Evaluating the Efficiency of Van Dhan Yojana Using DEA: Strategic Insights for Tribal Development

Neetu Mishra[1*], Astha Joshi[1], Anil Vashisht[2], Neelesh Kumar Mishra[3], Swapnil Shahoo[4]

[1]Amity University, Gwalior, Madhya Pradesh, [2]Amity University Lucknow, Uttar Pradesh, [3]XLRI: Xavier School of Management, Jamshedpur, Jharkhand, [4]Great Lakes Institute of Management, Gurgaon, Harayana, India. *Corresponding Author's Email: onemishraneetu@gmail.com

Abstract

This research article compares the effectiveness of government-initiated programs in India. It explores the technical and scale efficiency of the Van Dhan Yojana (VDY) and explains, using existing literature and results, how these schemes can enhance tribal communities. This article also tells that apart from the VDY, for the entrepreneurship of a tribal, the government has started such startups, under Developed India Initiative. The Van Dhan Yojana is more than just a welfare program; it's a means by which traditional knowledge gained from the forest may be transformed into economic independence and social empowerment. In this paper, we discuss how India can make efforts to become a developed country. The researcher focuses on the Data Envelopment Analysis (DEA), factoring inputs and outputs from the government initiative involving Van Dhan Yojana. Without taking on a functional form, DEA is a good fit for assessing government programs with multiple inputs and results. The research aims to see how well tribal welfare has improved in India's 22 provinces (also known as states). The study analyses input and output slacks to find areas of inefficiency and then uses DEA to quantify technical, scale, and returns-to-scale efficiencies. This article also explores the twenty-two states' improvement in livelihoods and how these schemes work.

Keywords: Data Envelopment Analysis (DEA), Efficiency Measurement, Tribal Welfare, Van Dhan Yojana.

Introduction

As we all know, to improve the livelihood of tribal communities, the government has made many efforts to promote the inclusive growth of the communities (1). However, the government has started various schemes to promote the One District One Product (hereafter used as ODOP) (2). To promote this ODOP, the government started up the Van Dhan Vikas Yojna, also known as Van Dhan Yojna (VDY), and this scheme helps the tribal communities (2). The VDY is a newly launched program established in 2018 by the Ministry of Tribal Affairs and Tribal Cooperative Marketing Development Federation of India (TRIFED) as a broader effort to expand income through the Minor Forest Products (MFP) sector (3). This sector is critical for the livelihood of millions of tribal communities. The program aims to assist indigenous communities in achieving economic independence by enhancing their ability to add value, develop their skills, and access markets (4). These schemes or programs are aligned with the Sustainable Development Goals (SDGs), and this goal helps in the Viksit Bharat (5). The aim of the visit to Bharat and the SDGs goal is to promote long-term growth in rural and emerging sectors of India (6). It is not easy for the government to start and to engage in the activity on VDY because there are several obstacles are facing while achieving the Van Dhan Yojana or scheme, especially geographical and market access components of the challenges and further challenges like poor infrastructure, restricted market access, and low levels of financial knowledge among the native people (7). These problems show how important it is to investigate what makes the VDY work and how it affects rural development. The primary objective of this research is to determine the extent to which the VDY has contributed to the economic and social development of India's tribal communities (8). This research focuses on 22 different provinces (hereafter used as states) in India to see how well the program worked using Data Envelopment Analysis (DEA) (9). Policymakers and governing authorities have been

continuously making regulatory efforts to improve the livelihood of Indigenous people with the help of entrepreneurship development (10). Initiatives such as One Product One District (OPOD), vocal for the local, establishment of marketplaces and warehouses, supporting commercial crops with minimum support prices (MSP), and the creation of VDVKs for product value addition are a few examples. However, the effectiveness of these initiatives remains challenging. While some initiatives are performing well in some localities, the performance is not consistent in other locations.

The Van Dhan Yojana's execution and results are impacted by substantial inter-state variation, which must be acknowledged. The demographics of India's indigenous peoples, the extent to which each state relies on timber from nearby forests, the accessibility of essential services, the ease with which each state can access outside markets, and the effectiveness of state governments all vary substantially. The tribal populations of some states, like Odisha, Chhattisgarh, and Madhya Pradesh, are densely concentrated and heavily dependent on forest-based livelihoods; in contrast, the tribal populations of some states, like Goa, Sikkim, and Uttarakhand, are smaller and more scattered, and they have more access to markets and institutions. Policy instruments, such as the distribution of funds, the creation of Van Dhan Self-Help Groups, the construction of Van Dhan Vikas Kendras, and the operationalization of convergence with affiliated schemes, are affected by these structural and institutional variations. Hence, it is unreasonable to anticipate consistent results in terms of performance from one state to another. This study's DEA framework takes into account the fact that states are different by viewing them as separate Decision-Making Units (DMUs). This allows for a relative efficiency assessment that takes into account the unique circumstances of each state, rather than assuming a uniform policy environment.

This research compares the performance of Van Dha Self-Help Groups (VDSHGs) sanctioned to determine what factors lead to the program's success or failure in different regions. Very little research has been done in this area, which remains an unexplored territory for researchers (11). However, there is limited understanding of how the program is perceived and experienced by the

tribal communities it aims to serve and what factors influence their participation and success in the initiative (12). This research seeks to fill this gap by providing a comprehensive analysis of the program's performance across different states, emphasizing the outcomes achieved in relation to the inputs provided.

The research contributes to the following questions: RQ1: What are the key factors influencing the successful implementation of the Van Dhan Yojana in different states? RQ2: How does the government's support for Indigenous communities lead to measurable improvements in value creation, access to markets, and entrepreneurial growth? RQ3: What are the primary barriers to effective participation in the program, and how can these be overcome?

