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Time Resolved Variations of $PM_{0.5}$, $PM_{2.5}$ and PM_5 in Number from some Selected Areas (Savar, Gazipur and Narayanganj) of Dhaka Division

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Abstract:- The study was conducted to find out the time resolve variations of particulate matters ($PM_{0.5}$, $PM_{2.5}$ and PM_5) in some selected places of Savar, Gazipur and Narayanganj of Dhaka division using Video Particle Counter 300 (VPC 300). We found the distribution pattern of atmospheric particles in all the area studied as 0.5 µm>2.5 µm>5 µm. In this study, we observed that $PM_{0.5}$, $PM_{2.5}$, and PM_5 particles have been increased from morning to noon and evening, indicating their sources are anthropogenic. During the morning, $PM_{0.5}$ particle in number ranged from 176269-268219 N (avg. 236407±30572 N). However, at noon particle having size of 0.5 µm in number ranged from 290785-412355 N (avg. 336525±43905 N) and at evening, particle of same size ranged from 390968 N-694691 N, (avg. 492003±85049 N). Interestingly, $PM_{0.5}$ size has been increased in the study area by ~1.4 times of same size from morning to noon and by ~1.5 times than that of noon. Such increment of $PM_{0.5}$ from morning to noon and evening may signify their sources in the study areas are associated with anthropogenic activities like vehicles, industry and construction activities. Moreover, in the morning time PM_5 loads in number has been decreased by ~4.5 times than those of $PM_{2.5}$, indicating atmospheric dry deposition of larger size particles from the study area.

Keywords:- *Particulate Matter, Atmospheric Particle, Dry Deposition, Anthropogenic Activities, Vehicles, Construction.*

I. INTRODUCTION

Atmospheric pollution as particulate matter (PM) is a regional as well as global concern and by the last couples of years PM pollution has drawn special attention by the policy makers around the globe (Begum *et al.*, 2010). Now-a-days, air pollution as PM in urban atmosphere and its adverse effects towards human health and its` properties are also flattering as matter of concern for developing countries like Bangladesh. However, to address the issues like air pollution by PM is a serious environmental concern, which adversely impacts human health and the natural environment (Mukta *et al.*, 2020; Hoque *et al.*, 2022, Hoque *et al.*, 2024a; Hoque *et al.*, 2024b). Atmospheric PM loads in urban atmosphere led to air quality degradation, haze formation, reduced visibility, causes climate change, build global warming, ecosystem deterioration (Ari *et al.*, 2020; Cesari *et al.*, 2020; Jain *et al.*, 2020) and human health risks including childhood asthma (Brugha *et al.*, 2014), chronic obstructive pulmonary disease (COPD) (Andersen *et al.*, 2010), heart disease (Beelen *et al.*, 2014), stroke (Pope *et al.*, 2014), neurodegenerative disease (Maher *et al.*, 2016), premature mortality (Anenberg *et al.*, 2010) ; urban PM loads can affect vital organs including human brain (Wong *et al.*, 2014; Cory-Slechta *et al.*, 2023), high exposure to PM with prenatal and early life exposure linked to autism (Gong *et al.*, 2016). In urban areas, it is important to know the possible sources and their strengths for the efficient management and improvement of air quality (Begum *et al.*, 2010).

Atmospheric PM originates from diverse primary sources including burning of fossil fuels such as coal, natural gas, oil as well as solid waste, trees, wood and wood products burning, as well as in the form of secondary particles formed by the photochemical processes of anthropogenic and natural precursor (Latake *et al.*, 2015; Hoque *et al.*, 2018; Dai *et al.*, 2019; Zalakeviciute *et al.*, 2020, Hoque *et al.*, 2020). However, concentrations of PM in urban air have increased during recent years because of the rapid growth urbanization, industrialization, and the resulting anthropogenic activities (Mukta *et al.*, 2020; Hoque *et al.*, 2022, Hoque *et al.*, 2024b). In fact, atmospheric concentration of PM concentrations vary from place to place and inevitably, over time, dependent on localized industrial activity, urbanization, transport networks, fuel consumption and pollution control legislations (Power *et al.*, 2023).

Atmospheric PM plays a crucial role in atmospheric visibility, precipitation, and air quality. Particles affect the climate directly because of their effects on solar and atmospheric radiation. Particles can behave as a cooling or warming factor, depending on the process that predominates light absorption or scattering (Myhre, 2009). They can also have an indirect effect on the climate by modifying the physical and radiative properties of clouds (Wang and Penner, 2009).

