

## Decentralised composting of urban waste – an overview of community and private initiatives in Indian cities

Christian Zurbrügg <sup>a,\*</sup>, Silke Drescher <sup>a</sup>, Almitra Patel <sup>b</sup>, H.C. Sharatchandra <sup>c</sup>

<sup>a</sup> Department of Water and Sanitation in Developing Countries (SANDEC), Swiss Federal Institute for Environmental Science and Technology (EAWAG), P.O. Box 611, Duebendorf CH-8600, Switzerland

<sup>b</sup> 50, Kothmur Village, Bagalur Road, Bangalore 560 077, India

<sup>c</sup> Centre for Research on Environment, Development Innovations, Technology and Trade (CREDITTe), P.O. Box 3225, Bangalore 560 032, India

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### Abstract

The national waste legislation, introduced in India in 2000, endorses the principle of “Recycle Before Disposal” and clearly stipulates composting as an option for organic waste treatment. It also recommends waste separation as prerequisite for treatment. Although various composting schemes of different scale, type and organisational structure currently exist in the country, a general overview is lacking and very little independent site-specific information is available. This paper presents the results of a study assessing 17 decentralised systems from the cities of Bangalore, Chennai, Pune, and Mumbai. The schemes were classified according to their organisational setup into: (1) citizens’ and community initiatives; (2) business and institution initiatives operating on their premises; and (3) small and medium-size private sector initiatives. These categories also coincide with different operational scales. Community initiatives have developed from unreliable collection services, and composting emerged mainly as a spin-off activity from the collection system to reduce waste delivery to the communal containers emptied by the municipal services. The potential to launch and sustain decentralised composting schemes is dependent on the municipal provision of adequate space. This paper summarises further key issues pertaining to the assessed schemes and reveals overall deficiencies in the field of accounting and transparency, composting technique and marketing, as well as municipal authority involvement.

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### 1. Introduction

Indian cities are faced with a serious solid waste problem (Ahmed and Jamwal, 2000). Similar to many cities in the developing world, the municipal authorities responsible for waste collection, transport and disposal in India rarely have appropriate strategies, methods for mobilisation of financial resources or the necessary appropriate infrastructure for organised waste management (Diaz et al., 1996). This leads to low collection coverage, especially in poor or marginal areas of the

cities, and to uncontrolled disposal. Up to 50% of the waste generated daily remains uncollected in the cities; the remaining waste is collected irregularly, dumped in an uncontrolled manner, or burnt on vacant plots in or on the outskirts of cities. This widespread practice leads to significant health risks for the population and to a rapid degradation of the urban environment (Hardoy et al., 2001; Rajagopal, 1998). The problems faced by the authorities are aggravated by rapid urban growth and increasing consumption patterns (Ahmed and Jamwal, 2000). The solid waste characteristics reveal that in India the organic fraction of the waste makes up 40–85% of the waste (National Solid Waste Association of India, 2003), depending on income and life style of the population (Lardinois and van de Klundert, 1993). By composting this fraction, a significant contribution could be made towards waste recovery and reduction and could, thus, help close a valuable material cycle.

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\* Corresponding author. Tel.: +41-1-823-54-23; fax: +41-1-823-53-99.

E-mail addresses: [zurbrugg@eawag.ch](mailto:zurbrugg@eawag.ch) (C. Zurbrügg), [silke.drescher@eawag.ch](mailto:silke.drescher@eawag.ch) (S. Drescher), [almitrapatel@rediffmail.com](mailto:almitrapatel@rediffmail.com) (A. Patel), [sharatchandra@vsnl.net](mailto:sharatchandra@vsnl.net) (H.C. Sharatchandra).

### 1.1. The new Indian waste legislation

By the end of the 1990s, the deplorable conditions in Indian cities led to the filing of a public interest litigation to the Honourable Supreme Court of India. A committee constituted by the Honourable Supreme Court of India was formed to look into all aspects of solid waste management in the Class 1 cities<sup>1</sup> of India and to submit appropriate recommendations. On the basis of these recommendations (Committee Constituted by the Honourable Supreme Court of India, 1999), a national legislation was adopted comprising the “Municipal Solid Waste (Management and Handling) Rules 2000” (Ministry of Environment and Forests, 2000). According to these rules, the municipal authorities have to develop a solid waste management system and provide appropriate sites for controlled disposal and sustainable treatment of waste. Based on these rules, citizens may now file suit against municipal authorities for neglecting their waste management responsibilities, thus putting the municipalities under pressure to improve their services.

