



DETERMINANTS OF SOLAR PV ADOPTION AMONG MICRO-ENTREPRENEURS IN INDIA: A CONCEPTUAL FRAMEWORK



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Original Article

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Abstract

This paper analyses the factors influencing solar photovoltaic (PV) adoption intentions among micro-entrepreneurs in India and proposes an integrative conceptual framework drawing on the Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Diffusion of Innovations (DOI), and Unified Theory of Acceptance and Use of Technology (UTAUT). Based on a literature review, six determinants are identified: Financial Accessibility, Policy Support and Incentives, Perceived Economic Benefit, Social Influence, Technological Awareness, and Social Enterprise Support (SES), with Entrepreneurial Orientation as a moderator and Self-Efficacy as a mediator. The framework suggests that adoption is shaped not only by financial considerations but also by awareness, confidence, peer behaviour, and institutional support, with social enterprises playing a critical role by providing awareness, financing linkages, training, and post-sale services often lacking in informal markets. The study proposes nine hypotheses with implications for policymakers, financial institutions, and solar providers and calls for future empirical validation using structural equation modelling, contributing an integrated, multi-theoretical framework focused on the under-researched segment of micro-entrepreneurs in India.

Keywords: *Conceptual Framework; Diffusion of Innovations; Micro-Entrepreneurs; Solar PV Adoption; Theory of Planned Behaviour; UTAUT*

Introduction

Entrepreneurial activity relies on energy as a key input. India has achieved near-universal electricity access, with over 99 percent of the population connected to the grid. Nevertheless, reliable and high-quality electricity supply remains a persistent issue, particularly in rural and peri-urban regions where most micro-enterprises operate [1]. Energy insecurity—the lack of, or poor, electricity supply for productive business activities—limits working hours, reduces output quality, and directly affects micro-entrepreneurs' incomes [2, 3]. Solar photovoltaic (PV) technology has emerged as a technically credible and increasingly cost-effective alternative to grid power and diesel generators for small-scale productive use [4, 5]. Micro-entrepreneurs in India are categorised under the MSME Development Act, 2006, as small businesses with limited investment. India has approximately 63 million such enterprises, most of which operate in the informal sector and have limited access to formal finance, institutional support, and technical information [6]. For these businesses, unreliable energy is not a trivial inconvenience—it directly translates into lost revenues and reduced competitiveness. Solar PV is relatively cheaper, with utility-scale solar generation costs decreasing by more than 89% worldwide between 2010 and 2022 [4]. Nevertheless, solar adoption among micro-enterprises in India remains extremely low [7, 8]. The policy environment is, in principle, supportive, with initiatives such as the National Solar

Mission, the PM-KUSUM scheme, and the Rooftop Solar Programme. India is the third-largest solar energy producer globally and aims for 500 GW of renewable energy capacity by 2030 [1]. However, a gap persists between policy goals and ground-level uptake by micro-entrepreneurs. Past research on solar adoption in India has focused largely on households and agriculture [9, 10, 11], leaving the micro-entrepreneur market underrepresented. Micro-entrepreneurs differ from households because their adoption decisions are influenced not only by individual cost-benefit analyses, but also by business survival pressures, irregular cash flows, minimal collateral, and informal operating conditions. Standard models of technology adoption, developed for formal enterprises or households, do not adequately capture these characteristics. Furthermore, institutional intermediaries provided by social enterprises have not been fully formalised in adoption approaches, despite evidence of their effectiveness in enhancing solar access in underserved populations in South Asia and sub-Saharan Africa [12]. This paper addresses these gaps by developing a conceptual framework that integrates TAM, TPB, DOI, and UTAUT to understand the intention to adopt solar PV among micro-entrepreneurs in India. Social Enterprise Support is explicitly incorporated as a theoretically grounded construct. Nine hypotheses are proposed and illustrated alongside a graphic representation of the suggested model. The paper is structured into the following sections: literature review, theoretical framework, conceptual model and hypothesis development, discussion, practical implications, limitations and future research, and conclusion.