These questions fill a vacuum in the literature and align with the study's aims; they guide the research and add to the conversation about economic empowerment and sustainable development in India's tribal areas (2). This study uses DEA, which is known as a non-parametric method that is used in the decision-making process of the efficiency of decision-making units (DMUs) that convert inputs into outputs (13). DEA was chosen over parametric methods like SFA or Frontier Analysis because it does not require assumptions about functional form or error distribution, making it more suitable for evaluating multiple inputs and outputs in public programs like Van Dhan Yojana. To prove the VDY with the help of the DEA method, the researcher took the 22 states of India and treated them as DMUs (9).

This study intends to provide useful information by comparing the efficiency scores of different states, and this study aims to identify the VDY and offer valuable insights for policymakers and practitioners involved in the program (14). This research is beneficial and important to tribal communities (15). At all levels, this scheme benefits tribal communities. After getting a satisfactory result or feedback, the policymakers can easily examine the effect of the VDY weather. While examining, it is also clear how the government helps the various states' tribals in one place and makes the ideal role for visiting Bharat, which will change the thought process of other developing country governments. This study aims to improve the efficacy of sustainable development

initiatives worldwide by determining what elements contributed to the success of the VDY.

As the existing literature or the information on the ground level, it is clear that this scheme can be initiated by the Ministry of Tribal Affairs (MoTA). The main motive of establishing the VDY is to enhance the skills culture and promote the Minor Forest Products (MFPs) by approaching the ODOP, and this can help the tribal communities economically and also provide financial support by the government and NGOs (16). Rather, it has been seen that this scheme starts a new chapter in the life of the tribals so that they can clearly present their skills, abilities, and culture in front of the whole world and the government has given a new name to this thing which is called ODOP, and in today's time it has also been considered the main form of a developed India (17). Recent studies highlight that tribal entrepreneurship fosters socio-economic resilience by leveraging indigenous knowledge and local resources, enabling communities to transition from subsistence to market-oriented activities. The VDY intends to assist tribe members in bettering their lives in several ways, including expanding tribal people's access to markets, offering programs to increase their skills, providing financial assistance, and encouraging the value addition of MFPs (18). This review uses DEA to examine the VDY program's primary features, challenges, and workable solutions to assess the program's efficacy and utility for tribal development. Government interventions such as ODOP, MSP for Minor Forest Products, and skill development programs have been shown to reduce dependency on middlemen and enhance value addition, thereby improving income security for tribal households.

The Van Dhan Yojana: An Overview

To support tribal livelihoods and promote inclusive growth, the VDY is an important program in India's tribal development plan. Tribal communities have historically and systemically struggled with poverty, market isolation, and middleman exploitation; the program's effectiveness will depend on how well it tackles these issues (19). Key elements of the program include:

Mobilization: Creating Self-Help Groups (SHGs) is a key component of the VDY's strategy for mobilizing tribal communities. All three of these goals, collective action, skill development, and resource access, are significantly advanced by these SHGs (20).

Training: This scheme offers a training program on various aspects of Minor Forest product processing, handloom, handicraft, and marketing. In this, they learn a new form of innovation (21).

Equipment and Quality Assurance: The program makes it easier to provide SHGs and VPCs with the infrastructure, tools, and technology they need to function (22). It is also concerned with ensuring that MFP goods are certified, standardized, and have quality control to fulfill market demands.

Marketing and Branding: The VDY's primary focus is expanding tribal product exposure through the Tribes India e-Marketplace and creating brick-and-mortar and virtual retail stores (23).

Financial Support: This program contributes to SHGs, and VPCs receive funding from the initiative to help with marketing, training, infrastructure development, and capacity building. Funding in the form of grants, subsidies, and credit connections are all part of this package.

Infrastructure Development: It has been observed that in order to make the life of the tribal community easier, the government has established a Haat Bazaar, godowns, processing units, and warehouse transfer units in many places that are provided to the tribals. These small efforts by the government can motivate the tribal communities to self-develop, and this development can easily be converted into infrastructure in the form of marketing.

Convergence with other Schemes: Several schemes are established by the government. This scheme slightly changes the everyday life of the tribal communities so that their thinking, way of life, and understanding of power can change, and they can see the world in a new form and change their lifestyle. The VDY works in tandem with various other government initiatives, including the Pradhan Mantri Kisan Sampada Yojana, the Skill Development Program (ESDP), the Scheme for the Promotion of Units for Rural Industries (SFURTI), and the Minimum Support Price (MSP) scheme for MFPs. This coming together is a great way to collaborate on resources, information, and support for a more all-encompassing plan for tribe development (24). Empirical evidence suggests that integrated policy frameworks combining

entrepreneurship support, infrastructure development, and market access significantly accelerate the socio-economic growth of indigenous communities, aligning with global sustainable development goals.

Data Envelopment Analysis (DEA): A Tool for Assessing Efficiency

DEA, a non-parametric approach, is useful when comparing the relative efficacy of DMUs that take in and process data from various sources. Program, project, and organization performance evaluations that take a holistic view will be especially helpful (25). It is possible to use DEA within the framework of the VDY to:

Assess the Efficiency of VPCs: DEA can evaluate VPCs locally and nationally by looking at their inputs, such as capital invested, training received, and resources used, and outputs, things as the number of MFPs processed and marketed, the number of tribal households employed, and the increase in income generated (26).

Identify Best Practices: By analyzing their methods, DEA can determine which VPCs are the most efficient and what makes them so effective. Other VPCs can benefit from this data by making them more efficient.

Measure the Impact of Interventions: To determine how effective various interventions, such as training programs, financial aid, and infrastructure development, are in enhancing VPC efficiency, DEA can be utilized. Program design and resource allocation can be optimized with this knowledge (27).

Van Dhan Yojana and DEA Applications

As government efforts motivate the communities to move as a new entrepreneur, this research on the VDYs is very important for their validity and shows the impact on the communities. However, there are some areas are there where the importance of VDYs is studied, and they are as follows:

Impact of the VDY on Tribal Livelihoods: The impact of VDY is crucial to improving the lives of tribal people by boosting them through economic empowerment, promoting sustainable practices, and developing their communities. This government project will help tribal communities become independent business entities by focusing on skill development with new innovative ideas and adding value, which the tribal people nowadays apply, whereas these non-tribal communities have used the products (21). The main objective of the VDY is to make the Viksit Bharat in front of the entire world socially and economically.