Article IV of the “Municipal Solid Waste Rules” specifically addresses private sector’s involvement in service provision. As regards municipal organic waste management, this led in the year 2001 to a multitude of new enterprises wishing to develop composting as a profitable business venture. Although citizens’ initiatives are not explicitly mentioned as contracting parties in the legislation, their presence can be considered as a model of public–private or public–community partnership. Community initiatives frequently appear as contracting parties of municipal administrations. Reliable data on the experience of formal cooperation between citizens’ initiatives and municipal administrations are unfortunately not available yet.

The law endorses the “Recycle Before Disposal” principle and clearly stipulates in Article II composting as a measure to treat organic waste, and waste separation as a prerequisite for effective composting and recycling (Ministry of Environment and Forests, 2000). Apart from the general principles, the law regulates construction of composting systems and compost quality standards, whereby special focus is placed on the maximum heavy metals content threshold.

### 1.2. Composting in India

Composting, which has a long tradition in India (Howard, 1943), is particularly widespread in rural areas. Centralised, large-scale composting plants in urban areas promoted in the 1970s proved to be uneconomical (Dulac, 2001). Only a few installations are currently still operational (United Nations Development Programme,

1991). Due to high operating and transport costs and the poorly developed market for compost, the expected profits could not be realised as planned. Composting of mixed waste also had a negative effect on compost quality and, thus, on its acceptance by farmers.

Since the 1990s, there is a trend towards smaller, manually operated composting plants at community level, initiated primarily by citizens’ initiatives or non-governmental organisations (NGOs) and also supported by international funds (Furedy, 1992). The following major advantages are generally anticipated from the decentralised approach:

- In combination with primary waste collection, composting improves the precarious waste situation in the communities, and residents become less dependent on the poor municipal waste collection service.
- Decentralised composting can be operated by an appropriate technology and implemented at reduced investment and operating costs.
- Manual composting in small, decentralised plants is more easily integrated in the prevailing Indian level of development and socio-economic background, as it requires labour-intensive processes. It also offers new employment opportunities and a source of income to the underprivileged in the Indian society.
- Decentralised composting allows reuse of organic waste where it is generated, thereby reducing waste quantities to be transported as well as transport costs. This has a positive effect on the overall municipal waste management costs.

Despite the aforementioned advantages, decentralised composting encounters similar problems as centralised composting plants in many urban areas. Compost is still not officially accepted as manure or soil conditioner, and is rarely financially competitive to heavily subsidised chemical fertilisers and traditional cow dung or poultry manure.

## 2. Methodology

Various composting systems of different scale, type and organisational structure are available in urban areas of India. This study aims at determining a framework for structuring the variety of schemes and at identifying potential advantages and disadvantages of decentralised schemes by means of case studies. It also assesses possible common challenges and needs for assistance or support by national or local authorities. A total of 17 decentralised systems in Bangalore, Chennai, Pune, and Mumbai were assessed by the authors in March 2002. The term “decentralised composting” is used here for schemes receiving the main organic waste bulk from the neighbourhood where the composting site is located. Assessment was conducted by guided interviews with the managers or main initiators of the composting scheme

<sup>1</sup> 65% of India’s urban population lives in 300 Class 1 cities with a population exceeding 100,000.

and, in the case of Pune and Mumbai, with the municipal composting consultants. The interviews were complemented by on-site observations and structured forms for systematic recording of quantitative data. The themes covered comprised:

1. institutional and organisational framework;
2. social implications;
3. waste collection;
4. composting site characteristics;
5. raw material supply;
6. composting technology used;
7. compost quality;
8. compost marketing; and
9. financial aspects.

### 3. Results

The widely differing schemes do not allow a direct comparison of individual data. Nevertheless, qualitative similarities were easily identified and allowed a general interpretation. Data analysis revealed that the schemes could be classified into categories based on their organisational setup, which often coincided with their operational scale:

1. citizens' and community initiatives;
2. business and institution initiatives operating on their premises;
3. decentralised, small and medium-size private sector initiatives; and
4. centralised, large scale public–private partnerships.

