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Science Museums as Inclusive Learning Spaces: Understanding Visitors' Diversity and Participation Pattern

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Abstract

This study examines science museums as inclusive learning environments by analysing visitor diversity and participation patterns based on primary data collected from 3000 respondents across major science museums in India. The primary objective of the study is to know that, who visits science museums in India. The findings reveal that science museums predominantly attract young adults aged 18–34 (approximately 59%), with a strong representation of students (41.8%) and highly educated individuals (over 87% holding undergraduate or higher degrees). Despite their role as informal learning spaces, participation reflects socio-demographic imbalances, including gender disparity (69% male) and urban dominance (52%). Museum visitation patterns indicate high awareness but moderate frequency, suggesting that museums are not yet habitual leisure destinations. Visitor perceptions highlight multilingual exhibits (21.3%), educational programs (17.9%), and age-specific engagement (14.8%) as key drivers of attractiveness. The study concludes that while science museums serve as effective informal educational platforms, they require targeted strategies to enhance inclusivity across gender, socio-economic, and geographic dimensions.

Keywords: Science museums, inclusivity, visitor diversity, informal learning, participation patterns, perception of attractiveness, accessible infrastructure.

1. Introduction

Science museums have evolved into dynamic centres of informal learning, integrating education, engagement, and public participation. In contemporary society, these institutions play a vital role in promoting scientific literacy and experiential knowledge beyond formal educational settings. In India, national-level science museums function as hubs for science communication and public engagement; however, their inclusivity remains a subject of critical inquiry.

Inclusivity in museum contexts extends beyond physical accessibility to encompass equitable representation and participation across demographic, socio-economic, and cultural groups. Understanding visitor diversity and participation patterns is essential to evaluate whether science museums function as democratic knowledge spaces. This study investigates who visits science museums, how frequently they engage, and what factors influence their participation, thereby assessing their inclusivity as learning environments.

2. Review of Literature

Museums are widely recognized as informal learning environments that foster self-directed and experiential learning (Hein, 1998; Falk & Dierking, 2016). Research suggests that visitor engagement is significantly influenced by demographic characteristics such as age, education, and socio-economic status. Science museums, in particular, have been identified as spaces that combine cognitive learning with experiential interaction.

Studies on museum inclusivity highlight persistent inequalities in access and participation. Hooper-Greenhill (2007) emphasizes that museums often attract educated and urban populations, thereby limiting outreach to marginalized communities. Similarly, Falk and Dierking (2016) argue that visitor experience is shaped by personal, sociocultural, and physical contexts.

Interactive exhibits and educational programming have been identified as key factors influencing visitor satisfaction and learning outcomes (Pine & Gilmore, 1999). However, empirical studies examining inclusivity in the Indian science museum context remain limited. This study contributes by providing data-driven insights into visitor diversity and participation patterns.

3. Methodology

The study was conducted through site visit to five major science museums under National Council of Science Museums in India. These five science museums have been selected due to the nature of representation of diverse category of visitors. The five science museums are as follows

1. Visvesvaraya Industrial and Technological Museum (VITM), Bengaluru.
2. Birla Industrial and Technological Museum (BITM), Kolkata.
3. National Science Centre (NSC), Delhi.
4. Nehru Science Centre (NSC), Mumbai.
5. Regional Science Centre (RSC), Tirupati.

3.1 Research Design

The study adopts a quantitative research design using primary data collected through a structured questionnaire. The questionnaire utilized the blend of open-ended, close-ended and Likert scales questions to assess visitor diversity and visiting preferences.

3.2 Sample and Data Collection

Primary data was collected through a structured questionnaire administered to 3000 visitors selected via Simple Random sampling to record their responses on socio-demographic and other details. Descriptive Statistics and Inferential Statistics methods were used to analyse the data. Data Cleaning and elimination of incomplete questionnaires was done rigorously.

- Sample size: 3000 respondents
- Location: Five science museums in India
- Sampling context: Visitors at national-level and regional level science museums

3.3 Data Analysis

Descriptive statistics, frequency distributions, and cross-tabulations were used to analyse the data:

- Demographic characteristics
- Socio-economic profiles
- Visitation patterns
- Perceptions of attractiveness

4. Results

The demographic profile of 3000 respondents provides the structural foundation for interpreting who visits the science museums and what are the patterns of visitation. The data evidently tells about diversity of visitors to science museums in India. It can also be observed that the trend is inclusive or exclusive to particular segment of visitors.