The government helped the program, and it has helped indigenous communities to get access to the local and ODOP markets. With the help of ODOP, these communities create and get jobs and raise their earnings. Although these studies have demonstrated that the program does have some beneficial effects, they have also demonstrated that findings vary by location and that additional research is needed to ascertain the program's long-term sustainability. Regarding as the studies, the researcher has found several problems faced by the tribal communities while implementing the VDY (28).

Application of DEA in Tribal Development: The DEA research on rural areas is the root of India, and the tribals are the branches of India (29). To make this statement in mind, the government has started a new project for tribal development, and to know how this project shows the impact on tribal development, the researcher used the DEA method to evaluate the actual result and also explore how much input and output resources have been allocating by the government for making the Vikisit Bharat (30).

Applying DEA to the VDY

DEA is an excellent tool for evaluating the VDY's effectiveness; with this tool, the researcher and government can easily evaluate the impact on tribal communities. The inputs and outputs for DEA are meticulously chosen to capture the essential components of the program's implementation and its impact on tribal people in the context of evaluating the efficacy of the VDY across several states in India (31). The government's inputs are the time and money it invests in something, and the outputs are the actual results of that investment.

The goal of the study is to use DEA so researchers can evaluate VPC performance in different states, find out what works, and see how different approaches affect the program's overall efficiency (32). By analyzing current practices, we can find ways to make the VDYs even better at empowering tribal communities and allocating resources more wisely (33).

Methodology

DEA is a non-parametric technique that compares input and output by analyzing each state with decision-making units(DMU) (34). We have taken 22 such states of India where Tribals and ODOP have been mainly seen, and in these 22 states, the researcher will apply the given technique, DEA, and find out in which state the Van Dhan scheme is being implemented and from where we are getting its correct output (32).

Inputs and Outputs : For this analysis, we used five inputs and five outputs that we felt adequately reflected the VDY 's essential features:

Inputs

Estimated Number of Tribal Households Covered (Input 1): To prove how far this data has reached and how much truth is there in this data, the researcher has chosen a state where tribal communities have been found the most and the most important state is Madhya Pradesh (21.1%) where the tribal communities are known as the second largest state of the tribal community. This variable represents the tribal population benefiting from the program in each state, with Madhya Pradesh having the highest number at 201,232 households, while Goa has the lowest at 300.

Total Potential Outlay (Input 2): To start the VDY formally, the government chose such tribal communities where the population of tribals is high and after going there, keeping their needs in mind, they decided how much money or funds could give to the communities so they could use this fund for the startups as the entrepreneur and this can help tribals to improve their skills and this VDY's can help to change their lifestyle (35). This input measures the state's allocated financial resources for the program, with Chhattisgarh having the highest outlay at 186.19 crores and Sikkim with the lowest at 0.73 crores.

Total fund Released (Input 3): Based on the Total Potential Expenditure (Input 2) and Tribal Household (Input 1), this input shows the actual funds allocated by the central government. The total fund released is a key indicator of the government's financial commitment to the program and explores its seriousness. This represents the funds disbursed by the central government to the states, with Chhattisgarh again leading at 163.56 crores and Sikkim at the lower end with 44.5 crores.

Sanctioned VDSHGs (Input 4): Based on the tribal population, this input represents the number of tribal populations Van Dhan Self-Help Groups (VDSHGs) sanctioned by the government based on the tribal population in each state. These VDSHGs are very important for the DEA because they directly impact the program's ability to organize and mobilize tribal communities for participation in the VDY (36). This input reflects the number of VDSHGs sanctioned based on the tribal population, with Rajasthan having the highest number of sanctioned groups at 7,322 and Uttarakhand the lowest at 180.

Formed Self-Help Groups (Input 5): The tribal population (Input 1) and the sanctioned VDSHGs (Input 4) are the sources of this input. Self-help groups (SHGs) are essential to the program's success, and this reflects the government's attempts to establish them among the tribal community. Tribal communities gain agency through SHG formation since it gives them a framework to participate in economic activities and reap the benefits of program initiatives. This measures the number of SHGs formed, with Andhra Pradesh forming the most at 6,225 groups, while Goa has the least at 150.

Outputs

Arranging and Packing of Tribal Products (Output 1): These outputs are the number of VDVKs set up by the government to train the tribal Self-Help Groups (SHGs) in packaging the forest products, which is measured as output (37). The development of VDVKs directly comes from the inputs, and it is is an important measure of the program's success, where the government can empower tribal communities through training and expanding their access to markets (38). This output tracks the number of VDVKs established for packaging forest products, with Odisha having the highest number at 156 and Uttar Pradesh the lowest at 5.

MSP for Minor Forest Products (Output 2): This output reflects the government's sourcing and efforts to ensure fair prices for the tribal community's forest products (39). By setting a normal price for MFPs, the non-tribal communities also purchase MFPs, which should benefit the tribal communities (40). With the product's regular price, the government wants to advertise the MFPs through word of mouth, and for marketing, the price should be regular so everyone

can make sure to use the MFPs. This output reflects the amount spent on Minimum Support Price for MFP, with Odisha leading at 46.21 crores and Sikkim at the lower end with 0.05 crores.

Availability of Marketplaces (Output 3): This output helps measure and set up marketplaces (Haats), warehouses, and the niche market and tries to sell the tribal products. Maintaining this kind of infrastructure to make effective marketing and distribution of products is very tough or critical, thus supporting the economic empowerment of tribal communities (4). This measures the availability of local marketplaces like Haats/Warehouses, with Madhya Pradesh having the most at 26.8 and Telangana having the least at 0.05.

