Original Article

# Integration of UTAUT model in context to Zigzag technology adoption in brick kilns of Punjab

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DOI: 10.47750/pnr.2023.14.03.124

## Abstract

Due to the increase in diseases and environmental pollution, nowadays everyone's attention is towards controlling pollution. Industries are mainly liable for increasing environment pollution. In Punjab there are around 3000 brick kilns, out which many kilns are using old type technology, while to control pollution there is option available in the form of Zigzag kiln. This technology is very helpful in reducing pollution and reducing usage of coal. Study aims to identify factors of Zig-zag technology adoption using Unified Theory of Acceptance and Use of Technology (UTAUT). For sampling the 340 brick kiln owners from 22 districts in the Indian region of Punjab served as the sample for this study, which was based on cross-sectional data. Data was collected from assigning authorities of brick kilns using structured questionnaires.

Zig-zag technology in brick kilns of Punjab has a remarkable impact on productivity, but impact of social influence on behavior intention is found to be pointless. Effort Expectancy (EE), Performance expectancy (PE) and Facility Conditions (FC) are revealed to have a significant impact on adoption of Zig-zag klin technology.

**Key words:** Brick kiln, UTAUT, India. Zigzag technology.

## 1. INTRODUCTION

India's brick industry is enormous. Following China, South Asia's second-largest producer of bricks is India (Patra 2021; Shahid and Shafqat 2020). Small-scale industries are acknowledged to play a significant role in environmental contamination. Out of them, the brick kiln industry is one that is expanding on a small scale. As the need for brick increases, so does the industry's output of environmental pollution. (Lundgren-Kownacki et al. 2018). Bricks are made from a variety of basic materials, including clay, fly ash, and others. In India, bull's trench brick kilns (FCBTK) were the most common type of kiln, which produced bricks using coal and wood. Ash contents comprising significant amounts of carbon dioxide (CO2), sulphur dioxide (SO2), PM2.5, and black carbon are produced during the manufacturing of bricks (Rahman and Kazi 2019, Akinshipe and Kornelius 2017). Not only FCBTK, while other thermally inefficient brick kiln technologies also contribute to the emissions of carbon dioxide (CO2), nitrogen oxide (NOX), ozone (O3), carbon monoxide (CO), methane (CH 4), and particulates. Additionally, the construction of brick kilns used cheap, leftover materials like trash, plastic, and old tyres, which led to the release of numerous environmentally damaging chemicals (Sanjel et al. 2016). Additionally, it has been calculated that there are around 2500 brick kilns in Punjab as opposed to an estimated 2,000,000 brick kilns in India. One of the main sources of dangerous greenhouse gas emissions is brick kilns. Brick kilns' fugitive and stack emissions are a part of the problem with air pollution. According to the research, FCBTKs provide a significant contribution to the creation of harmful pollutants, and emissions from kilns are rising alarmingly quickly and have reached dangerous levels (Sarker and Abir 2019; Saikawa et al. 2019; Mazumdar et al. 2018). Traditional brick kilns' role in pollution and the effects they have on the environment have drawn more attention (Khalid 2019; Chen et al. 2018). Emissions from brick kiln affect respiratory illnesses and air pollution in general (Paudel and Saud 2018; Nasir et al. 2021). Harmful emissions released in the environment by Conventional brick kilns. Except this brick kilns has a contribution in land degradation and water pollution.(David et al. 2020; Hussan 2020).

Numerous methods have proven that modernizing and transforming the brick industry is very doable. Up to 40% of the 180 MT (million tons) of carbon emissions produced by the Asian brick industry could be decreased by moving from conventional brick kilns to more efficient and innovative kiln technologies like the induced draught Zzk (zig-zag kiln). Additionally, the use

of hollow bricks will result in less soil erosion and greater energy savings (Valdes et al. 2020). An important feature of ZZK technology, which is an improved form of FCBTK technology, is how the bricks are arranged. The bricks are arranged such that air passes through them in a zigzag pattern. This technology probably works better and emits fewer greenhouse gases.ZZK uses less energy while producing more bricks per unit of time than traditional brick kilns, increasing profits for brick kiln owners. ZZK lowers the cost and gives decision-makers a chance to assist in decisions to enhance air quality and slow down climate change. Additionally, in underdeveloped nations, brick kilns are poorly managed and regulated, which creates enormous ambiguity regarding carbon emissions among brick kilns. Economic and environmental policymakers stressed people's responsibilities and what they can do to help achieve environmental goals (Ahmad et al. 2019). According to Nayak and Sangroya (2017), successful commercialization necessitates improvements in ongoing human communication and collaboration. Therefore, brick kiln owner's actions and reactions to ZZK technology may be required to move toward a greener, more sustainable future and achieve the intended aims.