The results presented here cover citizens' and community initiatives as well as small and medium-size private sector initiatives. Organic waste composting within enterprises or institutions such as for example in hotels or housing schemes of enterprises can be regarded as non-commercial, isolated solutions. The waste is separated directly on site, composted and returned to the cycle, generally also on site. Since such examples relate to individual environmental management activities of the enterprises, they are not described in detail in this document. Although centralised systems were also assessed during the study, they are not the main focus of this paper and will not be described further.

#### 3.1. The role of citizens' initiatives

In India, small-scale decentralised composting plants are found frequently at community level. Numerous initiatives have developed as a result of the unbearable solid waste condition in residential areas. The waste obstructed traffic, odour emissions were the order of the day, and animals and vermin posed a health risk to the inhabitants. Since complaints to the authorities were generally ignored, concerned residents organised and founded initiatives, which are financed by the services they provide.

Many of these initiatives were launched in middle to high-income neighbourhoods showing an enhanced level of environmental awareness and financial capacity to sustain regular payments. According to local initiatives and NGOs, composting is regarded more as a "sideline" of waste management, and is closely linked to primary solid waste collection. Composting is often carried out on vacant plots within the community. The organic waste, separated at household level, is composted in boxes equipped with aeration facilities, or in windrows (Fig. 1).

The active composting phase lasts about 3–5 weeks, depending on the daily waste volume and box size. The decomposed waste then remains in the boxes for another 4–6 weeks to allow maturing of the compost before it is removed from the boxes and sieved prior to use. A composting period of totally 8–10 weeks is required to obtain mature compost. The compost, purchased mainly by the same residents of the initiative area, is primarily used as organic fertiliser in private gardens and nearby parks. In a few cases, compost is also sold to households or institutions not participating in the collection scheme. Not all the citizens' initiatives sell compost; they also supply the compost free of charge or use it for conservation of public areas. Information on compost quantity produced is scarce, especially where compost is not marketed. Table 1 provides an overview of the examined citizens' initiatives in five Indian cities.

Composting plants at community level are mainly limited to a capacity of 50–300 kg of waste per day, and the number of participating households is less than 1000 units. The 1200 participating households of the citizens' initiative RISE are organised in four independent units to ensure close contact and communication with the households. The interviews conducted with the initiators and key persons responsible for community schemes reveal that the decentralised composting concept organised by citizens and communities can hardly be scaled up



Fig. 1. Box composting by the RISE Citizens Initiative in Bangalore. The compost boxes, covered by a roof structure, are brick built with passive aeration vents and a lockable metal grille cover to hinder indiscriminate dumping by residents and to prevent rodents and vectors from entering the compost pile.

Table 1  
Overview of citizens' initiatives for waste collection and composting in Indian cities

Name, Location, (year of start-up)	System	Available area (m <sup>2</sup> )	Connected households	Waste quantities (kg/day)	Compost production (kg/day)	Production cost <sup>b</sup> (US\$/ton compost) <sup>f</sup>	Share of revenues from compost sales <sup>c</sup> (%)	Compost price (US\$/ton) <sup>f</sup>
Sandu Lane ALM, Mumbai (2001)	Box system	16	120	n.i	n.i	n.i	2	327
Diamond Garden Residents Forum (DGRF ALM), Mumbai (1998)	Box system	100	125	60	9 <sup>a</sup>	108	0	123
Scientific Handling of Waste Society (SHOW), Bangalore (1987)	Box system with active ventilation	190	180	50	4.5	626	18	163
Sindh Colony, Pune (1998)	Low windrows	150	264	200	50.0	193	95	123
EXNORA Ramanathan, Chennai (1995)	Box system and individual household backyard bins	40	300	300	45 <sup>a</sup>	91	0	143
Shyam Nagar Slum, Mumbai (2001)	Compost pit	60	350	350	3.3 <sup>d</sup>	0 <sup>e</sup>	0	0
Pammal, Chennai (1996)	Worm composting in boxes	300	476	100	25	112	60	204
CEE Kalyana Nagar Residence Association supported by an NGO, Bangalore (1988)	Box system	500	980	122	14.2	1380	42	123
Residents' Initiative for a Save Environment (RISE), Bangalore (1997)	Box system	290	1200	300	45 <sup>a</sup>	n.i	n.i	123

n.i.: no information.