Number of Tribal Entrepreneurs Developed (Output 4): This output shows how many tribal entrepreneurs have used the advantage of the VDY. With this output, it can also be measured that with these schemes, the livelihood of the tribal entrepreneurs can be changed, and they all are economically independent and maintain a special kind of status in front of the world as this shows how Bharat is Viksit (Developed) and the branches of India can make this a make in India (41). This output tracks the number of tribal entrepreneurs developed, with Chhattisgarh at the top with 41,700 entrepreneurs and Goa at the bottom with 300.

Profit Sharing by States (Output 5): This result shows how much of the proceeds from the sale of tribal items and the program's implementation should be stored or kept by the state. The program can be funded eventually, where both the state and the Indigenous communities have benefited economically. This measures the profit-sharing portion retained by the states, with Odisha having the highest share at 27.05% and Tamil Nadu the lowest at 0.1%.

Data Envelopment Analysis Program (DEAP)

Using DEAP software, the efficiency scores for each state are calculated by comparing the weighted sum of outputs to the weighted sum of inputs. The model identified the most efficient states, which served as benchmarks for others (42). The efficiency of each state is then determined by its ability to maximize outputs while minimizing inputs relative to these benchmarks (43). States such as Chhattisgarh, Madhya Pradesh, and Odisha,

which consistently exhibited high values across inputs and outputs, are expected to be among the most efficient. Two states, Goa and Sikkim, show lower input and output values and are less efficient. With the help of these experimental techniques, the researcher can identify the most efficient states in implementing the VDY but also find the less efficient states.

Data Collection Process

Government Websites

To collect statistical data, we have mainly taken the help of many such websites of the Ministry of Rural Development and Tribal Ministry Affairs Government, and other government bodies are there where we get to know in which states and to how many tribals the VDY is given to the communities. From government websites, the researchers also get each state's financial allocation and other data determinants. These data consist of the tribal household, total potential outlay, and total funds. These websites also give information regarding the sanctioned Van VDSHGs and the formation of Self-Help Groups in each state from these platforms.

Published Newsletters and Reports

The Program execution is detailed in government newsletters and annual reports, which provide supplementary information on the Van Dhan Vikas Kendras (VDVKs), the procurement processes under the Minimum Support Price (MSP) scheme for Minor Forest Products (MFP), and the development of market infrastructure like Haats and Warehouses.

Cross-verification

To make data very accurate, data is cross-verified using different government websites to ensure it is accurate and reliable. For example, to validate the consistency, the data about budgetary allocations are compared with both the published records of the Ministry of Finance and reports particular to each state (44, 45).

Handling Missing Values

The data-collecting method is meticulous, yet there are four cases where some variables or states do not have values. Incorrect handling of missing data can invalidate the DEA analysis (32).

Imputation Using Averages

As a straightforward and known imputation method, we employ averages to preserve the dataset's integrity and comparability. We averaged the related variable across all other states where

data is available for each missing value. When some data points are missing, this average value is utilized to complete the set.

The Rationale for Using Averages

We decided to use averages to keep things uniform throughout the dataset and prevent bias. A fair method that does not unfairly benefit or hurt any state is to use averages to fill in missing numbers (46). This approach works well when a few missing values do not constitute a significant fraction of the dataset; this is true for our investigation. The use of average imputation is carefully considered to ensure that it does not significantly distort the results of the DEA (47).

Results

The DEA analysis shows that several states are performing efficiently, with many achieving perfect deficiency scores both under constant return to scale and variable return to scale (48). However, a few states, such as Chhattisgarh, Orissa, Andhra Pradesh, Rajasthan, and Tripura, are among the inefficient ones. Table 1 indicates the results that can further be utilized to enhance the performance and improve the effectiveness of the VDY in these regions.

Table 1: Result of DEAP

Name of the state	Firm	CRSTE	VRTSE	scale
Madhya Pradesh	1	1	1	-
Jharkhand	1	1	1	-
Chhattisgarh	0.789	1	0.789	DRS
Odisha	0.923	1	0.923	DRS
Manipur	1	1	1	-
Maharashtra	1	1	1	-
Gujarat	1	1	1	-
Andhra Pradesh	0.785	0.913	0.86	DRS
Tamil Nadu	1	1	1	-
Karnataka	1	1	1	-
Rajasthan	0.938	1	0.938	DRS
West Bengal	1	1	1	-
Tripura	0.922	0.976	0.945	IRS
Uttar Pradesh	1	1	1	-
Kerala	1	1	1	-
Telangana	1	1	1	-
Mizoram	1	1	1	-
Sikkim	1	1	1	-
Uttarakhand	1	1	1	-
Goa	1	1	1	-
Bihar	1	1	1	-
Nagaland	1	1	1	-

CRSTE: Constant Return to Scale model, VRTSE: Variable Return to Scale model, DRS: decreasing return to scale, IRS: Increasing return to scale.

The Constant Returns to Scale Technical Efficiency (CRSTE) major's technical efficiency indicates that an increase in input may be constant concerning output for the states (49). Meanwhile, the Variable Returns to Scale Technical Efficiency (VRTSE) assumes variable returns of output concerning changes in input values. Scale efficiency indicates the ratio of CRSTE to VRTSE (50).

Analysis of Results

Full Efficiency (Value of 1.000)

The following states are considered fully efficient under all tested conditions: Madhya Pradesh, Jharkhand, Manipur, Maharashtra, Gujarat, Tamil Nadu, Karnataka, West Bengal, Uttar Pradesh, Kerala, Telangana, Mizoram, Sikkim, Uttarakhand, Goa, Bihar, and Nagaland.