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In Dhaka, air pollution is estimated to be responsible for approximately 3,580 premature deaths, 10 million restricted activity days and 87 million respiratory symptom days per annum (ADB and CAI-Asia, 2006). It is estimated that 15,000 premature deaths, as well as several million cases of pulmonary, respiratory and neurological illness are attributed to poor air quality in Dhaka, and air pollution is a major cause of respiratory distress in urban Bangladesh. The study was conducted to satisfy the following objectives:

- To find out the distributions of $PM_{0.5}$, $PM_{2.5}$ and PM_5 in number in the study area.
- To assess the variations of these particulates with time.

II. MATERIALS AND METHODS

➢ *Study Area*

The study was conducted at some selected areas of Savar, Tongi and Narayanganj areas of Dhaka division. Savar, Tongi and Narayanganj are famous city of Bangladesh, because these cities belong to lot of industries and are highly populated. Savar is a puroshava area arranged on the east by the sullied Turag stream, very close to Dhaka city. This city having couple of garments, frozen yogurt plants, and EPZ. Narayanganj, which is a thickly populated locale and does have high gridlock. It is known for its business works out, a couple of significant ventures, and vehicle fixing studio. It is an especially loaded area with glass, plastic, and welding handling plants. Finally, Tongi, a northern present-day site of Dhaka dwelling the pharmaceutical, soap, and cleaning agent, excellence care items, pieces of clothing, food organizations, bata plant (Akther *et al.*, 2019).