<sup>a</sup> Compost production is estimated at 15% of raw waste processed.

<sup>b</sup> Excluding depreciation costs and hidden costs.

<sup>c</sup> The share of revenues obtained from compost sales compared to the total revenues.

<sup>d</sup> Most of the organic waste in the pit is eaten by cows and other animals.

<sup>e</sup> All voluntary work and contributions.

<sup>f</sup> 1 US\$ = 48.9 Indian Rupee (INR).

unrestrictedly. The limiting factor is not the technology used, but rather the problem of ensuring the flow of communication with the households and their participation, including the operational aspect of collection and composting activities. Feasibility of a community level scheme is dependent on the cooperation and support of the households as regards waste separation, collection, willingness to contribute financially, and willingness to accept the composting sites in the neighbourhood. Even quite successful initiatives are faced with households unwilling to pay or individual residents complaining about emissions from the composting site (e.g., flies or odour). Citizens' initiatives are often not in a position to manage more than 1000 households if they are not actively supported by NGOs or similar institutions. The share of revenues from collection fees compared to the total revenues, as listed in Table 1, shows the importance of collection fees for achieving cost recovery of the whole scheme. Citizens' initiatives are dependent on the good will and commitment of the residents, as they are not officially recognised by the municipal authorities, and the services they render do not have any legal basis in the new waste legislation. The households voluntarily agree to pay monthly fees in order to cover the waste collection and separation costs (salaries for personnel and maintenance of equipment). The initial investment costs are generally borne by the initiators or national and inter-

national funding agencies. This delicate informal community based setup could be easily upset by external influences. The municipality of Bangalore is planning for instance to introduce mandatory solid waste fees for all households, businesses and institutions to increase its financial resources for waste management services. From these user fees, residents will expect the municipality to provide waste collection services and are likely to give up their commitment to the community initiative, as they will not be willing to pay twice to finance two parallel systems. Neighbourhood-scale initiatives, thus, see their already established schemes threatened, and expect the overall waste management strategy to break down again into the elements of collection and disposal, and their recycling activities neglected. According to the initiators of decentralised composting schemes, finding a composting site seems to pose one of the main problems. Private or public owned vacant plots are basically suitable. However, due to the high property prices in Indian cities, these plots can only be leased. Since most Indian authorities are still very sceptical of citizens' initiatives, a persevering negotiating skill is required until appropriate areas are made available. Therefore, personal relations of the involved community members with key persons in local government are of major importance. Since authorisation to use these plots is generally only temporary, long-term investment in structures is too risky. Involve-

ment and cooperation of the neighbouring residents, which do not necessarily form part of the implemented community waste management system, is an important prerequisite for long-term implementation of a system, since the NIMBY syndrome (not-in-my-backyard syndrome) is also very common in India. Complaints by residents living close to the composting plants have in the past led to the relinquishment of public plots and, thereby, to the collapse of the entire scheme.

Nevertheless, the cities of Pune and Mumbai have adopted promising composting approaches at community level (together with primary waste collection), which are actively promoted by the authorities. The municipality of Pune supports composting activities and provides consulting experts to interested citizens. Mumbai backs citizens' initiatives within the framework of the programme "Advanced Locality Management", (ALM). ALMs are initiatives comprising on the average 250 households from individual streets or neighbourhoods committed to improving the living conditions in their area. The programme offers such initiatives a regular forum with specialists and authorities, where problems are addressed and potential solutions are jointly elaborated. Waste management is, thereby, only one of the many aspects of ALM activities. Six hundred and seventy ALMs were, thus, founded in the last few years, of which 284 compost and locally reuse their organic waste. However, future development of this promising programme remains to be seen, as it has been promoted up to now by individual political decision-makers and, thus, vulnerable in case of political change.

Still, promising approaches have been identified, which could establish a precedent. Private enterprises are still underrepresented in decentralised composting, or found only in market niches.