Analyzing the Non-Efficient States

With the help of performance, the efficiency results for a few states are babbled out. To make things clear, the researcher revealed the result of Chhattisgarh, which has a CRSTE of 0.789, a VRTSE of 1.000, and a scaling efficiency of 0.789. These results indicate the inefficiencies in scaling the operations, whereas Odisha displays a CRSTE of 0.923, a VRTSE of 1.000, and a scaling efficiency of 0.923. This value suggests that the scaling has inefficiencies. Andhra Pradesh shows a CRSTE of 0.785, a VRTSE of 0.913, and a scale efficiency of 0.860, reflecting inefficiencies in both returns to

scale and scaling operations. In contrast, Rajasthan achieves a CRSTE of 0.938, a VRTSE of 1.000, and a scale efficiency of 0.938, demonstrating some inefficiencies in scaling but relatively better performance compared to Chhattisgarh and Odisha, indicating inefficiencies under both returns to scale and scaling operations, although it operates slightly better than Andhra Pradesh in terms of variable returns to scale.

Mean Efficiency

The mean values indicate overall performance across all states. Mean CRSTE: 0.971, Mean VRTSE: 0.995, and Mean Scale Efficiency: 0.975. The mean CRSTE and VRTSE values close to 1.000 suggest that, on average, states are efficient in terms of technical efficiency. The mean scale efficiency of 0.975 suggests that, on average, there is some room for improvement in how states scale their operations.

Slack Analysis

Slack analysis consists of both quantitative metrics and qualitative sentiment evaluation. This analysis is very important for an organization that wants to make collaboration between optimization and communication through the platform (31). With the help of slack analysis, businesses or organizations may improve and enhance the productivity of any result (51). For output slacks, most states display zero values, which suggests that they are functioning at peak efficiency and not producing anymore (52).

Output Slacks

There are two states in India where output slacks have been seen namely Andhra Pradesh and Tripura and these output selects show that despite the output there, it is not able to improve their overall efficiency.

Table 2: Result of Output Slack

Output Slack	Output 1	Output 2	Output 3	Output 4	Output 5
Andhra Pradesh	11.499	1.793	3.462	0	0
Tripura	0	0	0.283	0	0

The analysis of data shown in Table 2 indicates that Andhra Pradesh lacks output slacks in several categories, whereas Tripura has a minor slack in a specific area.

Input Slacks

As far as the result is concerned, many states show no input slacks, which means they are using their

resources efficiently. Hence, Andhra Pradesh and Tripura are two examples of states with highly significant inefficiency; they have large input slacks, meaning they may reduce their inputs without seeing impairment in output.

Table 3: Result of Input Slack

Input Slack	Input 1	Input 2	Input 3	Input 4	Input 5
Andhra Pradesh	0	0	0	3888.079	0
Tripura	0	0	0	0	41.505

The resource shortage and slack value shoen in Table 3 highlight an opportunity for optimization where output and input positively boost the overall performance.

Discussion

Variability in tribal demographics, institutional capability, and implementation settings should be considered when interpreting his findings of efficiency score variances between states. Rather than problems with program intention, states that show scale inefficiencies typically deal with systemic issues including scattered tribal communities, inadequate infrastructure, and less market integration. On the flip side, states that are fully efficient tend to have more effective

integration with ODOP and MSP processes, higher levels of commercialization of MFP, and stronger institutional convergence. It is crucial to establish diverse, state-tailored implementation strategies, as these data confirm that efficiency outcomes under Van Dhan Yojana are context-specific.

According to the findings, there is potential for considerable improvement in scaling and using resources. Clearly, the number of states is doing exceptionally well in terms of technological efficiency. To boost Van Dhan Yojana's overall performance more efficiently, it is essential to address the inefficiencies and optimize input and output resources.

Scale Inefficiency

Based on ground research or data, the states' abilities are in control when they optimize their operations at different levels of scale inefficiency. Odisha and Chhattisgarh are the two states of India where poor scaling inefficiencies are indicated by high CRSTE and VRTSE values. Scale inefficiencies become apparent in states such as Odisha and Chhattisgarh, where poor scaling procedures are indicated by high CRSTE and VRTSE values. The states of Odisha (CRSTE=0.923, scale efficiency=0.923) and Chhattisgarh (CRSTE=0.789, scale efficiency=0.789) struggle to scale their activities efficiently. Andhra Pradesh's CRSTE of 0.785, VRTSE of 0.913, and scale efficiency of 0.860 all point to inefficiency in returns to scale and scaling. With a CRSTE of 0.922 and a scaling efficiency of 0.945, Tripura does somewhat better than Andhra Pradesh when it comes to scaling activities. However, Rajasthan and Tripura also exhibit some scale inefficiencies.

Mean Efficiency

In broad terms, technological efficiency is quite high, depending on the mean efficiency scores among states. The states are doing quite well in terms of technical efficiency, with an average CRSTE of 0.971 and a mean VRTSE of 0.995. There is potential for improvement in scaling activities, as indicated by the mean scale efficiency of 0.975. While states do a decent job running their operations on the whole, there is still an opportunity for improvement when it comes to scaling up their efforts.

Slack Analysis

When it comes to optimizing resource usage and business processes, Slack analysis is invaluable. A lack of excess output indicates that most states are running efficiently, as most have zero output slacks. Nevertheless, there is a noticeable production shortage in Andhra Pradesh across all categories, whereas Tripura shows a slight lack of production in just one category (51). Andhra Pradesh's notable slack in Input 4 (3888.079) highlights substantial inefficiencies, indicating that the state could reduce its input levels without impacting output. Tripura's slack in Input 5 (41.505) similarly suggests opportunities for resource optimization.

Implications

Policy Implications

Adopt state-specific resource allocation strategies to minimize input slacks and improve scale efficiency, ensuring optimal utilization of funds and infrastructure.

Institutionalize best practices from benchmark states to strengthen convergence with ODOP and MSP schemes, enhancing government operational efficiency and tribal market integration.

Managerial Implications

Resource Optimization

The study results can be used to emphasize the appropriate allocation and use of resources, particularly in those states, i.e., Andhra Pradesh and Tripura, which have high input and output gaps. Identifying and eliminating inefficiencies is the main purpose of allocating resources, as far as a manager is concerned (53). For some organizations, this will require innovative technology to streamline processes, refine existing purchasing methods, or modernize with improved inventory management practices (54). Both managers can reduce excessive input levels and output where deficiencies are noted to enhance the operational efficiency and effectiveness of the site and program.