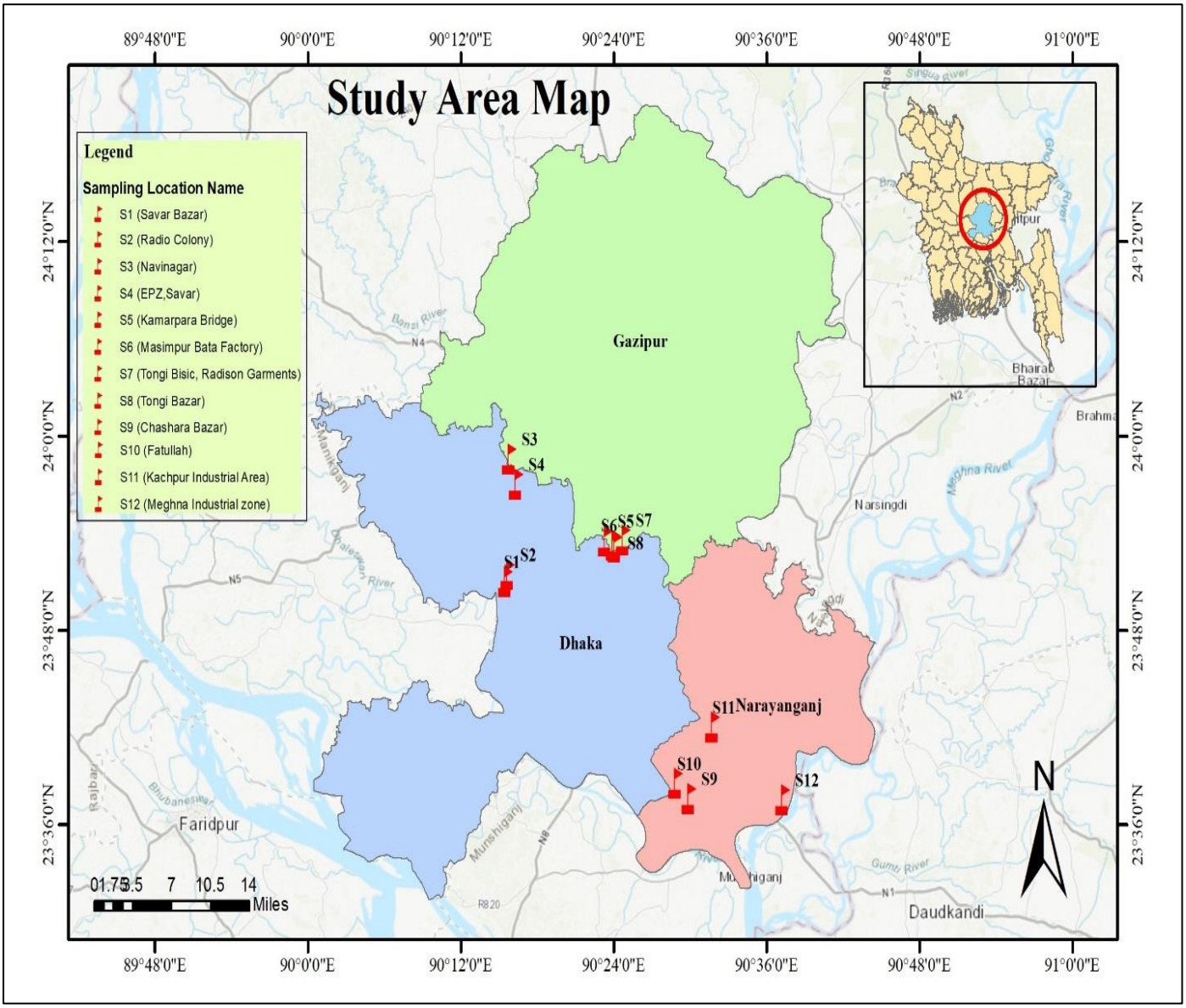

Fig 1 Map showing the study area of different sampling station (Savar, Tongi, and Narayanganj) of the study area.

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➢ *Data Collection Procedure*

The number of particles (PM) present in PM0.5, PM2.5 and PM5 size atmospheric dust were counted from tweleve (12) sampling stations including Savar Bazar, Radio Colony, Navinagar, Savar EPZ, Kamarpara Bridge, Masimpur, Tongi Bsic, Tongi Bazar, Chashara Bazar, Fatullah, Kachpur Industrial Area, Meghna Industrial Zone of the study area using a Video Particle Counter 300 (VPC 300). Data on particles size and number was measured at the morning, noon and evening of each day. To get good accuracy on collected data a triplicate measure was taken in each sampling station. Sampling sites were selected based on traffic load, industrial and commercial activities, population density, and human activities occurring within the areas. After data collection, results for each sampling station were noted down in a notebook immediately then consequently input in laptop. Secondary data were collected from national and international journals, available books, related reports, articles, and web-based information.

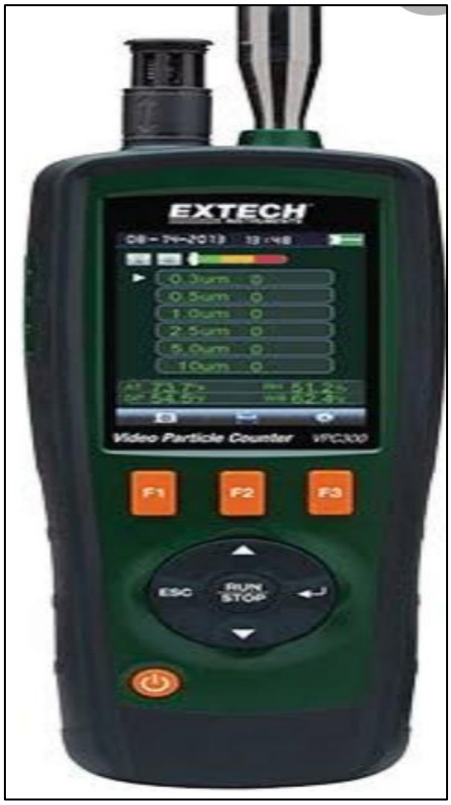

Fig 2 Video Particle Counter (VPC300).

III. RESULTS AND DISCUSSION

➢ *Distribution of $PM_{0.5}$ in the Study Area from Morning to Evning*

As shown in Table 1, during the morning particle size of 0.5 µm in number ranged from 176269-268219 N, (avg. 236407±30572 N). During morning, the highest number of particles having 0.5 µm in size was detected in Fatullah (268219 N) of Narayongonj, followed by Tongi Bsic (267495 N), Kamarpara Bridge (265209 N), Meghna industrial zone (254998 N), Chashara Bazar (251144 N), Masimpur Bata factory (234262 N), Savar EPZ (224642 N), Kachpur Industrial area (223476 N), Savar Bazar (211641 N). However, relatively fewer number of particles of the same size were observed in Radio Colony (195984 N) and Navinagar (176269 N).

