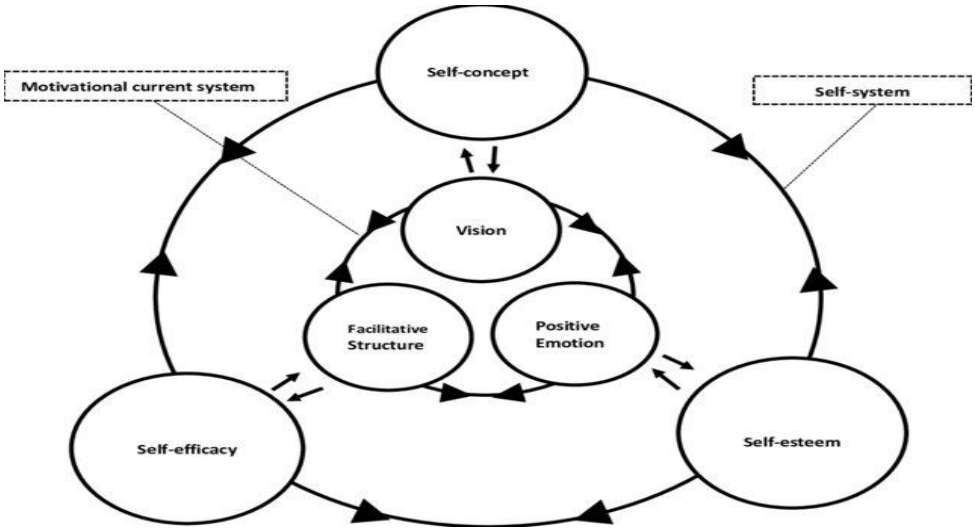

Fig. 8: Relationship between self-system and motivation

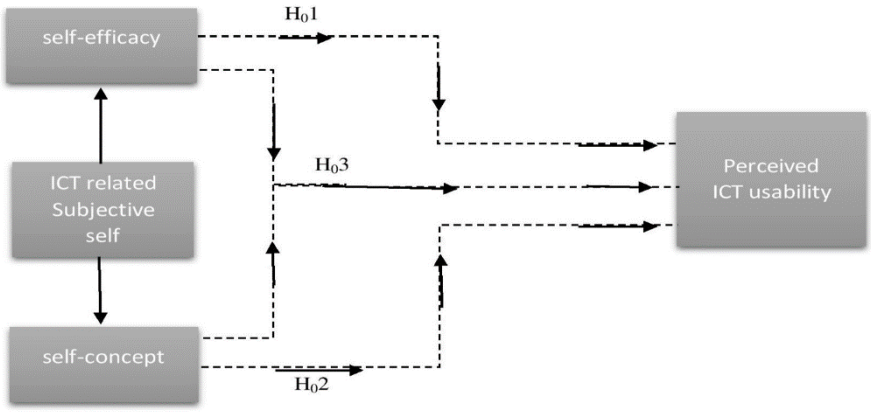

Fig. 9: Path diagram of the hypothesized relationship

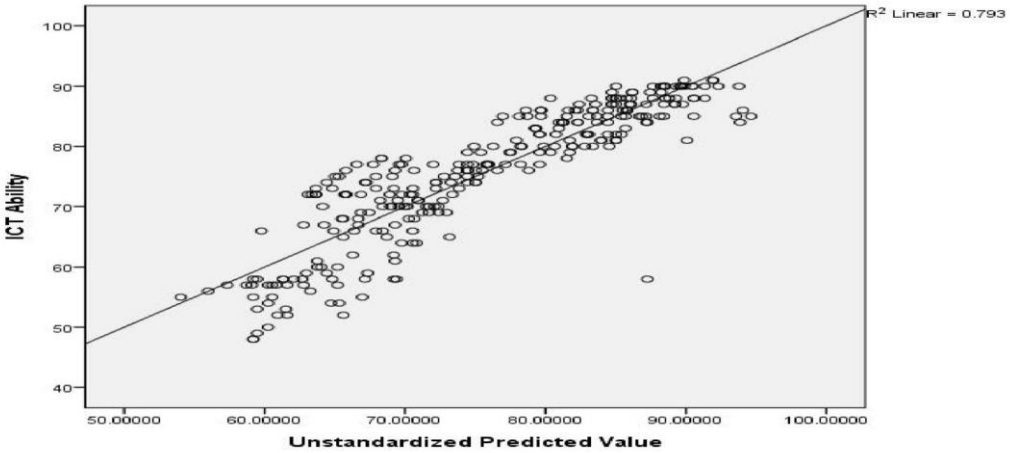

Fig. 10: Scatter plots analysis of the multiple regressions

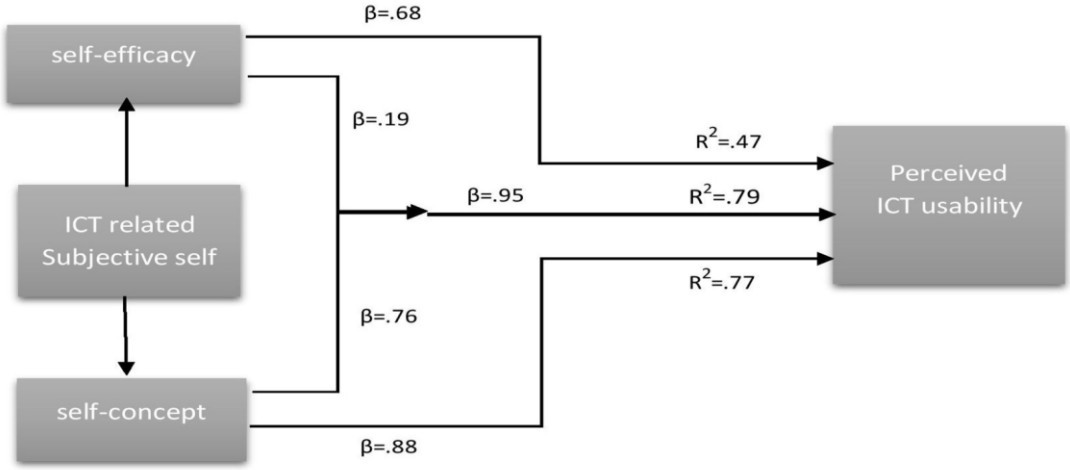

Fig. 11: Output path diagram

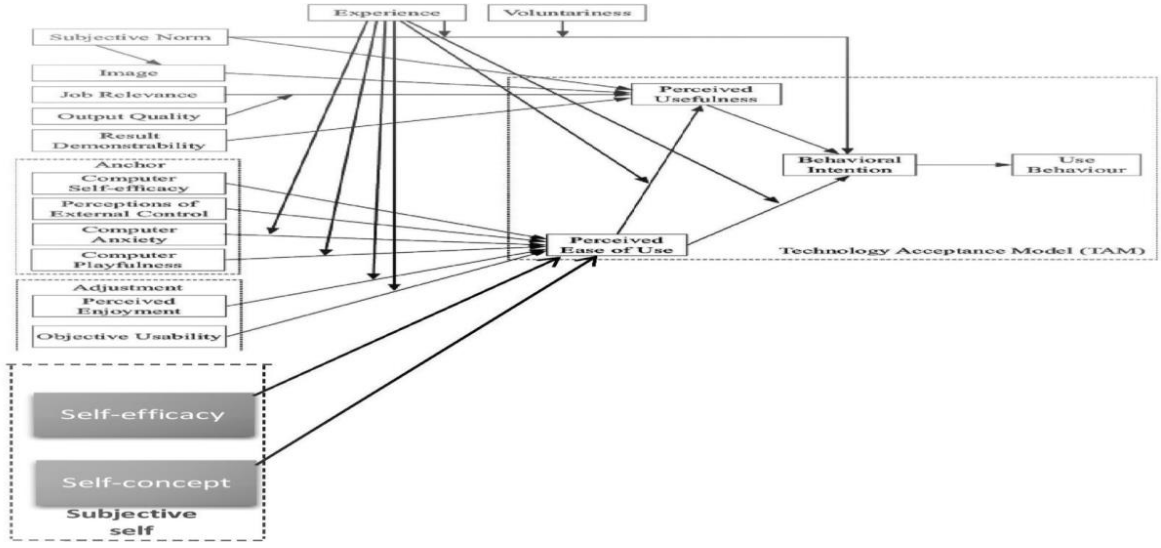

Fig. 12: Proposed TAM 3+ model

Table 1: Difference between self-efficacy and self-concept

Self-efficacy	Self-concept
Cognitive appraisal of self	Cognitive and affective appraisal of self
Perceived confidence	Perceived competence
Context-specific	Domain-specific
Future-oriented	Past oriented
Mell able	Stable
Can be task-specific	Not task-specific
Judgment of self-confidence	Judgement of self-worth
Answer the question-can I do this?	Answer the question- who am I?

It is empirically proven that users having a strong self will find ICT use easier. An exercise of self-analysis will help users gain clarity and concentration over the targeted operation by exploring where they have been and creating a lane to where they are willing to reach. A sound counseling program will help to find this target avenue by exploring strengths and weaknesses that will give necessary impetuous to have a growth mindset depending upon the situation. The authors said it is possible since past researchers have categorically mentioned the paths to enhance self-efficacy (Bandura, 1997) and self-concept (Skaalvik and Skaalvik, 2002). A reference to Kundu *et al*.

(2021b) surrounding this preparation may be taken where the authors in a design study made in an Indian elementary classroom have shown self-efficacy among teachers can be increased with suitable training interventions. Components of this subjective self (self-efficacy or self-concept) depend less on