4.1 Age Distribution

The mean age of 3.11 (SD = 1.34) on a coded seven-point scale (see Table 4.5) suggests concentration within young-adult cohorts, especially between 18–24 years (36.9 %) and 25–34 years (22.2 %) (see Table 4.1). Together these groups account for almost 59 % of the sample, revealing that the science-museum audience are predominantly youthful and by implication digitally literate and academically exposed. This concentration underscores the growing role of museums as informal learning spaces for higher-education students and early-career professionals seeking experiential enrichment beyond classroom boundaries and increasing interest in learning about science and technical aspects.

Table 4.1: Age Distribution of the Respondents

Age of the Respondents (N=3000)			
Age Group	**Frequency**	**Percentage**	**Cumulative Percentage**
Under 18	168	5.6	5.6
18-24	1107	36.9	42.5

25-34	666	22.2	64.7
35-44	549	18.3	83.0
45-54	342	11.4	94.4
55-64	138	4.6	99.0
65 and above	30	1.0	100.0
Total	**3000**	**100**	

Source – primary data

The findings indicate that science museums predominantly attract young adults:

- 18–24 years: 36.9%
- 25–34 years: 22.2%
- Total (18–34): ~59%

4.2 Gender Composition

Gender composition however, displays a marked imbalance—69% male, 30% female, and marginal representation from transgender and non-disclosing participants (<1%) (see Table 4.2). The resulting skewness of 1.524 and leptokurtic kurtosis (3.145) confirms clustering around male respondents (see Table 4.5). Qualitatively, this pattern corresponds with field observations at the science museums, where weekday footfall showed higher male participation, especially in student and professional groups. While this does not necessarily indicate gendered disinterest, it reflects persisting socio-cultural constraints in leisure mobility and STEM exposure for women in India—an important consideration for equitable museum engagement.

Table 4.2: Gender distribution of Respondents

Gender Distribution of Respondents (N=3000)			
Gender	**Frequency**	**Percentage**	**Cumulative Percentage**
Male	2070	69.0	69.0
Female	900	30.0	99.0
Transgender	09	0.3	99.3
Prefer not to say	21	0.7	100.0
Total	**3000**	**100**	

Source - Primary Data

Gender distribution shows a significant imbalance:

- Male: 69%
- Female: 30%

4.3 Educational Qualification

Educationally, the respondent pool is highly qualified. Over 87% possess undergraduate, postgraduate, or doctoral degrees, with postgraduate visitors (35.3%) and undergraduates (37.6%) dominating (see Table 4.4). This creates a negatively skewed distribution (−1.602) and kurtosis 2.744, indicating strong clustering toward higher qualifications (see Table 4.5). A cross-tabulation of age and education reinforces this, the 18–24 and 25–34 age groups correspond largely with undergraduate and postgraduate levels, while older cohorts (45+ years) include doctoral and postgraduate professionals. This educational skew is contextually logical—the data were collected at national level science museums located in metropolitan academic hubs, which naturally attracts educated audiences and student visitors. Yet, from a critical perspective, this overrepresentation limits inclusivity across lower-education segments and rural learners—precisely the strata most in need of accessible science communication.

Table 4.4: Educational Qualification of the Respondents

Educational Qualification	Frequency	Percentage	Cumulative Percentage
No formal education	48	1.6	1.6
Primary (up to 5th grade)	78	2.6	4.2
Secondary (6th–10th grade)	108	3.6	7.8
Higher Secondary (11th–12th grade)	138	4.6	12.4
Diploma	21	0.7	13.1
Undergraduate degree	1128	37.6	50.7
Postgraduate degree	1059	35.3	86.0
Doctoral degree	420	14.0	100
Total	3000	100	

Source - Primary Data

Educational attainment is notably high:

- Undergraduate: 37.6%
- Postgraduate: 35.3%
- Total higher education: >87%

Table 4.5: Descriptive Statistics on Age, Gender and Educational Qualification of Respondents

Statistics			
	Age of the Respondents in Years	**Gender of the Respondents**	**Educational Qualification of the Respondents**
N - Valid	3000	3000	3000
N - Missing	0	0	0
Mean	3.11	1.33	6.24