Literature Review

Solar PV Adoption in the Indian Context

In India, the solar sector has expanded significantly due to successive policy interventions, with utility-scale and rooftop installations in the formal sector exceeding 72 GW as of 2022 [1]. However, adoption among micro-enterprises—which make up the vast majority of India's 63 million MSMEs—remains disproportionately low [6], primarily due to high initial capital costs, limited technical awareness, and restricted access to institutional finance [13]. Interpretive structural modelling has shown that financial barriers and lack of awareness are the most entrenched constraints, and field surveys in rural Uttar Pradesh and Bihar by Chanda et al. [14] found that fewer than one in five micro-entrepreneurs had considered using solar PV for business energy, citing lack of information and fear of equipment breakdown as major reasons for rejection. Adoption also varies with income level, institutional support, and policy awareness [6, 9, 11], while structural barriers such as limited credit access and mobility particularly hinder women entrepreneurs, although proper support can foster high adoption intentions. Furthermore, the productive-use aspect highlighted by Dr. Pranav Desai et al. [7] indicates that income-generating solar applications—such as solar sewing machines, dryers, and cold storage units—encourage more durable adoption behaviour than adoption motivated solely by cost savings.

Theoretical Frameworks for Technology Adoption

Four main theoretical frameworks have been used to study technology adoption behaviour. The Technology Acceptance Model (TAM) [15] identifies perceived usefulness and perceived ease of use as the primary drivers of adoption intention, where perceived usefulness relates to economic benefits and ease of use reflects technical accessibility and self-confidence in the context of solar PV. The Theory of Planned Behaviour (TPB) [16, 17] explains intention through attitude, subjective norms, and perceived behavioural control, capturing social and confidence aspects of adoption. The Diffusion of Innovations (DOI) framework [18] focuses on how innovations spread within a social system, emphasising relative advantage, observability, trialability, compatibility, and the role of change agents. The Unified Theory of Acceptance and Use of Technology (UTAUT) [19] synthesises earlier models, highlighting performance expectations, effort expectancy, social influence, and enabling conditions as key determinants. In a rural Iranian study, Rezaei and Ghofranfarid [20] found that social influence and enabling conditions were the strongest predictors of renewable energy adoption intention.

Micro-Entrepreneurship and Energy Access

Micro-entrepreneurs heavily rely on energy to produce goods, provide services, and earn an income. Sovacool [3] noted that energy insecurity reduces working hours and increases operating costs due to reliance on alternative, expensive energy sources such as diesel generators and kerosene lamps. Drakaki et al. [21] found that micro-enterprises in India

with steady access to energy earned, on average, 23% more than those without. However, the decision to adopt energy solutions depends on factors such as the availability of finance, awareness of the technology, policy support, and the social environment in which the entrepreneur operates [22, 23, 24].

Role of Social Enterprises in Solar Adoption

Social enterprises occupy a distinct institutional niche in the renewable energy access ecosystem. Unlike purely commercial firms, they serve underserved populations—such as micro-entrepreneurs who may lack collateral, documentation, or access to formal financial and technical services—by integrating a social mission with viable commercial operations. A prominent example in India is SELCO Solar, which goes beyond selling solar products to provide comprehensive services, including community-level awareness, materials in local languages, and customised productive-use solar solutions tailored to specific enterprises (e.g., solar sewing machines for tailors, solar cold storage for food vendors, solar dryers for agricultural processors). Similar patterns have been observed in the Indian agricultural solar pump sector by Gautam et al. [25] and Sharma et al. [10]. Collectively, this evidence suggests that social enterprise support is not a peripheral or ‘soft’ factor but a core institutional enabler of solar adoption among micro-entrepreneurs.

Theoretical Framework

In this paper, four theoretical frameworks—TAM, TPB, DOI, and UTAUT—are combined to develop a comprehensive explanation of solar PV adoption among Indian micro-entrepreneurs, with each theory mapped to the constructs of the proposed model (Table 1). The theoretical basis incorporates these four prevailing technology adoption theories alongside institutional support perspectives. Adoption is explained using the Technology Acceptance Model (TAM) [15], where Perceived Usefulness and Ease of Use are operationalised as Perceived Economic Benefit and the combined effects of Technological Awareness and Self-Efficacy, reflecting their significant role in low-exposure settings [23]. This is reinforced by the Theory of Planned Behaviour (TPB) [16], where attitude is measured via economic benefits, social influence via subjective norms, and behavioural control via Self-Efficacy, further supported by Entrepreneurial Orientation in unfamiliar contexts [20]. Diffusion of Innovations (DOI) [18] contributes the constructs of relative advantage, observability, and trialability—captured by Perceived Economic Benefit, Social Influence, and Technological Awareness—while acknowledging the role of change agents, operationalised as Social Enterprise Support [26, 27]. Finally, UTAUT [19] integrates these elements into Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions, corresponding to economic benefit, awareness and self-efficacy, social influence, and financial, policy, and social enterprise support, further reinforced by institutional support theory.