During noon particle size of 0.5 µm in number ranged from 290785-412355 N, (avg. 336525±43905 N) (Table 1). Interestingly, number of particles having size of 0.5 µm has been increased in the study area by ~1.4 times of same size from morning to noon, may signify their sources in the study areas are associated with anthropogenic actions like vehicles, industry and construction activities. During noon, the highest number of particles having 0.5 µm in size was detected in Savar EPZ (412355 N) followed by Meghna industrial area (403989 N), Kachpur industrial area (378044 N), Fatulla (376091 N), Chashara Bazar (335342 N), Savar Bazar (317026 N), Tongi Bsic (314842 N), Navinagar (306612 N), Radio colony (302822 N), Tongi Bazar (300629 N), Masimpur Bata factory (299771 N) and lowest number of $PM_{0.5}$ was detected in Kamarpara Bridge (290785 N).

As shown in Table 1, during evening, particle of $MP_{0.5}$ size in number ranged from 390968 N-694691 N, (avg. 492003±85049 N). Interestingly, $PM_{0.5}$ size particle has been increased at evening in the study area by 2 times of same size from morning and by ~1.5 times than those of noon. In the evening, the highest number of particles having 0.5 µm in size was detected in Tongi Bazar (694691 N) followed by Masimpur Bata factory (593456 N), Kachpur industrial area (563482 N), Savar EPZ (482336 N), Chashara bazar (477490 N), Tongi Bsic (476952 N), Meghna industrial area (459604 N), Navinagar (461210 N), Fatulla (451412 N), Savar Bazar (430923 N), Radio Colony (421512 N). However, lowest number of 0.5 µm size particle were observed in Kamarpara Bridge (390968 N) (Figure 3c).

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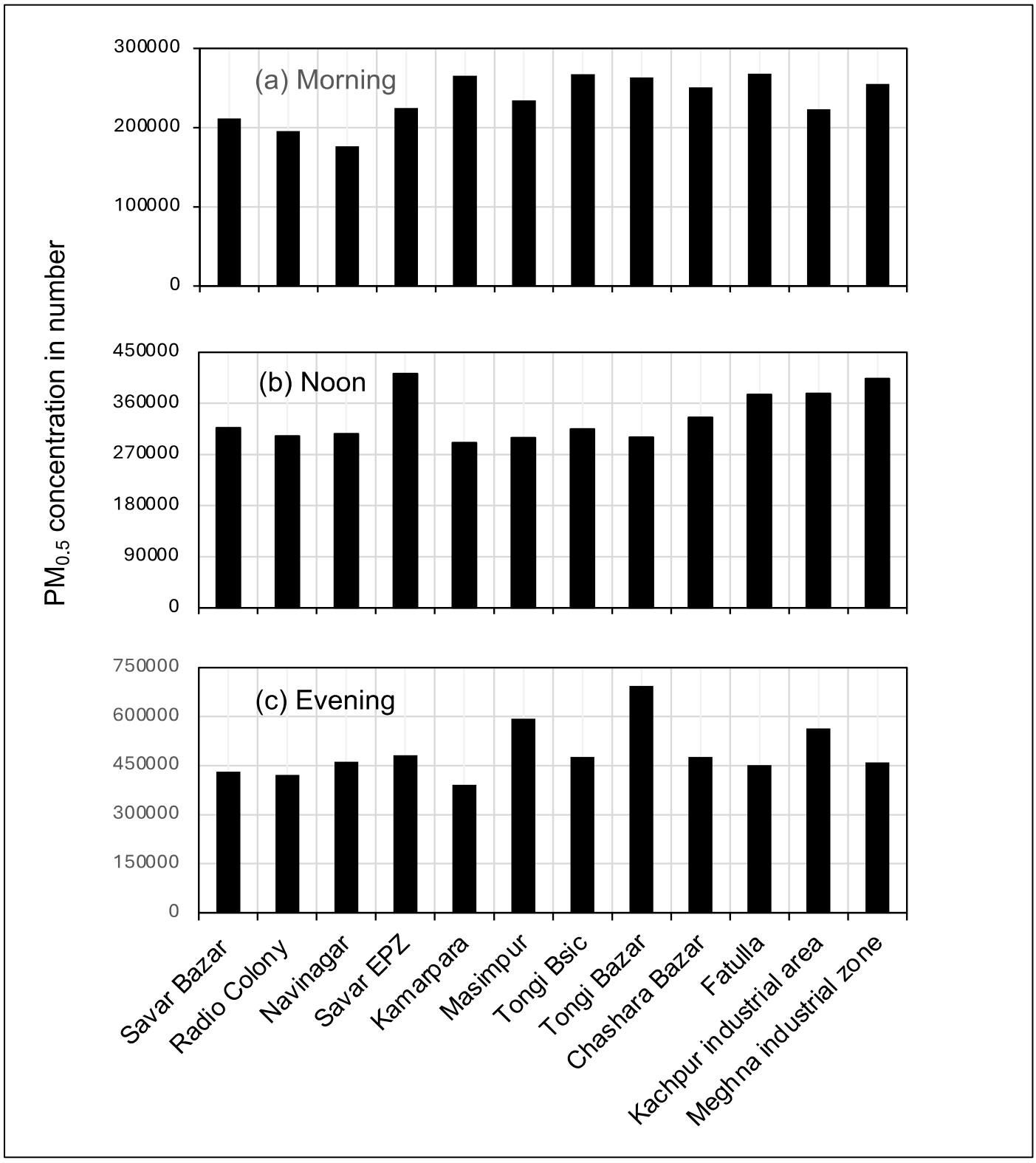