external strictures and more on self-introspection with necessary timely compliances. This finding could be especially efficacious in a developing country like India where e-infrastructure is still limited subject to several lacks. Here a sound counseling framework with a suitable training intervention for teachers could substantially inspire them to concentrate on what they are having instead of lamenting over what is not. Since a strong self itself has the potential to enhance ease of digital adoption and use.

The proposed restructuring of TAM 3 towards TAM 3+ is itself implicative which is domain neutral and covers any field of technology use. The proposed 'subjective self' domain and its manipulation will help better performance and achievement. Self-efficacy and self-concept are present in every human being irrespective of the field he/she has been operating. Enhancement and enforcement of this domain will promote their ease and efficiency in technology adoption that supports the title of this critical review-'TAM3+, a new approach to attract teachers towards technology adoption'.

In the 21st century, efficient access and utilization of information resources depend on the ability to effectively use the ICT tools. The inability to demonstrate expertise in this area can lead to ICT resistance which has been acknowledged as the main reason leading to impediments in embracing new and innovative technology. This can lead to many organizations investing in the new way of doing things and yet it will be underutilized by their workers. Understanding technology acceptance and the role of users' 'subjective self' will lead to better prediction of the use of new information resources and the building of a new information society. The implication gets deeper in the current post-COVID-19 new normal where ICT has occupied a vital role almost in every