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Moo-ving Forward: How Access to the Internet is Transforming Dairy Farming in Bangladesh

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Abstract:-This research paper examines the impact of internet access on dairy farming in Bangladesh, focusing on the relationship between access to the internet, social media, YouTube, artificial intelligence, and dairy farm performance. The study finds that there is a positive and interconnected relationship between social media, YouTube, and artificial intelligence when combined with internet access, which enhances dairy farm performance. However, the study also reveals a negative association between YouTube and dairy farm performance. The research sheds light on the dynamic landscape of dairy farming in Bangladesh and provides valuable insights into the multifaceted ways in which technology and internet access are transforming the sector. These findings have important implications for the future of the dairy industry in Bangladesh and beyond. It is crucial for dairy farmers to be aware of the potential impact of social media on their business and to take steps to mitigate any negative effects. Overall, this study highlights the transformative role of Internet access in dairy farming and underscores the need for continued research in this area.

Keywords*: Artificial Intelligence, Dairy Farm,Internet, Social Media, Technology.*

1. Introduction

In Bangladesh, cattle, buffalo, and goats are predominantly regarded as dairy animals [1]. Dairy farming constitutes a significant and promising agricultural sector within the Bangladeshi economy. The agricultural sector, encompassing fisheries, forests, livestock, and crops, accounted for around 12.5% of Bangladesh's GDP in the 2020–21 year of fiscal responsibility, based on the Bangladesh Bureau of Statistics [2-3]. On top of that, about 40% of the total workforce in the whole nation was employed in this sector of the economy [3]. In accordance with Bangladesh Bureau of Statistics (BBS) data for fiscal year (FY) 2021-22, the livestock population in Bangladesh comprised 26,219,492 cattle and buffalo, as well as 17,615,706 sheep and goats [2]. According to the Department Of Livestock Services (DLS) in the fiscal year 2022-23, milk production in Bangladesh stood at approximately 14.07 million metric tons, while the demand for milk was estimated to be 15.85 million metric tons [4]. This resulted in a deficit of 1.78 million metric tons, or 11.23% of the total demand [4]. The dairy industry in Bangladesh possesses significant potential for growth, and modern technology can serve as a key enabler in ensuring that this growth is sustained and leads to surplus production.

At the commencement of 2023, Bangladesh had 66.94 million internet users, representing an internet penetration rate of 38.9 percent [5]. As of January 2023, Bangladesh had a social media user base of 44.70 million individuals, constituting 26.0 percent of the nation's overall population [5]. In early 2023, there were 179.9 million active cellular mobile connections in Bangladesh, equivalent to 104.6 percent of the total population [5]. The aforementioned data portrays an accurate picture of Bangladesh's large internet user base and is encouraging for the nation's overall digitalization. The widespread adoption of the internet in Bangladesh

has granted its citizens access to platforms such as social media and YouTube, which are playing a pivotal role in various types of businesses across diverse sectors [6]–[10]. Concomitant with the pervasive influence of social media and YouTube on a vast array of businesses, these platforms are also playing a pivotal role in the dairy farming industry [11]–[15]. In addition to bestowing upon us the gifts of social media and YouTube, the internet has also unlocked the gateway to a vast treasure trove known as artificial intelligence. Artificial intelligence has been employed to enhance the scale and scope of various businesses since its inception [16]–[20]. Innovation's stronghold, artificial intelligence, is transforming the agriculture industry by giving it access to hitherto unrealized potential and accelerating its progress toward a brighter outlook for the future [21]–[25].