Std. Error of Mean	3.00	1.00	6.00
Mode	2	1	6
Std. Deviation	1.340	.516	1.484
Variance	1.795	0.267	2.204
Skewness	0.658	1.524	-1.602
Std. Error of Skewness	0.139	1.139	2.744
Kurtosis	0.271	3.145	2.744

Source - Primary Data

4.4 Respondents Occupation

Occupationally, students (41.8%) constitute the largest segment, followed by academicians (15.7%), private employees (15.4%), and government staff (12.1%). Professionals and self-employed respondents form smaller fractions, while homemakers and retirees together contribute less than 5% (see Table 4.6). This occupational distribution reinforces the educational tilt and highlights that science museums still function primarily as extensions of formal education, rather than broad civic spaces of lifelong learning. For a museum to be truly "attractive and educational for diverse visitors," the occupational composition would ideally include artisans, workers, entrepreneurs, and families—groups whose absence suggests a classed pattern of accessibility.

Table 4.6: Occupation of the Respondents

Respondents Occupation			
Category	**Frequency**	**Percentage**	**Cumulative Percentage**
Student	1254	41.8	41.8
Educator/Academic	471	15.7	57.5
Professionals (Engineers, Doctors, Advocates, etc)	108	3.6	61.1
Homemaker	99	3.3	64.4
Retired	30	1	65.4
Self-Employed	216	7.2	72.6
Govt. Employed	360	12	84.6
Pvt. Employed	462	15.4	100
Total	**3000**	**100**	

Source - Primary Data

Students represent the largest group:

- Students: 41.8%
- Academicians: 15.7%
- Private employees: 15.4%
- Government employees: 12.1%
- Lower participation is observed among homemakers, retirees, and informal sector workers.

4.5 Socio-Economic Profile

Income distribution reflects middle-class dominance, with limited representation from lower-income group. Income patterns further nuance accessibility. While responses are evenly spread across middle-income brackets, 33% declined to disclose income, possibly indicating discomfort in revealing financial data (see Table 4.7). Among valid responses, 14–15% each falls in the ₹25,000–₹1 lakh range, suggesting middle-class predominance. Only 12% earn below ₹10,000, implying that economic marginalization remains under-represented. The skewness (−0.39) and mild platy kurtosis (−1.23) denote a slightly flattened curve, reflecting income heterogeneity but bounded within relatively stable economic means (see Table 4.8).

Table 4.7: Income Level of Respondents

Income Level (Monthly Household Income)			
Income Slabs	**Frequency**	**Percentage**	**Cumulative Percentage**
Less than ₹10,000 / $125	360	12.0	12.0
₹10,001–25,000 / $126–$310	354	11.8	23.9
₹25,001–50,000 / $311–$625	432	14.4	38.2
₹50,001–1,00,000 / $626–$1250	423	14.1	52.3
Above ₹1,00,000 / $1250+	441	14.7	67.0
Prefer not to say	990	33.0	100.0
Total	**3000**	**100.0**	

Source - Primary Data

Table 4.8: Descriptive Statistics on Respondents Occupation, Residence, Native Language and Income Level

Statistics	Respondents Occupation	Residence Location	Income Level (Monthly Household Income)
N (Valid)	3000	3000	3000
Mean	3.53	1.84	4.07
Std. Error of Mean	0.162	0.053	0.102
Median	2.00	1.00	4.00
Mode	1	1	6
Std. Deviation	2.841	0.923	1.782
Variance	8.073	0.852	3.176