Table 1: Theory-to-Construct Mapping for the Proposed Framework

Theory	Core Constructs	Mapped Variables in This Study	Key References
TAM	Perceived usefulness; ease of use	Perceived Economic Benefit; Technological Awareness; Self-Efficacy	Davis [15]; Gangale et al. [23]
TPB	Attitude; subjective norms; perceived behavioural control	Perceived Economic Benefit; Social Influence; Self-Efficacy; Entrepreneurial Orientation	Ajzen, [16]; Rezaei and Ghofranfarid [20]
DOI	Relative advantage; observability; trialability; change agents	Perceived Economic Benefit; Social Influence; Technological Awareness; Social Enterprise Support	Rogers [18]; Urmee et al. [27]
UTAUT	Performance expectancy; effort expectancy; social	Perceived Economic Benefit; Technological Awareness;	Venkatesh et al. [19]

influence; conditions	facilitating	Social Influence; Financial Accessibility; Policy Support
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Note. TAM = Technology Acceptance Model; TPB = Theory of Planned Behaviour; DOI = Diffusion of Innovations; UTAUT = Unified Theory of Acceptance and Use of Technology.

Source: Collected by Author

Conceptual Framework and Hypothesis Development

The theoretical framework incorporates the key factors influencing solar PV adoption among micro-entrepreneurs, drawing on well-established models such as the Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Diffusion of Innovations (DOI), and Unified Theory of Acceptance and Use of Technology (UTAUT). Financial Accessibility (FA) represents the availability of low-cost financing options [5, 8, 22], while Policy Support and Incentives (PSI) reflect government mechanisms to reduce adoption barriers [1, 6, 9]. Perceived Economic Benefit (PEB) captures anticipated cost savings and potential income increases [12, 15, 25], and Social Influence (SI) denotes the impact of peers and prevailing norms [18, 19]. Technological Awareness (TA) measures knowledge of solar systems [10, 23], and Social Enterprise Support (SES) emphasises institutional facilitation [22, 25]. Self-Efficacy (SE) serves as an intermediary for adoption behaviour [16], Entrepreneurial Orientation (EO) acts as a mediator of relationships [11], and Adoption Intention (AI) reflects the likelihood of behavioural uptake [15, 19] (Refer to Figure 1).

Financial Accessibility (FA)

The most consistently documented barrier to solar PV adoption among micro-entrepreneurs in developing economies is financial constraints. Even a modest solar system can require an initial investment equivalent to several months of a subsistence-level entrepreneur's net revenue. Financial accessibility encompasses access to micro-loans, pay-as-you-go financing, subsidies, and lending institutions [5, 22]. As demonstrated by Pandey et al. [8], financial constraints are the most structurally entrenched obstacle in India's small-enterprise solar adoption system. Adoption becomes economically viable when such financing options are available, simultaneously reducing the psychological barrier associated with committing capital [28].

H₁: Financial Accessibility positively influences the Adoption Intention of solar PV among micro-entrepreneurs in India.

Policy Support and Incentives (PSI)

Government policy directly affects the cost-benefit assessment of solar adoption through subsidies, net-metering, and awareness programs. Narasimha Rao and Reddy [9] showed that policy frameworks and institutional support strongly influence household energy behaviour in India. Initiatives such as PM-KUSUM and the Rooftop Solar Programme have bolstered adoption in the formal sector but have limited reach among informal micro-entrepreneurs [1]. Kuldeep et al. [6] identified awareness of government schemes as the key factor distinguishing adopters from non-adopters among Indian MSMEs. Effective policies not only reduce direct costs but also enhance confidence and perceived legitimacy of the technology, thereby decreasing resistance to adoption [24].

H₂: Policy Support and Incentives positively influence the Adoption Intention of solar PV among micro-entrepreneurs in India.