1.1 Dairy Farming

The dairy sector in Bangladesh is experiencing growth and holds promise as a self-sustaining economic entity. This industry predominantly depends on ruminant animals, encompassing cattle, buffalo, sheep, and goats, to address global malnutrition challenges. The production of milk in Bangladesh has demonstrated a continuous upward trend. Furthermore, during 2018-2019, the private sector was responsible for the production of 9.920 million metric tonnes of milk, making a substantial contribution to alleviating poverty and malnutrition challenges in Bangladesh, while also generating employment opportunities; an example of this is PRAN Dairy Limited (PDL), a subsidiary of the PRAN Group, which plays a vital role in mitigating rural poverty and food insecurity in Bangladesh, highlighting the importance of striving for economic self-sufficiency, wherein PDL, alongside other endeavors within the dairy sector, endeavors to enhance the competitiveness of small-scale farmers and keep them well-informed about the dynamic market conditions [26]. The practice of dairy farming holds significant potential in benefiting impoverished rural households by contributing to their nutritional needs, income generation, employment opportunities, and the integration of diverse farming systems [27]. It also provides a substantial volume of organic manure, serving as a pivotal component in the agricultural inputs of Bangladesh [1]. The dairy sector in Bangladesh has incorporated contemporary technologies within its dairy farming practices, where innovation has become a crucial factor in optimizing milk production, and the amalgamation of time-honored methods with state-of-the-art technologies has not only fostered expansion and heightened production but has also facilitated product diversification to cater to evolving consumer inclinations [28]. According to the projections by the Department of Livestock Services, Bangladesh is anticipated to attain self-sufficiency in the dairy sector by the year 2030, underpinned by the promising upward trajectory in milk production, alongside the establishment of multiple private-sector milk collection and processing facilities to meet the rising consumer demand for dairy products, marking a significant stride toward self-reliance in the Bangladesh dairy industry [29].

1.2Social Media in Dairy Farming

Within Bangladesh, dairy farmers have progressively embraced social media as an essential tool to bolster elements such as production, marketing, and the sharing of knowledge. Female dairy farmers in Bangladesh are harnessing digital resources to enhance productivity and advance gender equality, utilizing social media platforms as a means to engage with prospective buyers and market their dairy products [30]. The objective of this project is to enhance the skills and knowledge of 12,000 women engaged in dairy farming by employing technology to facilitate the adoption of enhanced dairy practices. Under the 'Digital Inclusion and Empowerment for Women Dairy Farmers in Bangladesh,' an initiative funded by USAID, more than 12,000 female dairy farmers in the districts of Khulna and Jashore are now receiving Interactive Voice Response (IVR) messages with technical advice and suggestions meant to improve their methods of raising livestock, thus bringing about a major change in their everyday routines by utilizing relevant and easily accessible technology [31]. Social media can play a key role and hold enormous potential in this ever-evolving and fast-changing agricultural extension system [32]. Social media is actively employed for the dissemination of industry-related information and for establishing connections with fellow agricultural experts, while rural laborers have also started utilizing social media as a means to alleviate the sense of isolation associated with their occupation [33]. The approach advocates for developing community-based groups involved in production, processing, and marketing to address various limitations, encouraging small-scale milk producers to establish cooperatives and

similar associations to enhance their negotiation capabilities and access support services [27]. In a research investigation conducted by Md. Shaikh Farid and colleagues [34], it was determined that among Bangladeshi consumers, the key determinants affecting their intention to purchase dairy products were product quality, pricing, and the perceived brand image.

1.3YouTube in Dairy Farming

Although there is a scarcity of information regarding the influence of YouTube in the context of dairy farming in Bangladesh, there are pertinent aspects worth contemplating. In a video created by the International Fund for Agricultural Development (IFAD), the constructive influence of digital technologies on the welfare of Bangladeshi farmers, including those in dairy, livestock, and fisheries, is evident as it portrays the training of farmers in using mobile phones, tablets, and other digital tools to access information on weather, market prices, and agricultural practices, highlighting the transformative potential of digital technologies in improving farmers' livelihoods [35]. An article from CARE Bangladesh reports on the organization's efforts to enhance the dairy value chain in the nation, illustrating how CARE has supported farmers in enhancing their milk production, quality, and marketing strategies, resulting in elevated income and improved food security. Although the article does not exclusively pertain to YouTube, it underscores the capacity of development organizations to utilize videos as a means to exhibit their achievements and foster interaction with stakeholders [36]. A video from the Dairy Research Foundation presents Dr. Mark McGuire's insights on the future of research in the dairy industry and its potential impact, emphasizing the capacity of YouTube as a platform to illuminate expert perspectives and foster meaningful engagement with stakeholders regarding critical matters within the dairy sector [37]. Numerous YouTube videos on dairy farming are available, but their significance remains unexplored. This study could serve as a valuable resource for assessing the influence of YouTube videos within the dairy farming industry.