### 3.2. Initiatives of small and middle-size private sector

The new Indian Waste Legislation has encouraged some small-scale Indian entrepreneurs to consider organic waste treatment as a new business opportunity and compost as an increasingly marketable product. These enterprises are clearly profit-oriented and also concentrate on the production and sale of compost, as well as on providing consulting services in the field of composting. Several small and middle-size enterprises, already working as contractors for Mumbai's municipal government, are engaged in organic waste composting. The composting plant capacity averages 5 tons of organic waste per day,<sup>2</sup> and worm composting (vermi-



Fig. 2. Worm composting of vegetable market waste in shallow windrows on the premises of a former wastewater treatment plant, Vermigold, Mumbai.

composting) is the most widespread technological approach used (Fig. 2). Compost production makes up 10–15% of the processed raw waste.

This study further reveals that all the composting plants examined have specialised exclusively in treatment of "pure" organic waste streams from city markets as well as from food and beverage processing industries. This waste, almost free from foreign matter, is available in large quantities in central municipal locations. Although domestic waste can also be composted on this scale, the enterprises are reluctant to assume the organisational responsibilities associated with household collection and waste separation. Table 2 contains an overview of the assessed commercial composting schemes.

Since three of the four enterprises in this study have just recently been founded (one year old or less), data on their profitability were not available. Nevertheless, specific challenges common to all plants were identified and briefly described hereafter. The investment costs for a plant of this size are significantly higher than for the previously described units. Many entrepreneurs have invested considerable private capital in the projects or mortgaged their private property. Since banks consider composting a venture entailing a high risk due to its lack of long-term success, the collateral securities are unreasonably high. A further obstacle for entrepreneurs, like with citizens' initiatives, is the lack of appropriate composting locations. Enterprises also depend on the availability of cheap municipal leaseholds, whereby securities for long-term use are often only partially granted. Use of vacant municipal plots, such as former wastewater treatment plants or pumping stations, was observed. In contrast to community initiatives, composting enterprises are mainly dependent on the sale of the end product; i.e., the compost. In India, the market for compost is still underdeveloped despite its potential. Serious competing products of compost are subsidised commercial chemical fertilisers and cheap poultry ma-

<sup>2</sup> Except for Terra Firma which processes 96 tons of organic waste per day is located on the urban fringe of Bangalore and cannot be considered "decentralised" as defined in this paper.

Table 2  
Overview of commercial composting schemes

Name, Location (year of start-up)	Forms of organisation	Technique	Area (m <sup>2</sup> )	Waste processed (ton/day)	Compost produced (ton/year)	Production cost <sup>b</sup> (US\$/ton compost) <sup>c</sup>	Compost price (US\$/ton) <sup>c</sup>
Dadar Pumping Station, Vermigold, Mumbai (2002)	Private enterprise, contract with municipal government	Worm composting in windrows	1700	5	– <sup>a</sup>	– <sup>a</sup>	n.i.
Varsova, Green Cross, Composting Site, Mumbai (2001)	Private enterprise, contract with municipal government	Worm composting in windrows	1400	5	247	43	61
Clean Air Island, Colaba Pumping Station Composting Site, Mumbai (2001)	Non-governmental organisation, contract with municipal government	Worm composting in windrows	1347	5	183	107	409
Terra Firma, Bangalore (1994)	Private enterprise	Pre-composting in windrows and worm composting in boxes	40,000	96	5060	13	61

n.i.: no information.

<sup>a</sup> Plant only operational since two months.

<sup>b</sup> Excluding depreciation costs and hidden costs.

<sup>c</sup> 1 US\$ = 48.9 Indian Rupee (INR).

nure and cow dung, which maintain the sales value of compost low. However, appropriate marketing strategies and development of distribution channels have so far hardly been developed by the enterprises, which prefer to ensure their profitability by the revenue obtained from municipal waste collection contracts.

#### 4. Discussion

Numerous examples of community initiatives provide proof of some of the advantages of decentralised composting, such as improved environmental conditions in residential areas thanks to a functioning and regular waste collection system. The waste no longer overflows at public collection points, thereby facilitating secondary collection by the municipal waste service. Environmental awareness has increased among the citizens who also welcome the positive changes in their immediate environment. Separate collection and composting of market waste also contribute to reducing the environmental impacts and waste haulages in Indian cities. Composting schemes employ labourers, thus, enabling income opportunities to mostly underprivileged and vulnerable groups of Indian society. Some critical prevailing operational and institutional issues prevent decentralised composting from fully developing its effectiveness. To attain long-term feasibility and operational profitability, the stakeholders directly involved in decentralised composting are recommended to reflect on the following points:

*Accounting and transparency.* The data collected during the field study revealed a scarcity of documentation on mass flows and unclear financial figures. Since numerous schemes lack an information database, project planning is thus problematic. Such documentation and transparency is recommended as it could also provide a sound basis for negotiations with the municipal authorities. Improved data documentation could therefore increase the professional status of citizens' initiatives as well as junior companies.