Perceived Economic Benefit (PEB)

Perceived Economic Benefit reflects a micro-entrepreneur's belief that solar PV can reduce operating expenses, decrease reliance on costly diesel generators, extend productive working hours, and create new income-generating opportunities. This construct aligns with the perceived usefulness in TAM [15], performance expectancy in UTAUT [19], and relative advantage in DOI [18]. As Sovacool [3] observed, adoption rates increase when the benefits of a technology are clearly experienced by the business. Empirical studies in India

and sub-Saharan Africa by Montabon et al. [29] and Mukherjee and Chanda [12] further indicate that perceived economic benefits are the strongest direct incentive for solar uptake among productive users.

H₃: Perceived Economic Benefit positively influences the Adoption Intention of solar PV among micro-entrepreneurs in India.

Social Influence (SI)

Social Influence refers to the extent to which a micro-entrepreneur's decision to adopt solar PV is shaped by peers, family, community leaders, and local business networks. In the context of micro-enterprises, investment decisions are rarely made in isolation and are strongly guided by observations of others and prevailing social norms [19]. Rogers [18] highlighted observability—seeing others effectively use a technology—as one of the key attributes that accelerates innovation diffusion. In rural Asia, Urmee et al. [27] found that word-of-mouth communication is the primary source of solar product information. Similarly, Rezaei and Ghofranfarid [20] demonstrated the critical role of subjective norms in influencing renewable energy adoption in rural Iran.

H₄: Social Influence positively influences the Adoption Intention of solar PV among micro-entrepreneurs in India.

Technological Awareness (TA)

Technological Awareness reflects the extent of a micro-entrepreneur's knowledge and prior exposure to solar PV systems, including their functioning, reliability, cost structure, and economic advantages. In developing economies, lack of awareness is often the first and most significant barrier to adoption [10, 30]. According to DOI, awareness represents the initial stage of the adoption process, preceding persuasion, decision, and confirmation [31]. Gangale et al. [23] demonstrated that increased awareness positively influences attitudes and adoption intentions, while Saiyed et al. [32] found that access to information directly promotes the adoption of green technologies in developing countries. Technological Awareness also underpins self-efficacy, as entrepreneurs who better understand the technology are more confident in their ability to utilise it effectively.

H₅: Technological Awareness positively influences the Adoption Intention of solar PV among micro-entrepreneurs in India.

Social Enterprise Support (SES)

Social Enterprise Support (SES) provides multi-faceted, practical assistance to micro-entrepreneurs throughout the solar adoption process. Mission-driven organisations, such as SELCO Solar, go beyond product distribution by offering community-level awareness campaigns, customised productive-use solar solutions (e.g., solar sewing machines for tailors, solar cold storage for food vendors, solar dryers for agricultural processors), linkages to micro-finance institutions, practical training, and organised after-sales support. This bundled support directly addresses the three main constraints faced by micro-entrepreneurs: information gaps, limited access to credit, and concerns about technical failures after purchase. SES also strengthens Self-Efficacy, as hands-on training and post-sales guidance from a trusted organisation increase entrepreneurs' confidence in operating and maintaining their systems, thereby enhancing adoption intention. Empirical evidence shows that micro-entrepreneurs receiving support from mission-driven organisations are significantly more likely to adopt solar PV than those relying solely on government programs or commercial sales channels [12, 29].

H₆: Social Enterprise Support positively influences the Adoption Intention of solar PV among micro-entrepreneurs in India.

Mediating Role of Self-Efficacy (SE)

Self-Efficacy, grounded in Bandura's Social Cognitive Theory [33] and operationalised as perceived behavioural control in TPB [16], refers to a micro-entrepreneur's belief in their ability to install, operate, and maintain a solar PV system. This confidence is not automatic in the solar adoption context and depends on the quality and accessibility of available information. With greater knowledge of solar systems, entrepreneurs are better able to assess their own capacity to use them effectively, enhancing self-efficacy and, in turn, increasing adoption intention. Self-efficacy also mediates the relationship between information quality and adoption intention, as demonstrated by Gangale et al. [23], who further noted that observing peers adopting solar systems serves as a form of social influence. While these factors directly impact adoption intention, psychological

mechanisms such as self-efficacy are critical in translating external conditions—knowledge and social exposure—into behavioural decisions.

H₇: Self-Efficacy mediates the relationship between Technological Awareness and Adoption Intention of solar PV among micro-entrepreneurs in India.