1.4 Artificial Intelligence in Dairy Farming

In a scholarly article authored by Amin and Rahman, a concise overview of smart dairying (SDF) is presented within the framework of contemporary advancements in production methodologies. The authors highlight the potential contributions of Artificial Intelligence (AI) and the Internet of Things (IoT) in enhancing the efficiency, productivity, and sustainability of dairy farming operations [38]. An academic paper explores the possibilities and obstacles associated with incorporating Fourth Industrial Revolution technologies, such as Artificial Intelligence (AI), into the manufacturing of milk and its by-products, underscoring AI's capacity to evaluate the health and welfare of dairy cattle, offer decision support, and deliver analytical insights for enhanced management and productivity [24]. Artificial Intelligence (AI) is influencing the landscape of dairy farming in Bangladesh utilizing artificial insemination, smart dairying practices, cow monitoring with decision support, and the implementation of milking robots, suggesting that there is potential for further investigation into how AI can advance the efficiency, productivity, and sustainability of dairy farming.

2. Objectives

This investigation delves into the impact of the internet, social media, YouTube, and artificial intelligence on the performance of dairy farms in Bangladesh. The following hypotheses were tested to unravel the mysteries of the internet's transformative power, as it empowers dairy farmers to navigate the ever-changing tides of the marketplace. The hypotheses are as follows:

H1: Does a correlation exist between internet-based platforms such as social media, YouTube, and artificial intelligence (AI), and the accessibility of the internet?

H2: Is there a discernible association between the utilization of social media and the productivity of dairy farms?

H3: Is there a discernible association between the utilization of YouTube and the productivity of dairy farms?

H4: Is there a discernible association between the utilization of Artificial Intelligence and the productivity of dairy farms?

The conceptual framework is given below:

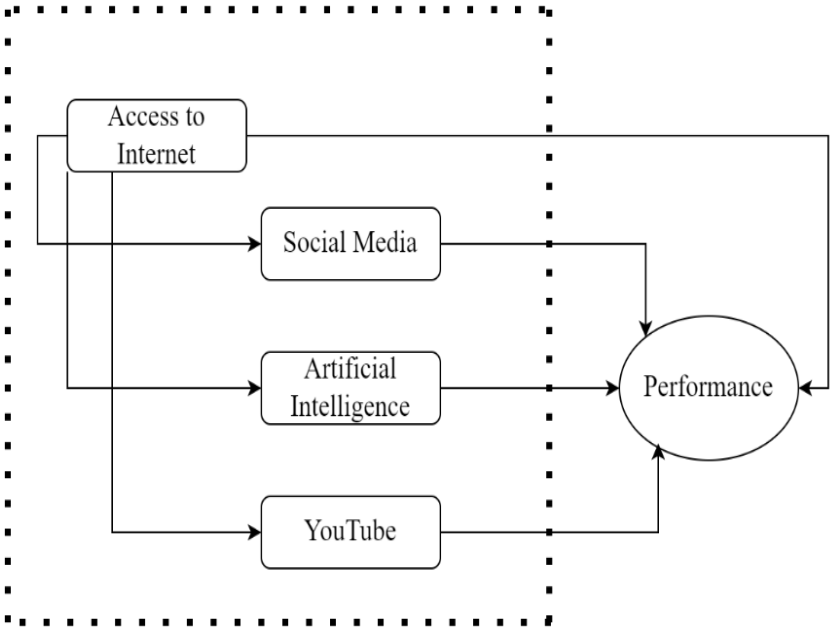

Figure 1Conceptual Model (Proposed by authors)

3. Methods

3.1 Research Design

In Figure 2 below, the research design for the study is depicted. Initially, an extensive review of relevant literature from 2019 up to the most recent publications was conducted. Subsequently, hypotheses and a conceptual model were developed based on identified research gaps in prior studies. Data from various dairy farms were collected to assess the models and test the hypotheses. Upon completion of data collection, the information was processed for evaluation, and subsequently analyzed against the conceptual model using appropriate analysis software, leading to the presentation of the research findings.