After China, India is the country that produces the most bricks in Asia. Nearly 25% of the kilns are operating all year, while the others are for at least six months (ILO 2017). The government of India taking actions to combat the negative effects of this industry on environment. Brick kiln owners who cause environmental pollution may face penalties under the environmental protection act.

Additionally, the Punjab government promotes the use of ZZK technology, which offers a means of bringing quality of air closer to the required level for environmental quality in Punjab. More than 90% of the brick kilns in Punjab are converted into ZZK. However, the transition to new technology took a while, and only about 10% of brick kilns still employ outdated equipment. This study's objective is to gauge the adoption of Zigzag Technology in Punjab's brick kilns. using the UTAUT Model and the constructs developed by Venkatesh et al. (2003). The results of this investigation will also show, among other findings:

1) The relationship of Effort Expectancy (EE), Social Influence (SI) and Performance Expectancy (PE) with Behavioral Intention (BI) in the adoption of ZZK in brick kilns.

2) The relationship of Facilitating Conditions (FC) with use behavior (UB.

Figure 1: High draught Zigzag kiln. (Source: The Express Tribune)

## 2. PRIOR RESEARCH AND THEORETICAL BACKGROUND

There are eight theories and models like, UTAUT (Unified theory of technology adoption and use Technology Acceptance) Model, Hybrid TAM-TPB Model, Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Model of PC Use, Social Cognitive Theory, Motivational Model (MM) and Innovation Diffusion Theory are the eight research theories on which the UTAUT formulation is based. According to a thorough investigation of these eight models, users' intentions to adopt technology were significantly influenced by Performance Expectancy (PE), Effort Expectancy (EE), Social influence (SE), and Facilitating Conditions (FC) (Abd. Ghani and Rahi, 2018b; Venkatesh et al., 2003b).

There is significant impact of Performance expectancy (PE) on users' behavioral intentions to adopt new technology, according to numerous research (Oliveira, 2016; Martins, 2014; AbuShanab et al., 2010; Khalil et al., 2010; Foon and Fah, 2011). As per given evidence hypothesized for PE is as:

H1: PE will be positively related to adoption of ZZK technology among brick kiln owners.

User expectations for easiness are related to effort expectancies (EE). Previous research has established a remarkable link between expected effort and user intention to adopt new technology (Abd. Ghani and Rahi, 2018a; Martins et al., 2014; Chaouali et al., 2016; Riffai et al., 2012).Thus, hypothesized for effort expectancy is as:

H2: EE will be positively related to behavioral intention of brick kiln owners to adopt ZZK.

The link between Behavioral Intention (BI) and Social Influence (SI) is widely discussed. Social influence refers to the pressure society puts on a person to adopt new technologies (Martins et al., 2014; Singh Bisht and Kesharwani, 2012; Chaouali et al., 2016). Martins et al. (2014) claim that SI will have a favourable impact on users' intentions to use new technology. On given arguments SI is hypothesized as:

H3: SI will have positive impact on brick kiln owners to adopt ZZK.

The concept of facilitation was derived from perceived behavioral control and suggests that users need accessibility of system in the workplace. It is argued that people may be less likely to use technology if there is inadequate infrastructure. In the words of Hong et al. (2008), "Ifthey lacked the fundamental operating skills, users would be less likely to employ information technology (IT). In keeping with earlier research (Oliveira et al., 2016; Martins et al., 2014), scientists made the assumption that the facilitating condition has a significant impact on consumers' behavioral intention to adopt and utilize new technology. According to the justifications given, the enabling condition is as follows:

H4: Facilitating condition will be positively related to brick kiln owners' intention to adopt ZZK.

## 3. Measurement

Scales, which are used in the current research were modified from previously conducted empirical research on technology adoption and UTAUT. All components or statements or items were evaluated by using a five-point Likert scale. The statements or items representing each construct in the suggested study model were scored on a five-point Likert scale ranging from 1, strongly disagree to 5, strongly agree. To measure the respondents' demographic data, including their age, gender, education, and experience a nominal scale was used. An expert Hindi-Punjabi translator initially created the questionnaire in English before translating it into Hindi and Punjabi. Prior to doing further research, we did a pilot test with 50 randomly selected participants to revise and alter the questionnaire items as well as to establish the content validity and reliability of the instrument. After pilot testing, some elements were examined and changed.