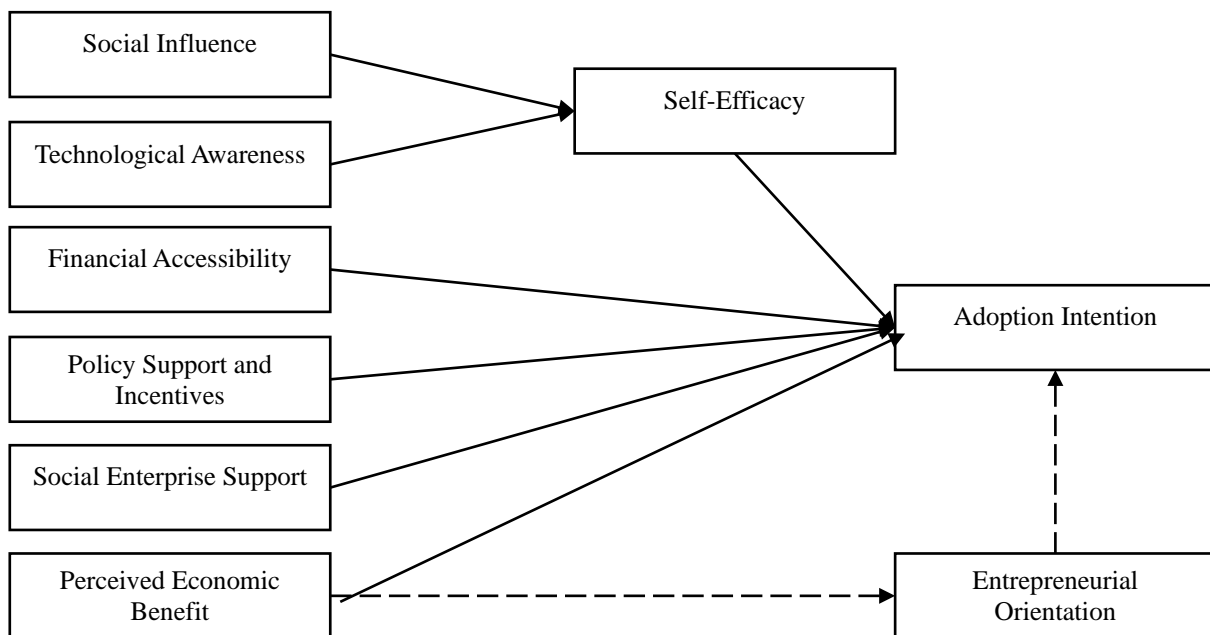
H₈: Self-Efficacy mediates the relationship between Social Influence and Adoption Intention of solar PV among micro-entrepreneurs in India.

Moderating Role of Entrepreneurial Orientation (EO)

Entrepreneurial Orientation (EO) captures the degree of risk-taking, innovativeness, and proactiveness demonstrated by a micro-entrepreneur in business decisions [6]. EO moderates the relationship between Perceived Economic Benefit and Adoption Intention in solar PV adoption: a micro-entrepreneur who recognises potential economic returns is more likely to translate that belief into adoption intention if they also exhibit an entrepreneurial orientation, being willing to take calculated risks and actively pursue business gains. Standal [11] found that entrepreneurial disposition significantly influenced solar adoption outcomes among micro-entrepreneurs in rural India, while Wustenhagen and Bilharz [24] observed that innovative propensity strengthens the link between economic incentives and the adoption of green technologies.

H₉: Entrepreneurial Orientation positively moderates the relationship between Perceived Economic Benefit and Adoption Intention.

Figure 1: Conceptual Framework for Solar PV Adoption Among Micro-Entrepreneurs in India



Note. Solid arrows (→) represent direct positive effects of independent variables—Financial Accessibility (FA), Policy Support and Incentives (PSI), Perceived Economic Benefit (PEB), Social Influence (SI), Technological Awareness (TA), and Social Enterprise Support (SES)—on Adoption Intention (AI). Green dashed arrows indicate indirect (mediated) effects through Self-Efficacy (SE), where all independent variables influence AI via SE. The red dashed arrow represents the moderating effect of Entrepreneurial Orientation (EO) on the relationship between Perceived Economic Benefit (PEB) and Adoption Intention (AI), such that the relationship is stronger at higher levels of EO.