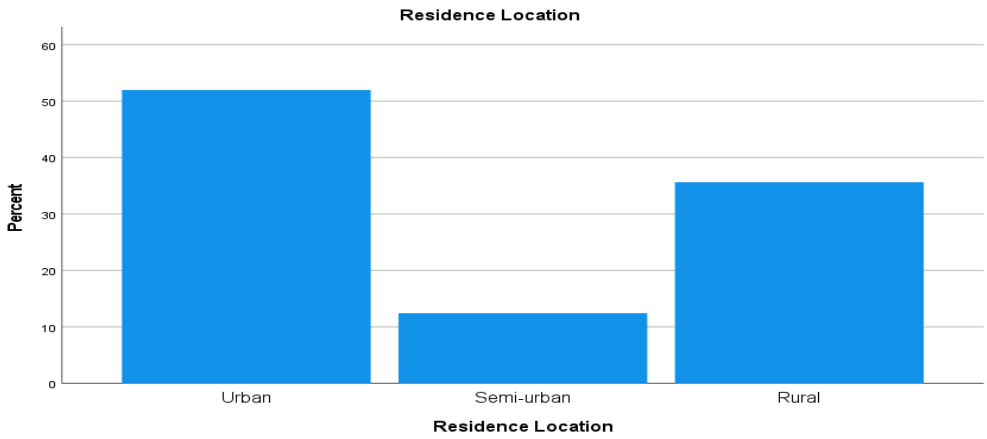
Skewness	0.556	0.330	0.390
Std. Error of Skewness	0.139	0.139	0.139
Kurtosis	-1.463	-1.751	-1.230
Std. Error of Kurtosis	0.278	0.278	0.278

Source - Primary Data

4.6 Geographic Distribution

Residence and linguistic data confirm the urban-centric nature of museum engagement. 52% of respondents live in urban areas, 36% in rural and 12% in semi-urban zones (see Figure 4.1). The data shows the awareness of museum existence among urban population and their accessibility to the museums.

Figure 4.1: Residence Location of Respondents



- Urban: 52%
- Semi-urban: 12%
- Rural: 36%

4.7 Museum Visitation Patterns

Patterns of prior museum visitation reveal a community already engaged with science learning. Over 97% of respondents have visited at least one museum before among which 81.7% have previously visited a science museum, while 15.4% have explored two or more museums. Only 2.9% are first-time visitors. Such saturation indicates that the sample comprises museum-aware audiences, further validating the high-education bias. The mean visitation frequency across all museum types (M = 2.31, SD = 0.77) translates to "rarely to occasionally," meaning that although museums are valued, they are not habitual destinations (see Figure 4.2 & 4.3 || Table 4.9 & 4.10).

Figure 4.2 Frequency of Visiting Museums

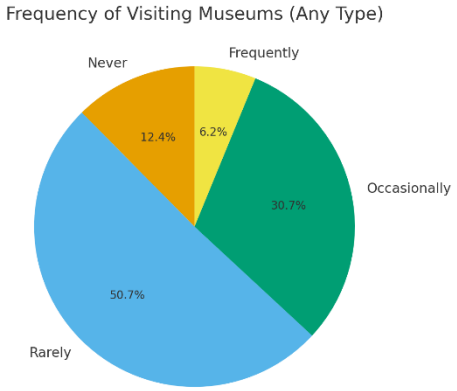


Figure 4.3 Museum Visitation type

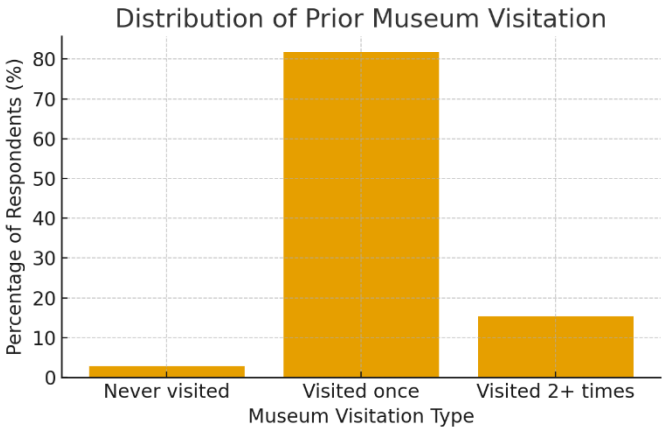


Table 4.9 Museum Visitation Pattern

Which Science Museum did you visit?		
Museum	**Frequency**	**Percent**
Previously visited one Science Museum	2451	81.7
Previously visited 2 or more Science Museums	462	15.4
Never visited a Science Museum before this	87	2.9
Total	**3000**	**100**
Frequency of visiting museums (Any type)		
	Frequency	**Percent**
Never	372	12.4
Rarely (Once every few years)	1521	50.7
Occassionally (Once or twice a year	921	30.7
Frequently (More than twice a year)	186	6.2
Total	**3000**	**100**