*Composting technique.* Although technical aspects have barely been addressed in this paper, improvements are also necessary, particularly as regards a controlled composting process to prevent odour emissions and related complaints from nearby residents. During the field study, various competence centres for composting were identified for their important role in dissemination of appropriate composting techniques.

*Marketing.* Development of adequate strategies and outlets for compost are prerequisites for successful marketing of decentralised composting. Most of the enterprises examined lack appropriate marketing strategies. A timely assessment of different improvement options is required, such as direct marketing or use of

already available outlets of other contractors of agricultural products.

*The role of municipal authorities.* Immaterial and also financial support to community and private sector initiatives by municipal authorities will be the right trailblazer for development of this waste treatment option. The political will of decision-makers and continuity in urban policy are two basic prerequisites for tackling the waste problem. Appropriate measures can differ according to the degree of organisation, waste volume, level of environmental awareness, and required financial resources. Municipal authorities should encourage citizens' initiatives and private enterprises and integrate them in a future overall municipal waste management strategy. They could, thus, form part of urban waste management and ease the pressure off the available resources. Should municipal waste service user fees be introduced in the near future, public–private partnerships with neighbourhood initiatives could be negotiated to maintain decentralised recycling activities. Qualified specialists could further assist citizens' initiatives with consulting services on organisational issues or technical composting problems and possibly act as advisors to the city. The city plays a key role in the provision of adequate areas for decentralised composting. If such areas are allocated free of charge or at a reasonable rental value to initiatives or enterprises, the main financial obstacle associated with investment costs is overcome. The city could further support composting campaigns designed to introduce waste separation at household level. Early separation of the waste flows and their decentralised recycling contribute to reducing the waste quantities to be transported by the city and to free capacities which can be used elsewhere. Support of waste separation can motivate citizens and private enterprises to assume responsibility for waste management at community level and to introduce composting. Non-governmental organisations could thereby play an important role by acting as intermediary between the city and the informal sector (underprivileged groups of society such as waste collectors). Regular removal of the remaining waste from the districts is fundamental to ensure citizens' motivation. Commitment by the citizens can only be ensured if the city also assumes its share of responsibility. Close collaboration between municipal government and citizen helps to enhance citizens' confidence in the municipal system. Therefore, the poorly developed sense of responsibility for the immediate surroundings and environment can be improved on a long-term basis. Since private sector composting initiatives can contribute significantly to enhancing municipal waste management, such initiatives should be examined without delay, comprehensively, and possibly backed by contractual agreements. The request for tax relief of these enterprises, submitted by the Committee constituted by the Honourable Supreme Court (Committee Constituted by the

Honourable Supreme Court of India, 1999) should particularly be taken into account here. In India, compost is not yet accepted as a fertiliser on a large scale. The agro-policy framework still foresees massive subsidies for chemical fertilisers. The cities could, for example, back promotion of the compost market by purchasing compost for their own green areas.

## 5. Conclusion

“Composting does not make you rich”, as stated by a composting plant operator, sums up appropriately the current situation of organic waste treatment in Indian cities. However, most plant managers or initiators interviewed mentioned that with the support of the municipal authorities (e.g., land provision), operation of decentralised composting combined with a collection service can recover costs and even yield a profit. Financial data obtained through the interviews were not detailed enough to confirm or reject this statement. Nonetheless, we can assume that cost recovery is possible as many of the assessed initiatives have been operating continuously for the last few years. Making a profit by compost sales will remain low for as long as the national compost market is not expanded and promoted further. Integration of private initiatives in existing structures prevents development of parallel waste management systems and helps enhance efficiency of the overall municipal system. Commitment of the private sector; i.e., of the citizens and enterprises, offers an opportunity particularly to smaller Indian cities to redistribute and use existing resources more effectively.

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