Scaling Operations

The scale inefficiency displayed by states such as Odisha and Chhattisgarh suggests they are not efficiently using their inputs to raise operations. To fix these inefficiencies, management has to spend capital on scalable infrastructure, implement the best practices for scaling their operations, and train their employees specific to their job functions (25). Technology, workflow processes, and proper site alignment with state operating significance can help improve scalability. With better scaling efficiency, these states can produce more output relative to the total resources used.

Academic Implications

Enhanced Understanding of DEA in Public Programs

This study enriches the academic understanding of how DEA can be applied to evaluate the efficiency of public programs (55). By demonstrating the application of DEA in assessing technical, scale, and resource efficiency within the Van Dhan Yojana, the study provides a valuable case for using DEA in similar contexts (56). This contributes to the broader literature on DEA by showcasing its

effectiveness in evaluating complex public programs and offering insights into the nuances of program performance (57, 58).

Identification of Efficiency Patterns

The study's results reveal distinct patterns of efficiency and inefficiency across different states, contributing to the academic discourse on performance metrics in development programs. Identifying these patterns helps understand the underlying factors contributing to performance variations. Researchers can leverage these insights to explore how different variables, such as scale of operations, resource allocation, and program design, impact the success of public initiatives. This deepens the theoretical framework for analyzing public program performance and offers a foundation for further research.

Limitations and Future Directions

This study offers significant insights into the efficiency of the Van Dhan Yojana across various states, yet it is not without limitations that could affect the interpretation and generalizability of the findings. One notable limitation is the reliance on secondary data, which may introduce inaccuracies or inconsistencies in reporting. Variations in data collection methods, reporting standards, and completeness across states could impact the accuracy of the efficiency results. For instance, discrepancies in reported figures might skew the DEA results and influence the perceived efficiency of the program. Additionally, the study's scope is constrained by the limited number of inputs and outputs, potentially overlooking other critical factors such as socio-economic conditions, local administrative efficiency, and community engagement. These omitted variables could significantly determine the program's success and its broader implications. The study's reliance on data from a specific period also limits its ability to capture Van Dhan Yojana's dynamic implementation. Changes in economic conditions, policy interventions, or program dynamics over time might affect the program's effectiveness, making the findings less applicable to current or future contexts.

Only 22 states were analyzed because comprehensive data for all 28 states and 8 Union Territories was not available on government portals. The exclusion of Union Territories is unlikely to affect the findings significantly, as their tribal population, investment under Van Dhan

Yojana, and business volume are minimal compared to the selected states. Integrating qualitative research methods, such as interviews and focus groups with stakeholders, would complement quantitative findings and offer deeper insights into the challenges and successes of the program. Understanding the experiences and perceptions of beneficiaries, local administrators, and policymakers could uncover factors affecting program efficiency that are not captured in quantitative analysis. Comparative studies involving similar development programs in different regions or countries could provide valuable lessons and identify best practices for improving program outcomes. Additionally, exploring the impact of specific policy interventions and administrative practices on program efficiency could inform more effective and context-specific strategies. Incorporating external factors, such as market conditions and political stability, into the efficiency analysis would provide a more comprehensive understanding of the factors influencing program performance and enhance the robustness of the findings.

Conclusion

The study provides a valuable assessment of Van Dhan Yojana's efficiency, highlighting areas of both strength and weakness across various states. The analysis reveals that while states perform relatively well regarding technical efficiency on average, there is room for improvement in scaling operations and resource utilization. The slack analysis identifies significant inefficiencies in states like Andhra Pradesh and Tripura, suggesting opportunities for optimization that could enhance overall program performance. Despite the study's contributions, its limitations underscore the need for further research to address data constraints, expand the scope of analysis, and incorporate qualitative insights. By addressing these limitations and pursuing the recommended future research directions, stakeholders can work towards more effective and impactful implementation of the Van Dhan Yojana, ultimately advancing the socio-economic development of tribal communities.

Abbreviations

DEA: Data Envelopment Analysis, MFP: Minor Forest Products, MSP: Minimum Support Price, ODOP: One District One Product, TRIFED: Tribal

Cooperative Marketing Development Federation of India, VDSHGs: Van Dhan Self-Help Groups, VDVKs: Van Dhan Vikas Kendras, VDY: Van Dhan Yojana.

Acknowledgement

Author Contributions

Neetu Mishra: conceptualization, literature review, data collection, data analysis, writing original draft, Astha Joshi: review of the manuscript, supervision, intellectual inputs, Anil Vashisht: critical revision of the manuscript, Neelesh Kumar Mishra: methodology design, data validation, statistical analysis, final approval of the manuscript, Swapnil Shaoo: addressing reviewer comments, refining the manuscript. All authors reviewed and approved the final version of the paper.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Declaration of Artificial Intelligence (AI) Assistance

No AI tool was used for data generation, data analysis, interpretation, or drawing scientific conclusions. The authors take full responsibility for the content of this manuscript.

Ethics Approval

This study did not require formal ethics approval as it involved no experiments on humans or animals. Participation was voluntary, and informed consent was obtained from all respondents**.**