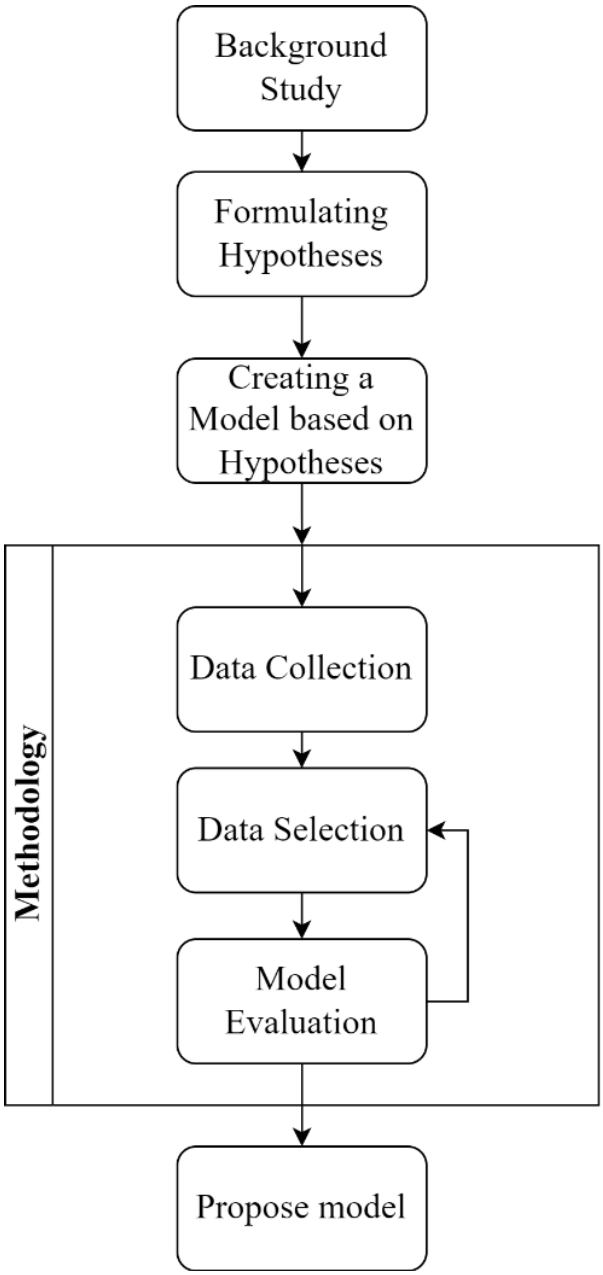

Figure 2 Research Design

3.2 Data Collection

This research was executed through a cross-sectional survey approach, utilizing a quantitative methodology and employing purposive sampling techniques. Purposive sampling, an approach in qualitative research, is a non-probabilistic sampling method designed to deliberately select a particular group of individuals or entities for examination, where participants are intentionally chosen rather than randomly selected [39]. Moreover, researchers may posit that purposive sampling has the potential to yield time and cost savings [40]. In this study, a brief and concise survey was administered, and after a meticulous screening process, the researcher ultimately selected a sample of 200 dairy farmers for participation. The data for this research were collected from multiple dairy farms establishments situated around Dhaka, the capital city of Bangladesh. The researcher designed a survey instrument consisting of 25 items in both English and Bengali languages. Among these items, ten pertain to demographic information, while the remaining 25 questions employ a 5-point Likert scale (ranging from 1, denoting "Strongly Disagree," to 5, signifying "Strongly Agree").

3.3 Data Selection

On the 3rd of September 2023, 350 hardcopy questionnaires were disseminated among several dairy farms in the vicinity of Dhaka City, and these questionnaires were subsequently retrieved on the 6th of September 2023. The questionnaires were submitted to the farm supervisors. 267 out of 350 questionnaires were collected from the respondents. Nonetheless, out of the initial 267 surveys, 47 were excluded because they contained incomplete responses, and an additional 20 were removed due to apparent straight-line or questionable responses. The response rate for this study amounted to 76.28%, meeting the threshold set by W. Black and Babin, who stipulated that a minimum response rate of 50% should be achieved in surveys [41].

3.4 Analysis Method and Tools

The analysis and assessment of the data were performed utilizing smartPLS version 3.2.8. SmartPLS is a software program employed for the implementation of variance-based structural equation modeling (SEM) through the application of the partial least squares (PLS) path modeling methodology [42]. It serves as a statistical and multivariate analysis tool that is specifically designed for partial least squares regression [43]. Partial least squares structural equation modeling (PLS-SEM) is a statistical technique employed in exploratory research to model latent variables and their relationships. It is a valuable tool in a wide range of industries, including family business, marketing, strategic management, tourism and hospitality, healthcare, and psychiatric studies. PLS-SEM facilitates the identification of key determinants and competitive advantages for significant target constructs such as customer satisfaction, loyalty, behavioral intentions, and user behavior [44]–[48]. The selection between covariance-based structural equation modeling (CB-SEM) and partial least squares structural equation modeling (PLS-SEM) should be guided by the specific research objectives. For instance, CB-SEM is well-suited for research that aims to predict indicators using component expansion techniques. In contrast, PLS-SEM is a more appropriate choice for research that focuses on examining relationships between observed variables [49]–[51].