## 4. Descriptive analysis

As per findings of demographic analysis majority of the respondents were male (n = 337, 99.4 per cent), and left (n = 3, .6 %) were females, reason behind that mostly this operation is handled by male. Concerning age, findings revealed that respondents with age between 30-45 are more inclined toward the adoption of green technology. Result of descriptive analysis depict that majority of the participants had qualification of graduate-level (n = 157, 46.17%), followed by those who had high school qualification (n = 145, 42.64 %). Respondents were asked about their experience. As per findings the maximum number of the respondents were experienced more than five years in the field of brick kiln industry (n = 113, 33 %). Overall, a good mixture of respondents had participated in the ZZK adoption survey.

### 4.1 Harman's single factor test

Studies that employed data from a single source may be affected by common method variance bias in quantitative research (Rahi, 2017a, 2017b). It is essential to test the CMV problem before conducting an inferential study. The current study includes Harman's single factor test for common method variance bias as per Podsakoff et al (2003). The requirement is that fewer than 50% of the overall variation should be explained. The findings of the Harman's single factor test showed that the largest covariance explained by a single factor solution was 32.863%, demonstrating that this study is free from the common method variance issue and suitable for inferential data analysis. The findings of Harman's single factor test are displayed in Table I.

Table I: Harman's single factor test.

**Total Variance Explained**

| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| Component | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 14.460 | 32.863 | 32.863 | 14.460 | 32.863 | 32.863 |

4.2 Measurement model

In order to examine the relationship between the variables in the proposed model, this investigation followed the recommendations made by Lomax and Schumacker (2010) and Gerbing and Anderson (1988). Prior to testing the study's hypotheses in the structural model, the measurement model's reliability and validity were determined. For this, software SmartPls 4 was used. This study employs the maximum-likelihood method to estimate the model's parameters, and variance-covariance matrices were used for all analyses (Hair et al., 2010). Before moving forward with our analysis, a multicollinearity test, however, was required. Multicollinearity, according to Pallant (2010), happens when two or more variables have a strong correlation with one another. Different academics advocated for various values as being satisfactory.For example, correlations above 0.8 or 0.9 are seen highly troublesome by Fidell and Tabachnick (2007), but a value of 0.7 or above is deemed cause for concern by (Pallant, 2010). Tolerance and the variance inflation factor (VIF) are two metrics that indicate the presence of multicollinearity (Pallant, 2010). No mulitcollinearity means tolerance value is larger than 0.10 and the VIF value is less than 3.0. The VIP values for all of the independent constructs were less than 3.0 and the tolerance values were greater than 0.10, this shows that multicollinearity was absent in our sample.

4.3 Composite Reliability

If the composite reliability (CR) value is more than 0.7, a construct is regarded as reliable. Hair et al. (2010) stated that the composite reliability (CR) value of 0.7 and above is allowed, and the average extracted variables (AVE) value must be larger than 0.5. Results of the research show that value of all the constructs have a CR value greater than 0.7 and an AVE value is greater than 0.5.The reliability test outcome utilizing SmartPLS 4 is shown in Table II.

Table II: Composite reliability.

| **CONSTRUCTS** | **ITEMS** | **LOADINGS** | **AVE** | **CR** |
|---|---|---|---|---|
| | BI1 | 0.8 | | |
| | BI2 | 0.791 | | |
| | BI3 | 0.734 | | |
| | BI4 | 0.716 | | |
| BEHAVIOR INTENTION | BI6 | 0.795 | 0.59 | 0.847 |
| | EE2 | 0.91 | | |
| | EE3 | 0.909 | | |
| | EE4 | 0.915 | | |
| EFFORT EFFICIENCY | EE6 | 0.673 | 0.736 | 0.907 |
| | FC3 | 0.922 | | |
| | FC4 | 0.897 | | |
| | FC6 | 0.936 | | |
| FACILITY CONDITION | FC7 | 0.892 | 0.831 | 0.933 |
| | PE1 | 0.88 | | |
| | PE10 | 0.649 | | |
| | PE2 | 0.672 | | |
| PERFORMANCE | PE6 | 0.75 | | |
| EXPECTANCY | PE9 | 0.636 | 0.536 | 0.788 |
| | SI1 | 0.704 | | |
| | SI2 | 0.695 | | |
| | SI5 | 0.775 | | |
| SOCIAL INFLUENCE | SI6 | 0.81 | 0.559 | 0.762 |
| | UB1 | 0.896 | | |
| | UB2 | 0.833 | | |
| USE BEHAVIOR | UB3 | 0.888 | 0.761 | 0.861 |

4.4 Discriminant Validity

In research study the level of various constructs is measured by using Discriminant Validity. Fornell and Larcker (1981) claim that discriminant validity is assumed to be attained when the average square root value of two retrieved variants is greater than the correlation value between all the variables. It will measure and test two different items. When the Average variance extracted (BOLD) average square root value of two extracted variants is higher than the value of correlation between all the variables, discriminant validity is attained. (Table III).