Source: Collected by Author

Discussion

This paper conceptualises the adoption intention of solar PV among micro-entrepreneurs in India through the integration of TAM, TPB, DOI, and UTAUT. The framework posits that six independent variables—Financial Accessibility, Policy Support and Incentives, Perceived Economic Benefit, Social Influence, Technological Awareness, and Social Enterprise Support—positively influence Adoption Intention, with Self-Efficacy and Entrepreneurial Orientation serving as mediating and moderating variables, respectively. While these relationships are theoretically grounded, their practical impact may vary across contexts due to differences in institutional capacity, regional policy implementation, and local market conditions. Financial Accessibility is critical, as the high initial cost of solar PV systems is the most widely reported barrier for Indian micro-enterprises; micro-finance or pay-as-you-go financing can reduce this barrier and make adoption economically feasible [5, 8, 22]. However, access to such financing is uneven, limited by informal business structures, low creditworthiness, and procedural constraints. Policy Support and Incentives influence adoption by reducing cost uncertainty and enhancing awareness of available technologies and financing schemes. Micro-entrepreneurs often lack clear information on these schemes and how to access them, making effective communication and streamlined access as important as subsidies themselves [3, 15, 29]. State-level variations in implementation and administrative inefficiencies can further limit the real impact of policies, widening the gap between policy design and adoption outcomes. Perceived Economic Benefit remains a central motivator, as the anticipated cost savings, income generation, and productivity gains strongly drive adoption intention. Adoption decisions become more tangible and practical when micro-entrepreneurs can clearly observe, through demonstrations, peer experiences, or personal calculations, that solar PV reduces diesel costs, increases working hours, and enhances income [3, 10, 15]. However, doubts about system reliability, maintenance, and long-term performance can weaken this relationship, particularly in settings with limited-service support. Social Influence, operating through informal networks and community norms, strongly shapes decision-making, as witnessing peers successfully using solar PV provides a more credible signal than formal communication channels. This aligns with DOI theory, which highlights observability and interpersonal communication as key drivers of innovation diffusion [18, 27]; conversely, adoption may lag in areas without early adopters or where initial experiences are poor. Technological Awareness is a necessary precondition for adoption: without understanding solar PV's functionality, cost, and benefits, meaningful adoption intentions cannot form [23, 27]. Yet awareness alone is insufficient; it must be grounded in context-specific knowledge and practical experience to translate into behavioural intention. Self-Efficacy serves as a mediator, capturing how awareness and social exposure convert into confidence and adoption intention. Exposure to demonstrations or peer usage builds knowledge and confidence, enhancing self-efficacy, though this effect diminishes where continuous technical support is lacking or operational risks are high [33]. Entrepreneurial Orientation mediates the link between Perceived Economic Benefit and Adoption Intention, as risk-taking and innovation-driven entrepreneurs are more likely to act on perceived benefits than risk-averse individuals [6, 11]. Notably, Social Enterprise Support is a uniquely important construct, filling a gap in current solar adoption models in India by providing practical, mission-driven facilitation that addresses the typical barriers faced by micro-entrepreneurs. Social enterprises such as SELCO Solar focus on micro-entrepreneurs who are often excluded from the formal economy due to low income, informal business structures, lack of collateral, geographic remoteness, or low literacy. Their integrated support model—including awareness campaigns in local languages, personalised productive-use solutions, financial linkages, technical training, and after-sales service—directly addresses the key barriers faced by this segment. Social Enterprise Support also strengthens Self-Efficacy: training and follow-up build confidence in the technology, translating awareness into adoption intention. Empirical studies in South Asia and sub-Saharan Africa show that micro-entrepreneurs supported by mission-driven organisations are more likely to adopt solar PV than those relying solely on government programs or commercial channels [12]. However, the scalability of such support models is constrained by resource requirements, organisational capacity, and geographic reach. In India's large and predominantly informal micro-enterprise sector, Social Enterprise Support functions as a critical institutional facilitator rather than an ancillary variable, though its success depends on systemic factors such as policy alignment, infrastructure availability, and market development. Thus, while the framework captures the essential behavioural and institutional drivers of solar adoption, actual adoption outcomes are also influenced by macro-level forces beyond individual-level determinants.

Practical Implications

Combined Financial and Behavioural Interventions.