4. Results and Findings

In order to identify the primary factor influencing dairy farm performance, the study focused on analyzing independent variables. To carry out this analysis, the research utilized the PLS-SEM algorithm, implemented through the SmartPLS 3.2.8 software, renowned for its capacity in PLS-SEM algorithm application. The results of this algorithm application are depicted in Figure 3, revealing the structure of both the inner and outer models of PLS-SEM. Additionally, Table 1 provides a summary of the guidelines derived from the PLS-SEM analysis.

Table 1: Bootstrapping Parameters

Subsamples	1000
Number of Results	Complete Bootstrapping
Test Type	Two Tailed
Significance Level	5%

In the context of Partial Least Squares Structural Equation Modeling (PLS-SEM), the evaluation of the statistical significance of various outcomes is accomplished through the application of bootstrapping. Bootstrapping is a nonparametric method employed for estimating the sampling distribution of statistics through data resampling. This technique allows for the examination of path coefficients, Cronbach's alpha, and R^2 values, among other model attributes. Complete bootstrapping offers comprehensive insights and detailed information regarding the model's performance and validity.

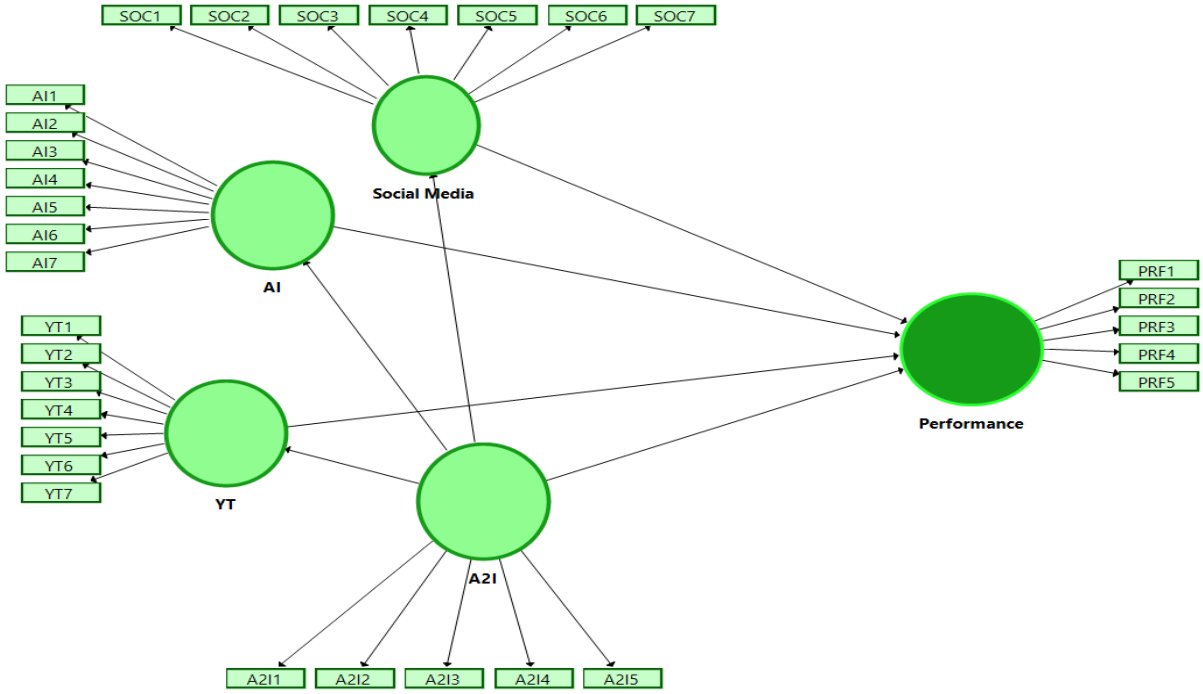

Figure 3Conceptual model on SmartPLS 3.2.8 software

In SmartPLS 3.2.8, the significant relationships were identified and the PLS-SEM algorithm with bootstrapping was employed to gain a comprehensive understanding of the model. Once the model was constructed, a visual representation of the final model, as depicted in Figure 4, was obtained.