Table III: Discriminant validity.

| | AVE | BI | EE | FC | PE | SI | UB |
|---|---|---|---|---|---|---|---|
| **BI** | 0.59 | **0.768115** | | | | | |
| **EE** | 0.736 | 0.753 | **0.857904** | | | | |
| **FC** | 0.831 | 0.691 | 0.877 | **0.911592** | | | |
| **PE** | 0.523 | 0.745 | 0.716 | 0.667 | **0.763187** | | |
| **SI** | 0.559 | 0.553 | 0.663 | 0.733 | 0.675 | **0.74766** | |
| **UB** | 0.761 | 0.65 | 0.694 | 0.697 | 0.562 | 0.585 | **0.8723531** |

4.5 Testing Suggested Model

The Path Coefficient R2 for each construct (latent variable) in Figure 3 demonstrates the variation in levels of collaboration. The findings indicated that PE (t=5.582, p<0.05) and EE (t=9.053, p< 0.05) have positive impact on Behavior intention, while behavioral intention is unaffected by social influence SI (t=0.576, p>0.05.

Table IV. Path coefficient and their significance

| | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (\|O/STDEV\|) | P values |
|---|---|---|---|---|---|
| BI -> UB | 0.288 | 0.289 | 0.056 | 5.116 | 0 |
| EE -> BI | 0.472 | 0.471 | 0.052 | 9.053 | 0 |
| FC -> UB | 0.445 | 0.446 | 0.063 | 7.009 | 0 |
| PE -> BI | 0.313 | 0.316 | 0.056 | 5.582 | 0 |
| SI -> BI | 0.037 | 0.036 | 0.063 | 0.576 | 0.565 |