The proposed framework suggests that the adoption of solar photovoltaic (PV) by micro-entrepreneurs is shaped by the interplay of behavioural and financial factors, rather than finance alone. This implies that financial institutions and solar service providers should design integrated solutions that combine financing mechanisms—such as micro-finance or pay-as-you-go models—with awareness-building initiatives, demonstrations of economic benefits, and user training. Addressing both financial constraints and behavioural readiness in tandem can substantially enhance adoption outcomes and ensure that micro-entrepreneurs are equipped to make informed and confident decisions about solar PV technology.

Enhancing Policy Delivery Mechanisms.

The framework indicates that policy support influences solar PV adoption not only by reducing costs but also by enhancing awareness and perceived legitimacy of the technology. Its effectiveness, however, depends on micro-entrepreneurs' ability to access and understand existing schemes. Policymakers should therefore focus on last-mile delivery by streamlining processes, improving local-level communication, and coordinating with local institutions and intermediaries. Such measures help ensure that policy initiatives translate into practical adoption rather than remaining underutilised.

Building on Social and Contextual Dynamics.

Social Influence and Technological Awareness suggest that adoption decisions are embedded within local social networks and information environments. To facilitate adoption, solar providers, NGOs, and social enterprises should leverage peer networks, demonstration effects, and community-based strategies. Highlighting clear success stories and enabling peer-to-peer learning can accelerate diffusion, particularly in areas where confidence in formal communication channels is low.

Developing User Confidence and Ability.

The mediating role of Self-Efficacy implies that awareness and exposure lead to adoption only when they enhance confidence in the ability to use and maintain solar PV technology. This underscores the importance of reinforcing training programs, technical support, and after-sales services to build user capability. Continuous interaction with micro-entrepreneurs reduces perceived risk and narrows the gap between knowledge and action, thereby strengthening adoption outcomes.

Enhancing Support Systems in the Institution.

The framework emphasises the critical role of institutional support, particularly social enterprises, in simultaneously addressing financial, informational, and confidence-related barriers to solar PV adoption. Social enterprises, development organisations, and impact investors should expand localised support models that integrate access to finance, awareness generation, technical training, and after-sales services. At the same time, policymakers need to create enabling conditions—through partnerships and supportive regulations—that facilitate the scalability and effectiveness of these models across broader micro-entrepreneur populations.

Limitations and Future Research Directions

This study has two primary limitations. First, it presents a conceptual framework that has not been empirically tested. While the proposed relationships are theoretically grounded, the absence of primary data prevents verification of the strength and significance of these relationships. Future research should collect data from micro-entrepreneurs across diverse regions and employ Structural Equation Modelling (SEM) or Partial Least Squares SEM (PLS-SEM) to analyse both direct and mediated or moderated effects. Second, the study treats micro-entrepreneurs as a homogeneous group, whereas their energy requirements, financial capacity, and operational contexts vary significantly across industries. This limits the generalisability of the framework. Future studies should conduct sector-specific and cross-regional

comparative analyses to assess how adoption determinants differ by enterprise type and institutional environment, allowing the framework to be calibrated accordingly.

Conclusion

This paper analysed the predictors of solar photovoltaic adoption intention among micro-entrepreneurs in India and developed a combined conceptual model integrating TAM, TPB, DOI, and UTAUT. The model identifies six primary determinants, with Self-Efficacy as a mediator and Entrepreneurial Orientation as a moderator and proposes nine hypotheses. Three key conclusions emerge. First, solar adoption is not purely a financial endeavour but also a behavioural and institutional one, shaped by awareness, confidence, and the presence of enabling support systems; financial incentives alone are insufficient and must be complemented by awareness-building and support mechanisms. Second, existing technology adoption models inadequately capture the constraints faced by micro-entrepreneurs in informal contexts, highlighting the need for a context-specific framework. Third, Social Enterprise Support plays a critical role, as it addresses the three main adoption barriers—financial, informational, and confidence-related—simultaneously. Overall, this study provides a theoretically integrated framework tailored to micro-entrepreneurs, offering a foundation for future empirical research and informing more effective policy design and implementation strategies.

Conflict of Interests

The authors declare that they have no conflict of interests.

Data Availability

No primary data were generated or analysed for this conceptual paper.

Ethical Approval

Not applicable. This is a conceptual paper involving no human subjects.

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