4.1 Model Evaluation

In SmartPLS 3.2.8, the significant relationships were identified and the PLS-SEM algorithm with bootstrapping was employed to gain a comprehensive understanding of the model. Once the model was constructed, a visual representation of the final model, as depicted in Figure 4, was obtained.

4.2 Convergent Validity

Convergent validity, a facet of construct validity, assesses the degree to which a measure converges with other measures purportedly tapping the same latent construct. In other words, it gauges the extent to which a measure demonstrates consistency with other measures of the same construct [52]. In the study, the authors employed convergent validity to appraise the trustworthiness and authenticity of our survey instrument. This entailed a comparison of the survey scores against those obtained from established measures related to factors like internet accessibility, social media usage, YouTube engagement, and artificial intelligence.

Table 2: Reliability and Validity

	Cronbach's Alpha	*rho_A*	*Composite Reliability*	*Average Variance Extracted (AVE)*
A2I	0.761	0.865	0.838	0.533
AI	0.927	0.962	0.943	0.708
Performance	0.891	0.904	0.920	0.697
Social Media	0.888	0.913	0.917	0.624
YT	0.700	0.783	0.795	0.378

These criteria are pivotal for assessing the quality of the measurement model within the context of PLS-SEM. The primary objectives in this research involve achieving robust reliability, assessed through metrics like

Cronbach's Alpha [53] and Composite Reliability (CR) [54]. Additionally, the aim is to illustrate convergent validity by utilizing the Average Variance Extracted (AVE) [55] for each latent construct. Equally significant is the confirmation of discriminant validity among these constructs, substantiating that each one effectively encapsulates a distinct aspect of the underlying theoretical framework. The comprehensive evaluation of reliability and validity holds a crucial role in ensuring the resilience and precision of the measurement model, ultimately contributing to more dependable and valid findings in the PLS-SEM analyses.

Cronbach's alpha is a gauge of internal consistency reliability, with values exceeding 0.7 considered suitable for the study. Composite reliability (rho_A), another indicator of internal consistency reliability, should surpass the threshold of > 0.7 as Composite Reliability, AVE serves as a measure of convergent validity, with a criterion of 0.5. Convergent validity of the scale is evaluated by considering AVE and combined reliability (CR) values, while divergent validity is established by comparing the square root (√) values with the correlation coefficients among the factors. These criteria serve as widely recognized and commonly utilized standards in numerous research studies to assess the reliability and authenticity of constructs [56]–[58].