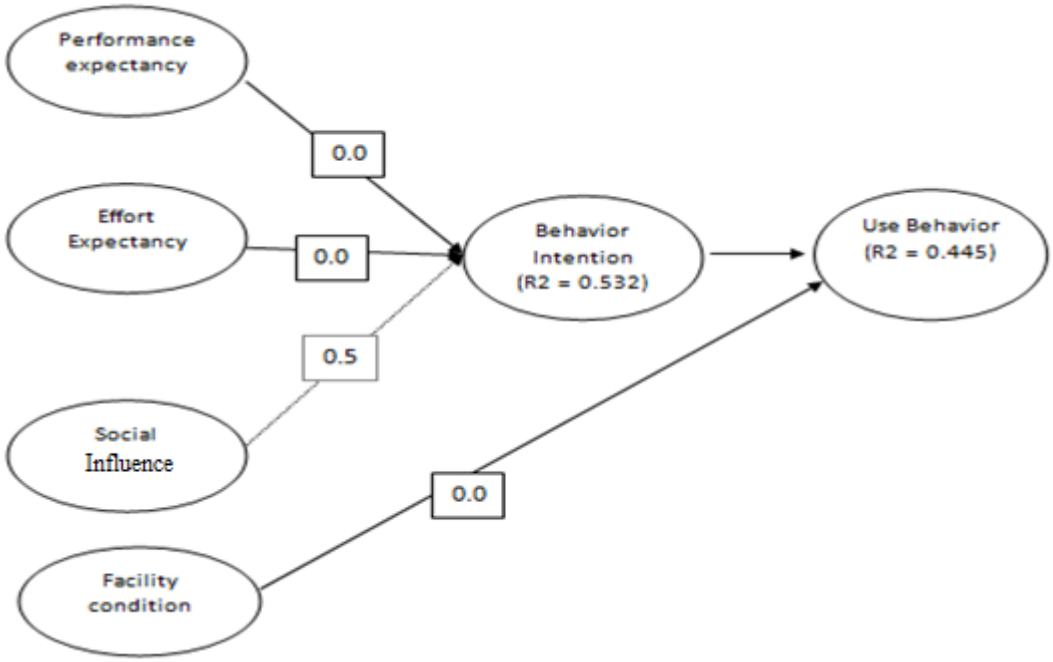


Figure 2: Path Coefficients

## 5. Discussion

Recommended model is made of four constructs, Performance Expectancy, Effort Expectancy, Social Influence, and Facility Condition. Three of the hypotheses were found to be accepted and the fourth to be rejected when these constructions were examined. Behavior intention is not significantly influenced by social influence, but it is significantly influenced by performance expectations and effort expectations. However, facility conditions have a great impact on how use behavior. The study concludes that the brick kiln owners believe that technology performance can be useful in production. In brick kiln industry in FCBTK (fixed chimney bull trench kiln) lot of efforts need to accomplish tasks compare to ZZK. How much efforts need to accomplish a task also matter in adoption of new technology. Except these factors facilitating features of a technology also have great impact on its adoption.

On the other hand this study concluded that in brick kiln industry there is no impact of social influence on behavior intention of brick kiln owners to adopt ZZK. Reason behind that people do not have any interest to know which type of technology is used in brick kilns. This study recommended that the government and policy makers should emphasize on SI. Additionally, it is necessary to develop rule and regulations that could fully notify people about the environment friendly effects of ZZK technology. Findings from the study might be useful in understanding cutting-edge brick kiln technology.

Like other research, this one has some restrictions on the data it utilized and the model it employed. As a result, the study was limited to Punjab's districts and had a small sample size, making it impossible to take into account all the elements influencing adoption attitude. It could be extended to other states of India with a large sample size.. Future research options are many in the burgeoning sector of the brick kiln industry. Applying this method to quantify conscious behavior toward additional environmentally friendly technologies may prove useful in the future. The forecasts will provide thorough policy recommendations that will boost the use of green technologies.

## References


1. Abir AH, Sarker AH (2019) Role of laws to control brick manufacturing and kiln establishment in Bangladesh: scope of alternative bricks. VNU JSci: Earth and Environmental Sciences. 35
2. Ajzen I (2002a) Residual effects of past on later behaviour: habituation and reasoned action perspectives. Personal SocPsychol Rev 6(2): 107–122
3. Ajzen I (2002b) Perceived behavioural control, self-efficacy, locus of control, and the theory of planned behaviour. J ApplSocPsychol 32(4):665–683
4. Ali MR, Shafiq M, Andejany M (2021) Determinants of consumers' intentions towards the purchase of energy efficient appliances in Pakistan: an extended model of the theory of planned behaviour. Sustainability 13(2):565
5. Chau, P.Y.K. (1996). An empirical assessment of a modified technology acceptance model.Journal of Management Information Systems, 13(2), pp. 185-204.
6. Clark, R. and Lyons, C. (1999).Using Web-based training wisely.Training, 36(7), pp. 51-56.
7. David M, Afzal M, Shoaib M, Aman F, Cloete KJ, Turi N, Jahan S (2020). Study of occupational exposure to brick kiln emissions on heavy metal burden, biochemical profile, cortisol level and reproductive health risks among female workers at Rawat, Pakistan.Environ SciPollut Res, 27(35):44073–44088.
8. Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology".MIS Quarterly, 13(3), pp. 319–340.
9. Hutchins, H.M. (2001). Enhancing the business communication course through WebCT.Business Communication Quarterly, 64, 87-94.
10. Janz, B.D. (1999). Self-directed teams in IS: correlates for improved systems development work outcomes.Information & Management, 35(3), pp. 171-192.
11. Landry, B.J., Griffeth, R., and Hartman, S. (2006). Measuring student perceptions of blackboard using the technology acceptance model.Decision Sciences Journal of Innovative Education, 4(1), pp. 87-99.
12. Saud B, Paudel G (2018). The threat of ambient air pollution in Kathmandu.Nepal J Environ Public Health, 2018.
13. Valdes H, Vilches J, Felmer G, Hurtado M, Figueroa J (2020) .Artisan brick kilns: state-of-the-art and future trends. Sustainability, 12(18): 7724
14. vanDijk WF, Lokhorst AM, Berendse F, De Snoo GR (2016). Factors underlying farmers' intentions to perform unsubsidisedagri environmental measures. Land Use Policy, 59:207–216
15. Venkatesh, V. and Davis, F.D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies.Management Science, 46(2), pp. 186-204.
16. Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. (2003). User acceptance of information technology: toward a unified view.MIS Quarterly, 27(3), pp.425-478.