Fig 3 Variation of $PM_{0.5}$ at (a) Morning (b) Noon and (c) Evening in the study area

➢ *Distribution of $PM_{2.5}$ in the Study Area from Morning to Evening*

As shown in Table 1, during the morning particle size of 2.5 µm in number ranged from 3,182-4,038 N, (avg. 3,645±270 N). During morning, the highest number of particles having 2.5 µm in size was detected in Fatullah (4,038 N), Narayngonj followed by Chashara Bazar (4,011 N), Narayangonj, Kamarpara bridge (3,871 N) of Tongi, Tongi Bsic (3,792 N), Savar EPZ (3,753 N). However, moderate number of particles of the same size were observed in Meghna industrial zone (3,649 N), Tongi Bazar (3,675 N) and Radio colony, Savar (3,595), Savar Bazar (3,473 N) and Navinagar (3,435 N). The lowest number of particles was observed in the Masimpur Bata Factory of Tongi areas (Figure 4a).

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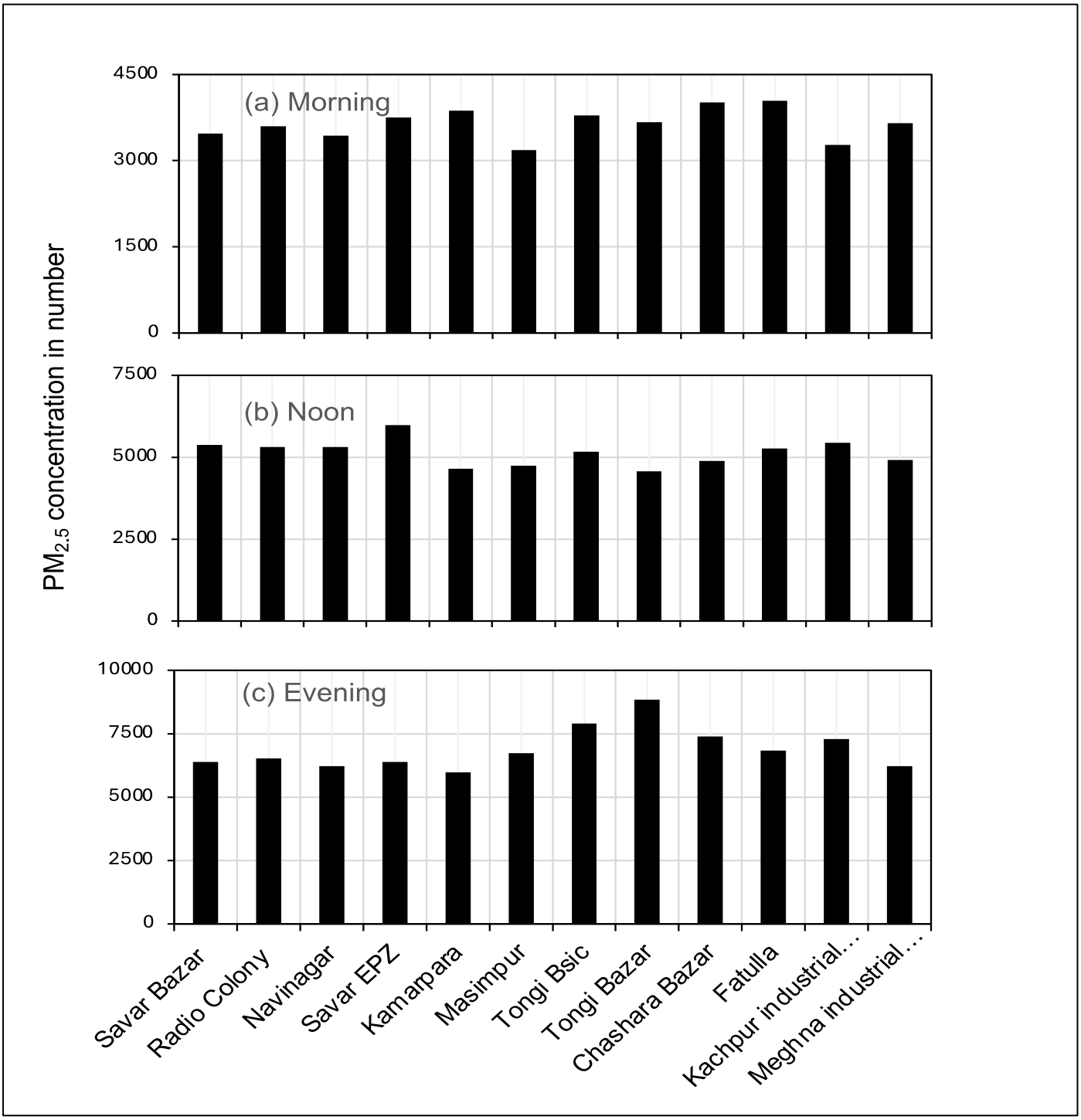