sphere of human life in some way or other (Kundu and Bej, 2021a). Here, the authors feel to get better involvement in ICT application the assessment, enhancement, and enforcement of users' subjective self bears resonance and deep implication. The authors conclude that the TAM 3+ needs empirical testing after developing a counseling framework for authentication.

Conclusion

This review concludes with this note that TAM 3+ is a timely extension of TAM by putting special attention to the users' 'subjective-self' encompassing two vital aspects of human self-self-efficacy and self-concepts. The inheritance of a long philosophical focus over the human self gets empirical scaffolding through this extension. It proves the importance of users' ICT-related self-efficacy and self-concept as vital predictors of users' behaviors. This self-introspection as Howard Gardener also advocated helps users nurture within them a love of challenge, resilience in the face of setbacks, belief in efforts, and greater success. This only reasserts the importance of the human subjective self, the main concern in this reviewed literature. On an optimistic note, in this review author has taken up a broad-based view over several versions of TAM aiming to understand individual behavior concerning ICT use and wishes to recommend TAM 3+, supported by sound work plans, which may help in defacing the blurred line between intent and actuality that often brings a negative effect on academic fields specifically concerning technology adoption in a country like India. It appears as a novel approach to teacher preparation and attracts them towards technology adoption with deeper intents.

Acknowledgment

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Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues are involved.

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