Table 4.10 Descriptive Statistics on visitation pattern

Descriptive Satistics		
Value	Which Science Museum did you visit	Frequency of visiting Museums (any type)
N	3000	3000
Mean	1.21	2.31
Median	1.00	2.00
Mode	1.00	2.00
Std. Deviation	0.476	0.766
Variance	0.227	0.587
Skewness	2.198	0.250
Std. Error of Skewness	0.139	0.139
Kurtosis	4.149	-0.218
Std. Error of Kurtosis	0.278	0.278

Source - Primary Data

4.8 Perceptions of Attractiveness

Visitor perceptions on what makes a science museum "attractive"? gives multidimensional insights. When asked to identify key attractive features, respondents prioritized **"**Exhibits in multiple languages" (21.3%), **"**Educational programs and workshops**"** (17.9%), and "Engaging activities for different age groups" **(**14.7%). This triad underscores that cognitive accessibility (language), pedagogic enrichment (programs), and age-specific engagement form the core of attractiveness (see Table 4.11).

Table 4.11 Attractive Features of Science Museums

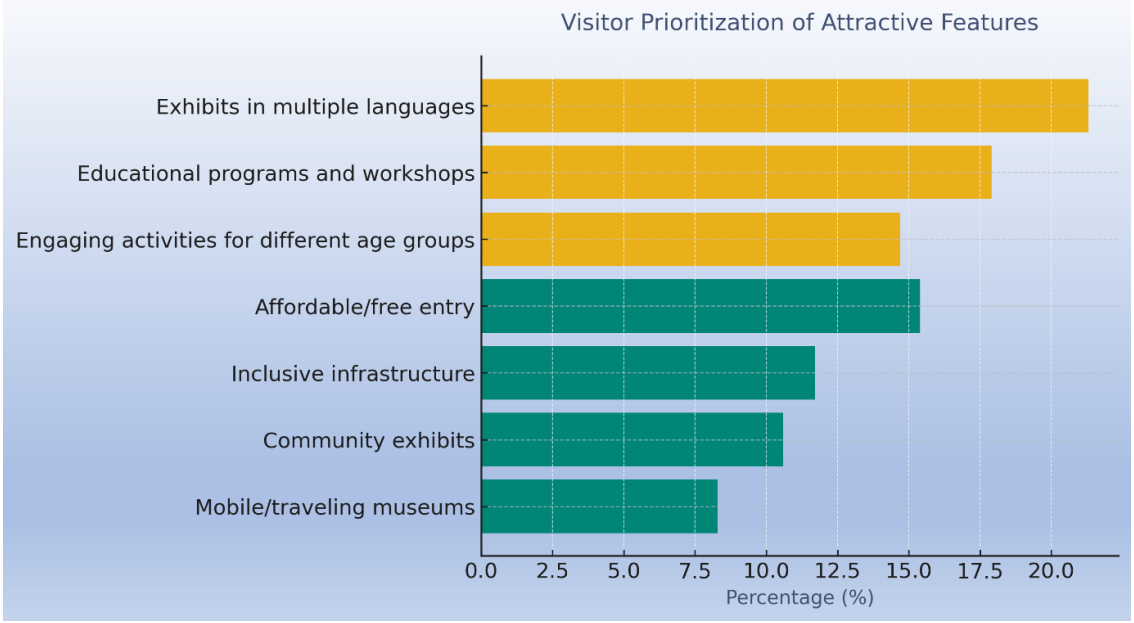
Attractive Features of Science Museums	Frequency	Percentage
Exhibits in multiple languages	639	21.3
Educational programs and workshops	537	17.9
Engaging activities for different age groups	444	14.8

Inclusive and accessible infrastructure	351	11.7
Affordable or free entry	462	15.4
Community-based exhibits or collaborations	318	10.6
Mobile or travelling science museums	249	8.3
Total	**3000**	**100**

Source - Primary Data

Moreover, Inclusive and accessible Infrastructure (11.7%) demands for raising concerns to visitors with special needs, reflecting awareness of universal design and empathy for differently abled visitors—a dimension often neglected in traditional museum planning. Affordable entry fee (15.4) is a matter of concern for marginalised income group visitors, Community-based exhibits or collaborations reflecting the need to incorporate the local, handicraft, innovations, knowledge system into the exhibits and finally mobile or traveling science museums (8.3 %) emerge as significant for rural respondents, suggesting latent demand for decentralized science outreach.