Fig 4 Variation of $PM_{2.5}$ at (a) Morning (b) Noon and (c) Evening in the Study Area

During noon particle size of 2.5 µm in number ranged from 4,570-5,975 N, (avg. 5,135±401N) (Table 1). Interestingly, number of particles having size of 2.5 µm has been increased in the study area by ~1.4 times of same size from morning to noon. During noon, the highest number of particles having 2.5 µm in size was detected in Savar EPZ area (5,975 N) followed by Kachpur Industrial area (5438 N), Savar Bazar (5384 N) Navinagar (5319 N), Tongi Bsic (5179 N). However, moderate number of particles of 2.5 µm were detected in Meghna industrial zone, Chashara Bazar, Kamarpara Bridge, Masimpur Bata factory, Tongi Bazar and the lowest one was observed again in Tongi Bazar (Figure 4b). As shown in Table 1, during evening particle size of 2.5 µm in number ranged from 5,982 N-8,842 N, (avg. 6,895±831 N). During evening, number of particles having size of 2.5 µm has been increased in the study area by ~1.9 times of same size from morning and by ~1.3 times than those of noon. During the study, the highest number of particles having 2.5 µm in size was detected in Tongi Bazar followed by Tongi Bsic, Chashara Bazar, Kachpur industrial area, Fatullah, Masimpur Bata factory, Radio colony, Savar EPZ, Savar Bazar, Navinagar, Meghna industrial zone. However, lowest particles of 2.5 µm were observed in Kamarpara Bridge (Figure 4c).

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Table 1 Time Resolve $PM_{0.5}$, $PM_{2.5}$ and PM_5 Distribution in the Study Area