Funding

References

1. Jnanesha AC, Kumar SR, Venugopal S, *et al*. Nutrient-feeding strategy promotes the growth, biomass, and quality of genotype/variety CIM Megha of Kalmegh. Ecological Genetics and Genomics. 2024; 32:100275.
2. Romabai W, Pamei T, Manikho PF, Nevidita L, Panmei R. Assessment of economically important tree-based NTFPs in Indo-Burma region, Manipur, India. Forests, Trees and Livelihoods. 2023 Jan 2;32(1):1–11.
3. Das M, Mukherjee D. Cosmopolitanism, Materialism, Consumer Ethnocentrism and Consumer Behaviour: Evidence from Aboriginal Tripuri Tribe of India. IIM Kozhikode Society & Management Review. 2019;8(2):104–19.
4. Vaidya OS, Kumar S. Multi-criteria Performance Evaluation Framework for Rehabilitation Service Operations. Global Business Review. 2021;22(6): 1490–506.
5. Mahalwal S, Kabra A. Indigenous knowledge and sustainability concerns in an era of climate change: the Sahariya Adivasi and salai trees (*Boswellia serrata*) in central India. Forests, Trees and Livelihoods. 2023 2;32(1):26–41.
6. Sandhiya E, Gajanand MS. Context-Dependent evaluation of electric vehicles and charging infrastructure in an emerging economy. Transportation Research Part D: Transport and Environment. 2024;137:104490.
7. Dunn D. Gender inequality in education and employment in the scheduled castes and tribes of India. Popul Res Policy Rev. 1993;12(1):53–70.
8. Bhattacharjee S, Sarkar I, Sen G, Ghosh C, Sen A. Biochemical and Metagenomic sketching of microbial populations in the starter culture of 'Chokot', a rice-based fermented liquor of Rabha Tribe in North Bengal, India. Ecological Genetics and Genomics . 2023;29:100193.
9. Yadava AK, Neog Y. Public Sector Performance and Efficiency Assessment of Indian States. Global Business Review. 2022;23(2):493–511.
10. Tran TMA, Gagnon VS, Schelly C. A review of traditional ecological knowledge in resilient livelihoods and forest ecosystems: lessons for restoration sciences and practices. Forests, Trees and Livelihoods. 2024; 9:1–27.
11. Smith HE, Eigenbrod F, Kafumbata D, Hudson MD, Schreckenberg K. Criminals by necessity: the risky life of charcoal transporters in Malawi. Forests, Trees and Livelihoods. 2015;24(4):259–74.
12. Lakhani KG, Suthar K, Singh D, Jha S, Patil H, Niyaria R. Cross transferability of finger millet SSR markers to little millet (Panicum sumatrense Roth. Ex Roem & Schult.). Ecological Genetics and Genomics . 2024;32:100281.
13. Mishra NK, Chakraborty A, Singh S, Ranjan P. Efficiency analysis of engineering colleges in India: Decomposition into parallel sub-processes systems. Socio-Economic Planning Sciences. 2023;89:101708.
14. Panigrahi R. Evaluating Level Efficiency Versus Growth Efficiency in the Indian Automobile Industry in a Non-parametric DEA Approach. Global Business Review. 2021;22(4):963–76.
15. Arsha K, Vishnu B, Siril EA. Utilization of Start Codon Targeted (SCoT) Markers for the Evaluation of Population Structure and Genetic Variability in Persicaria glabra (Willd.) M. Gomez. Ecological Genetics and Genomics . 2025;34:100333.
16. Das U, Behera B. Forest Dwellers' livelihoods and attitudes towards relocation: insights from Buxa Tiger Reserve, India. Forests, Trees and Livelihoods. 2023 3;32(3):144–66.
17. Balasubramanian K, Dwivedi P. Using mental model approach for ascertaining socio-cultural perceptions

of forest-based ecosystem services among female forest landowners in Georgia, United States. Forests, Trees and Livelihoods. 2024 2;33(2):135–57.

18. Mishra N, Joshi A, Vashisht A, Mishra NK. Development of Entrepreneurship Among Indigenous Communities in Central India: An Analysis of Challenges and Outcomes Abstract. International Journal of Rural Management. 2025 Dec;21(3):311-32.

19. Banerjee AK, Mishra NK, Mishra N, Klein T, Sensoy A. Gaining ground or losing foothold: Game-theoretic lens to unveil strategic bargaining between oil exporters and importers. International Review of Financial Analysis. 2025 Nov 21:104802. doi: 10.1016/j.irfa.2025.104802

20. Mathur I, Bhattacharya P. Perception of agroforestry practices and factors influencing adoption among shifting cultivators in Tripura, India. Forests, Trees and Livelihoods. 2024 2;33(1):23–41.

21. Dohale V, Ambilkar P, Mangla SK, Narkhede BE. Critical factors to sustaileanant innovations for net-zero achievement in the manufacturing supply chains. Journal of Cleaner Production. 2024;455:142295.

22. Mishra NK, Raj A, Jeyaraj A, Gupta R. Antecedents and Outcomes of Blockchain Technology Adoption: Meta-Analysis. Journal of Computer Information Systems. 2024 3;64(3):342–59.

23. Joshi A, Nema G. Store promotion techniques creating brand image of FMCG in India. Asian Journal of Management . 2017;8(3):873–80.

24. Sharma S, Jaisinghani D, Joshi M, Goyal J, Aggarwal A. Persistence of financial efficiency in tourism and hospitality firms. Journal of Tourism Research. 2022;24(1):158–68.

25. Mishra NK, Pande Sharma P, Chaudhary SK. Redefining agile supply chain practices in the disruptive era: a case study identifying vital dimensions and factors. Journal of global operations and strategic sourcing. 2025 Feb 5;18(1):64-90.

26. Al-Jamimi HA, Binmakhashen GM. A Scientometric Analysis of Multiobjective Optimization Research. Journal of Scientometric Research . 2022;11(1):15–29.

27. Arana-Barbier PJ. The relationship between scientific production and economic growth through R&D investment: A bibliometric approach. Journal of Scientometric Research . 2023;12(3):596–602.

28. Dhanshyam M, Srivastava SK. Decision Framework for Efficient Risk Mitigation in BOT Highway Infrastructure Service Projects. J Constr Eng Manage. 2023;149(9):04023081.

29. Arabmaldar A, Sahoo BK, Ghiyasi M. A generalized robust data envelopment analysis model based on directional distance function. European Journal of Operational Research. 2023;311(2):617–32.

30. Goli RC, Sukhija N, Rathi P, *et al*. Unraveling the genetic tapestry of Indian chicken: a comprehensive study of molecular variations and diversity. Ecological Genetics and Genomics. 2024 Mar 1;30:100220.