Figure 4.4 Attractive Features of Science Museums



5. Discussion

The findings indicate that science museums in India function primarily as extensions of formal education systems, attracting students and highly educated individuals. While this demonstrates their effectiveness as learning environments, it also reveals limitations in inclusivity.

The gender imbalance reflects broader socio-cultural constraints, while the dominance of educated visitors suggests barriers for less-educated populations. Urban concentration further indicates limited accessibility for rural communities.

Although visitors value museum experiences, the moderate visitation frequency suggests that museums are not yet integrated into routine leisure practices. Visitor preferences highlight the importance of

multilingual communication, interactive exhibits, and educational programming, emphasizing the need for inclusive and accessible design.

The analysis of 3000 responses indicates that science museums predominantly attract young, educated, and urban-oriented audiences, with a strong concentration in the 18–34 age groups, reflecting their relevance as informal learning spaces for students and early-career individuals. The considerable representation is there from rural visitors as well. The sample is heavily skewed toward male participants, yet 30% female participation is recorded in respondents' group. This may be also because of non-interest of female visitors to participate in the survey. Educational attainment is notably high, with the majority holding undergraduate and postgraduate qualifications, reinforcing the idea that science museums currently serve as extensions of formal education systems rather than fully inclusive public learning environments. Occupational distribution further supports this trend, with students forming the largest segment, followed by academicians and salaried professionals, while representation from other socio-economic groups such as homemakers, artisans, and retirees remains limited. Additionally, the dominance of urban and South Indian respondents suggests that geographical proximity and regional concentration significantly influence museum accessibility and participation.

Income distribution reflects middle-class dominance, with limited representation from lower-income groups, indicating potential economic barriers to inclusivity. Museum visitation patterns reveal that respondents are largely museum-aware and previously exposed, with the majority having visited science museums before. However, despite high awareness, visitation frequency remains moderate, suggesting that museums are not yet habitual or routine leisure destinations. Overall, the findings indicate that while science museums are successful in attracting educated and motivated visitors, there are clear gaps in inclusivity across gender, socio-economic status, and geographic reach, highlighting the need for broader engagement strategies to position museums as truly inclusive spaces for diverse populations. By understanding who the visitors are, why they visit, and what they find appealing, this study has laid the foundation for evaluating the museum's broader inclusivity nature.

6. Suggestions

The study aims to suggest the following measures out of the findings identified by analysing the data collected from the museum visitors.

1. **Promote Gender Inclusivity:** Targeted outreach programs can be designed and implemented to encourage participation among women and underrepresented groups.
2. **Expand Rural Outreach:** Mobile and travelling science museums or exhibitions have been already implemented effectively by NCSM science centres. These Mobile Science Museums can reach to rural and remote areas further to include more rural population.
3. **Enhance Accessibility:** Affordable entry and inclusive infrastructure for differently-abled visitors can be ensured. Such infrastructure can be designed in upcoming buildings of science museums.
4. **Diversify Visitor Base:** Programs can be designed for non-student audiences, including families and informal sector workers, less educated visitors and children.

5. **Strengthen Multilingual Communication:** Expand language accessibility in exhibits and educational materials. Audio guides, translations and AI supported Chatbot can be some applications to address the issues related to language barriers.

7. Limitation

A key limitation of this study is the restricted scope, which involved data collection from only five NCSM science museums. Consequently, the findings, while indicative, may not be fully generalizable to all 26 science museums across India, each with unique operational contexts and visitor demographics.

8. Future Research

There is a scope for conducting future research to analyse the following areas related to Science Museums in India.

- Explore qualitative aspects of visitor experience
- Examine participation among marginalized communities
- Conduct comparative international studies
- Investigate long-term engagement patterns

9. Conclusion

Science Museums in India truly attract diverse visitors and serve as effective informal learning environments but are not fully inclusive. While they successfully attract educated and motivated visitors, disparities persist across gender, socio-economic status, and geographic access. Addressing these gaps is essential to transform science museums into truly inclusive and democratic learning spaces. National Council for Science Museums and all Science Museums under NCSM have designed several outreach programmes to include underprivileged people of the society in the visitor category. Such programmes have been effectively implemented and proved to be successful in achieving the objectives of NCSM.

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