Sampling Station/Particle in number (N)																	
Time	Particle size (µm)	Savar Bazar	Radio Colony	Navinagar	Savar EPZ	Kamarpara Bridge	Masimpur Bata Factory	Tongi Bsic	Tongi Bazar	Chashara Bazar	Fatulla	Kachpur industrial area	Meghna industrial zone	Min	Max	Average	SD
Morning	0.5	211641	195984	176269	224642	265279	234262	267495	263476	251144	268219	223476	254998	176269	268219	236407	30572
	2.5	3473	3595	3435	3753	3871	3182	3792	3675	4011	4038	3271	3649	3182	4038	3645	270
	5.0	816	704	713	731	938	936	875	826	712	971	913	771	704	971	825	99
Noon	0.5	317026	302822	306612	412355	290785	299771	314842	300629	335342	376091	378044	403989	290785	412355	336525	43905
	2.5	5384	5308	5319	5975	4647	4736	5179	4570	4887	5269	5438	4916	4570	5975	5135	401
	5.0	1078	1184	1058	1275	1266	1209	1198	1154	1161	1293	1365	1433	1058	1433	1222	109
Evening	0.5	430923	421512	461210	482336	390968	593456	476952	694691	477490	451412	563482	459604	390968	694691	492003	85049
	2.5	6384	6528	6219	6396	5982	6743	7893	8842	7396	6829	7297	6231	5982	8842	6895	831
	5.0	1505	1469	1502	1698	1975	1737	1895	2812	1894	2372	1984	2138	1469	2812	1915	391

➢ *Distribution of PM_5 in the Study Area from Morning to Evening*

As shown in Table 1, during the morning particle size of 5 µm in number ranged from 704-971 N, (avg. 825±99 N). During morning, the highest number of particles having 5 µm in size was detected in Fatullah (971 N) of Narayongonj, followed by Kamarpara Bridge of Tongi (938 N), Masimpur Bata Factory of Tongi (936 N), Kanchon industrial area (913 N), Savar EPZ (3,753 N). However, moderate number of particles of the same size were observed in Tongi Bsic (875 N), Tongi Bazar (826 N), Savar Bazar (816 N), Meghna industrial zone (771 N) and Savar EPZ (731 N), Navinagar (713 N), Chashara Bazar (712 N). The lowest number of particles was observed in Radio Colony (704 N) (Figure 5a). Moreover, in the morning time PM_5 loads in number has been decreased by ~4.5 times than those of $PM_{2.5}$, indicating atmospheric dry deposition of larger size particles from the study area.