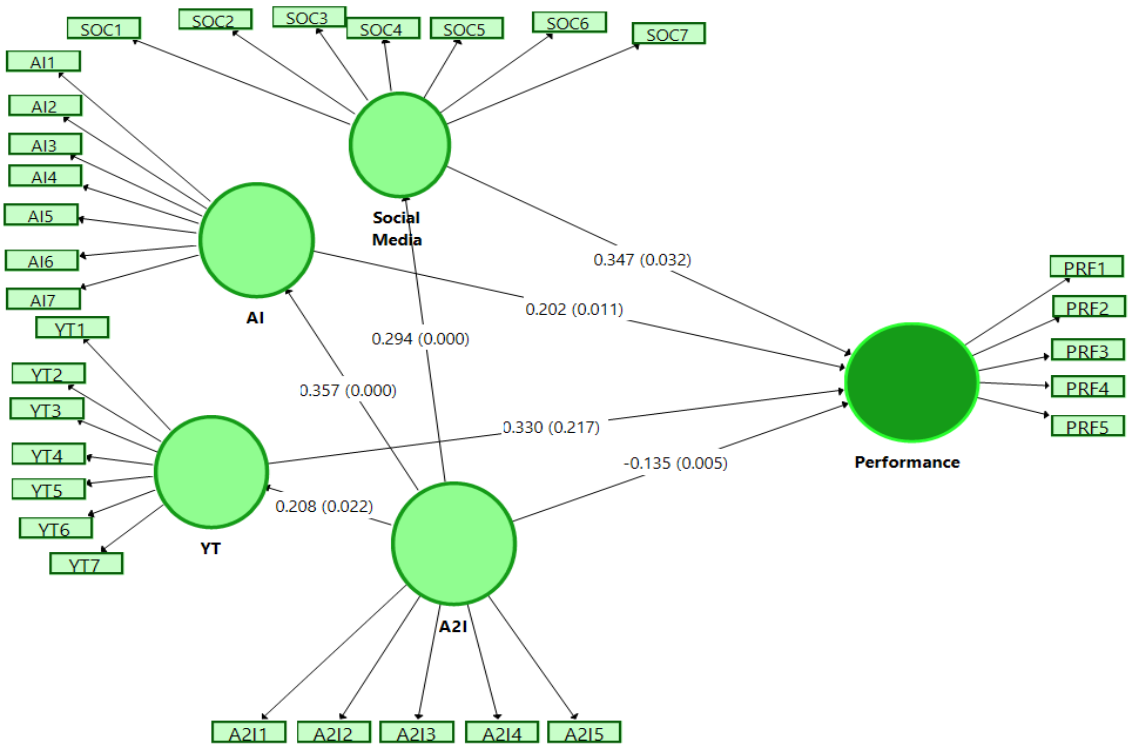

Figure 4Conceptual model after PLS-SEM analysis

The Heterotrait-Monotrait Ratio of Correlations (HTMT) serves as an assessment tool within structural equation modeling to evaluate discriminant validity. It quantifies the average correlations among indicators both within and across constructs. Generally, values below 0.90 are considered indicative of acceptable discriminant validity [52], [59], [60].

Table 3: Heterotrait-Monotrait Ratio of Correlations Table

	A2I	***AI***	***Performance***	***Social Media***	***YT***
A2I					
AI	0.394				
Performance	0.165	0.359			

Social Media	0.364	0.338	0.555		
YT	0.354	0.301	0.555	0.559	

4.3 Hypotheses Testing

The assessment of internal consistency reliability is conducted using composite reliability, with an anticipated threshold above 0.70. In cases of exploratory research, values ranging from 0.60 to 0.70 are also considered acceptable [58]. Composite reliability serves as the upper limit of internal consistency reliability, whereas Cronbach's alpha is viewed as the lower threshold. Additionally, indicator reliability demands that the outer loadings of indicators should surpass 0.70. Indicators with outer loadings in the range of 0.40 to 0.70 may be contemplated for removal, but only if their elimination enhances composite reliability and AVE beyond the 0.5 threshold. The t-statistic test is executed within the partial least squares (PLS) analysis model using SmartPLS 3.2.8 software with the aid of the direct effect test.

Table 4. Hypotheses Testing

Hypotheses	***Connection***	***Original Sample (O)***	***Sample Mean (M)***	***Standard Deviation (STDEV)***	***T Statistics (|O/STDEV|)***	***P Values***	***Decision***
H1	**A2I -> AI**	0.357	0.363	0.044	8.026	**0.000**	**Supported**
H1	**A2I -> Performance**	-0.135	-0.114	0.049	2.786	**0.005**	**Supported**
H1	**A2I -> Social Media**	0.294	0.303	0.042	6.974	**0.000**	**Supported**
H1	**A2I -> YT**	0.208	0.245	0.091	2.290	**0.022**	**Supported**
H4	**AI -> Performance**	0.202	0.185	0.077	2.624	**0.009**	**Supported**
H2	**Social Media -> Performance**	0.347	0.330	0.159	2.181	**0.029**	**Supported**
H3	**YT -> Performance**	0.330	0.323	0.272	1.212	**0.226**	**Not Supported**

The findings derived from the calculations presented in Table 4 indicate that H1, H2, and H4 received support, while H3 did not find support, as reflected by the p-values falling below 0.05.

5. Conclusion

In summary, it can be affirmed that a favorable relationship exists between internet access, social media, artificial intelligence, and YouTube. However, it's important to note that YouTube does not have a direct influence on the performance of dairy farms. Instead, there is a beneficial correlation between social media, internet accessibility, and artificial intelligence with dairy farm performance. Internet access has greatly expanded the scalability of the dairy industry, enabling farmers to utilize these technologies for business expansion and enhanced production efficiency. Dairy farmers are also leveraging social media for marketing their products. Notably, artificial intelligence plays a pivotal role in enhancing the sustainability, scalability, and efficiency of dairy operations. In conclusion, the adoption of technology can indeed enhance the performance of

dairy farms, with the caveat that potential negative consequences resulting from the misuse of these technologies should be carefully considered.

In the context of a developing country like Bangladesh, future work in the dairy farming sector should prioritize affordable and accessible technology solutions for small-scale farmers. Research should assess the impact of these technologies on improving farm performance and economic development in rural areas. Additionally, sustainability and environmental considerations, crucial in a climate-vulnerable country, should be central to future investigations.

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