31. Jindal A, Nilakantan R. Falling efficiency levels of Indian coal-fired power plants: A slacks-based analysis. Energy Economics. 2021;93:105022.

32. Srivastava SK, Narkhede BE, Raut RD, Mishra NK. Examination of adoption barriers of digitalization of

33. maritime logistics: a DEMATEL approach. Journal of Modelling in Management. 2025 Dec 19:1-26. doi: 10.1108/JM2-06-2025-0259

34. Dhillon AS, Vachharajani H. Productivity Analysis of Coal-fired Thermal Power Plants in India Using Malmquist Index Approach. Global Business Review. 2020;21(6):1338–53.

35. Dutta A, Sengupta PP. Efficiency Measurement of Indian Life Insurance Industry in Post-Reforms Era. Global Business Review. 2011;12(3):415–30.

36. Sahoo NR, Mohapatra PKJ, Sahoo BK, Mahanty B. Rationality of energy efficiency improvement targets under the PAT scheme in India – A case of thermal power plants. Energy Economics. 2017;66:279–89.

37. Mehdiloozad M, Zhu J, Sahoo BK. Identification of congestion in data envelopment analysis under the occurrence of multiple projections: A reliable method capable of dealing with negative data. European Journal of Operational Research. 2018;265(2):644–54.

38. Pal V, Sharma V, Gour VS. *Ailanthus excelsa* Roxb. in India: A multipurpose "tree of Heaven" for semi-arid regions. Forests, Trees and Livelihoods. 2023 2;32(4):268–83.

39. Patyal VS, Kumar R, Lamba K, Maheshwari S. Performance evaluation of Indian electricity distribution companies: An integrated DEA-IRP-TOPSIS approach. Energy Economics. 2023;124: 106796.

40. Chand S, Behera B. Does secured forest land tenure enhance forest dwellers' food security? Empirical evidence from West Bengal, India. Forests, Trees and Livelihoods. 2023 3;32(3):125–43.

41. Mishra N, Vashisht A, Raghuwanshi S. Transforming Indian agriculture: unleashing the potential of digital agriculture using efficiency analysis. Digital agricultural ecosystem: revolutionary advancements in agriculture. 2024 Apr 25:123-43. doi: 10.9734/ajaees/2021/v39i630596

42. Kokate LS, Kumar S, Das AK, Rahim A, Debnath J. Investigation of post-immunization immune response gene expression kinetics in lymphoid tissues of White Leghorn and Indian native chicken. Ecological Genetics and Genomics . 2024;31:100251.

43. Debasish SS. Efficiency Performance in Indian Banking—Use of Data Envelopment Analysis. Global Business Review. 2006;7(2):325–33.

44. Singh S, Solkhe A, Gautam P. What do we know about employee productivity?: Insights from bibliometric analysis. Journal of Scientometric Research. 2022;11(2):183–98.

45. Preeti, Roy S. Application of hybrid approach in banking system: An undesirable operational performance modelling. Global Business Review. 2025 Jun;26(3):684-706.

46. Rakshit B. Evaluating Profitability and Marketability Efficiency: A Case of Indian Commercial Banks. Global Business Review. 2021;22(4):977–95.

47. Saxena M, Chotia V, Rao NVM. Estimating the Efficiency of Public Infrastructure Investment: A State-wise Analysis. Global Business Review. 2018;19(4):1037–49.

48. Jain RK, Natarajan R, Ghosh A. Decision Tree Analysis for Selection of Factors in DEA: An Application to Banks in India. Global Business Review. 2016;17(5):1162–78.

48. Sahoo BK, Khoveyni M, Eslami R, Chaudhury P. Returns to scale and most productive scale size in DEA with negative data. European Journal of Operational Research. 2016;255(2):545–58.

49. Shetty A, Basri S. Assessing the Technical Efficiency of Traditional and Corporate Agents in Indian Life Insurance Industry: Slack-based Data Envelopment Analysis Approach. Global Business Review. 2020;21(2):490–506.

50. Mishra NK, Raj A, Mukherjee I, Chakraborty A. Blockchain adoption in the supply chain management based on technology–organization–environment framework: evidence from developing and developed economies. Journal of Business & Industrial Marketing. 2025 Apr 10;40(3):815-32.

51. Nandy A, Singh PK, Singh AK. Systematic Review and Meta- regression Analysis of Technical Efficiency of Agricultural Production Systems. Global Business Review. 2021;22(2):396–421.

52. Haider S, Danish MS, Sharma R. Assessing energy efficiency of Indian paper industry and influencing factors: A slack-based firm-level analysis. Energy Economics. 2019;81:454–64.

53. Mishra NK, Sahoo S, Agarwal S, Sharma PP, Ilahi F. Impact of institutional pressures and security on blockchain technology adoption and organization performance: an empirical study. J Technol Transf . 2024; 50(1): 245-270

54. Herrera-Vallejera D, Gorbea-Portal S. Technology Foresight Index to Support Science and Technology Policy-Making in the Field of Pharmacology/ Pharmacy: A Scientometric Analysis. Journal of Scientometric Research . 2024;13(1):137–47.

55. Mehdiloozad M, Mirdehghan SM, Sahoo BK, Roshdi I. On the identification of the global reference set in data envelopment analysis. European Journal of Operational Research. 2015;245(3):779–88.

56. Shankar U, Kaul V, Gupta V, Mishra NK. Workplace ostracism and counterproductive work behaviour: parallel mediation of felt accountability and emotional exhaustion. Journal of Management Development. 2024 Nov 26;43(6):849-62.

57. Ray SC, Das A. Distribution of cost and profit efficiency: Evidence from Indian banking. European Journal of Operational Research. 2010;201(1):297–307.

58. Chhatoi BP, Sahoo SP, Nayak DP. Assessing the academic journey of'Financial Inclusion'from 2000 to 2020 through bibliometric analysis. Journal of Scientometric Research. 2021;10(2):148–59.