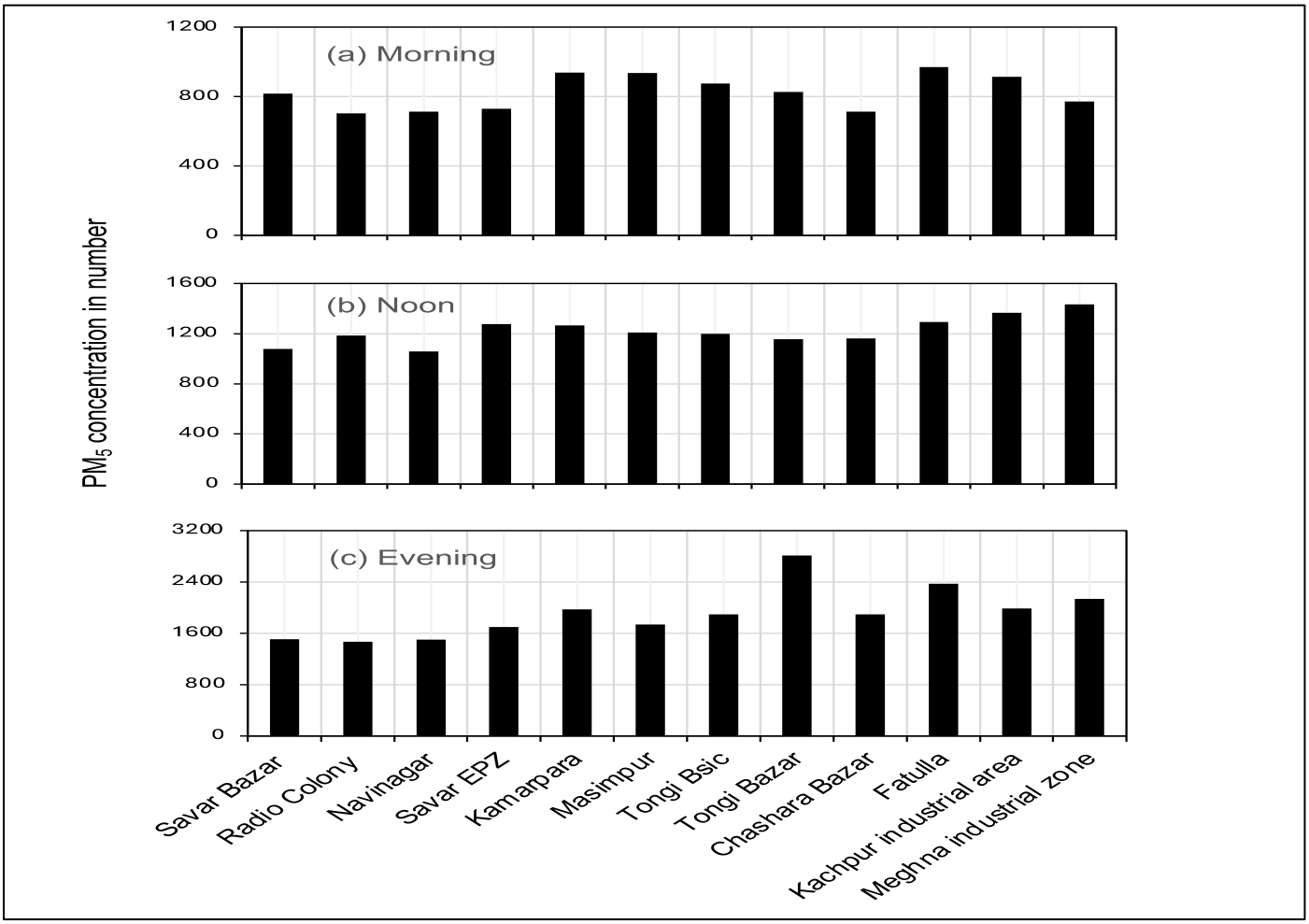

Fig 5 Variation of $PM_{0.5}$ at (a) Morning (b) Noon and (c) Evening in the study area

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During noon, particle size of 5 µm in number ranged from 1,058-1,433 N, (avg. 1,222±109 N) (Table 1). Interestingly, number of particles having size of 5 µm has been increased in the study area by ~1.5 times of same size from morning to noon, signifying anthropogenic activities are the significant source of particulates matter in the study area. During noon, the highest number of particles having 5 µm in size was detected in Meghna Industrial area (1433 N) followed by Fatulla (1293 N), Savar EPZ (1275 N), Kamarpara Bridge (1266 N), Masimpur bata factory (1209 N). However, moderate number of particles having size of 5 µm were detected in Tongi Bsic, Tongi Bazar, Chashara Bazar, Kamarpara Bridge, Masimpur Bata factory, Tongi Bazar and Savar Bazar and the lowest one was observed in Navinagar (Figure 4b). As shown in Table 1, during evening, particle of MP_5 size in number ranged from 1459 N-2812 N, (avg. 1915±391 N). Interestingly, particle having size of 5 µm has been increased at evening in the study area by ~1.5 times of same size from morning and by ~1.6 times than those of noon. In the evening, the highest number of particles having 5 µm in size was detected in Tongi Bazar followed by Fatulla (2372 N), Meghna industrial area (2138 N), Kachpur industrial area (1982 N), Kamarpara Bridge (1975 N), Tongi Bsic (1895), Chashara Bazar (1894 N), Masimpur Bata factory (1737 N), Savar EPZ (1698 N), Savar Bazar (1695), Navinagar (1502 N). However, lowest number of 5 µm size particle were observed in Radio colony (1469 N) (Figure 4c).

IV. CONCLUSION

To evaluate the time-resolved variation of particulate (PM) matter in number from the ambient aerosols of Dhaka division we conducted the study in some selected areas of Savar, Gazipur and Narayanganj using Video Particle Counter 300 (VPC 300). In this study, we counted MP0.5, PM2.5 and PM5 in the study areas each day from morning to noon. During morning particle size of 2.5 µm in number ranged from ranged from 3,182-4,038 N, (avg. 3,645±270 N). However, during noon particle having same size (PM2.5 µm) in number ranged from 4,570-5,975 N, (avg. 5,135±401 N). Interestingly, PM2.5 µm size particle has been increased in the study area by ~1.4 times of same size from morning to noon. At the evening particle size of 2.5 µm in number ranged from 5,982 N-8,842 N, (avg. 6,895±831 N). Interestingly, at the evening number of particles having size of 2.5 µm has been increased in the study area by ~1.9 times of same size from morning and by ~1.3 times than that of noon, indicating their sources are anthropogenic including fossil fuel combustion and biomass burning. Number of particles having size of 5 µm has been increased in the study area by ~1.5 times of same size from morning to noon, signifying anthropogenic activities are the significant source of particulates matter in the study area.

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