

Additional Experimental Results

To demonstrate the utility and effectiveness of the **MOBINS** dataset collection, we conduct extensive experiments using various baseline models for mobility networked time-series forecasting. The experiments aim to showcase the diverse challenges and opportunities presented by the datasets. In Table 5 – 8, we use a four-day look-back window and the following abbreviations: “Pred.” means “Prediction”, “Trans.” refers to “Transportation” and “Epic.” denotes “Epidemic”.

Experimental Setup

We evaluate the performance of several state-of-the-art and basic forecasting models, including Linear-based (DLinear, NLinear), RNN-based (SegRNN), Transformer-based (Informer, Reformer, PatchTST), CNN-based (TimesNet), and GNN-based (STGCN, MPNNLSTM) approaches. These models are selected to cover a wide range of architectures and methodologies, ensuring a comprehensive assessment of their capabilities in handling mobility networked time-series data.

The experiments are conducted on the transportation and epidemic datasets from four cities (Seoul, Busan, Daegu, and New York City) and two countries (South Korea and the United States). We consider three different prediction lengths: 7 days, 14 days, and 30 days, to evaluate the models’ performance in both short-term and long-term forecasting scenarios.

Implementations Resource: All baselines are implemented using Python 3.11.5 and PyTorch 2.1.2, and experiments are conducted on a server with an NVIDIA RTX 3090Ti GPU.

Data Splits The datasets are partitioned into training 75% and testing 25% sets. The training data is further divided into a training set 80% and a validation set 20%.

Model Configurations and Hyperparameters

For representation learning, the SGD optimizer is employed with a learning rate of 0.001 and a momentum of 0.9. The prediction model utilizes the Adam optimizer with an initial learning rate of 0.001. Due to the large size of each training instance and GPU memory constraints, the batch size is set to 8 for most datasets. For the computationally demanding Transportation-Seoul dataset, the batch size is reduced to 4. All models are trained for 10 epochs, with early stopping applied if no improvement is observed within 5 epochs. A dropout rate of 0.2 is applied to mitigate overfitting and enhance generalization. To ensure fair and unbiased comparisons with the baseline methods, we adhere to the original model configurations proposed by their respective authors.

Evaluation Metrics

We employ two widely used evaluation metrics, Mean Absolute Error (MAE) and Mean Squared Error (MSE), to assess the performance of the forecasting models. These metrics provide a comprehensive understanding of the models’ accuracy and robustness in handling the complex spatiotemporal patterns present in the **MOBINS** datasets.

Results and Analysis

In the context of mobility networked time-series forecasting, the experiments are conducted to predict three different targets: total, node, and origin-destination movements. Each of these targets provides valuable insights into various aspects of mobility patterns and serves specific purposes in understanding and forecasting human mobility.

- **Total:** We introduce novel forecasting target attributes that encompass both node time series and OD movements. The target dimension is defined as $N^2 + d \cdot N$, where N represents the number of regions and d denotes the number of feature variables associated with each node. This formulation captures the complex interactions between spatial and temporal components, enabling a comprehensive representation of mobility patterns within the network. This target is useful for understanding the aggregate trends and patterns of human mobility across all nodes and edges.
- **Node:** Forecasting at the node level focuses on predicting the local feature at individual nodes or locations within the network. For each node, the target dimension is defined as d . This target is important for understanding the spatial distribution of mobility and identifying hotspots or areas with high mobility activity. Node-level predictions can assist in local transportation planning, traffic management, and resource optimization at specific locations.
- **Origin-Destination:** Predicting OD movements involves forecasting the mobility flows between pairs of nodes in the network. For each node, the target dimension is defined as N . OD predictions provide insights into the directional patterns and connectivity of mobility within the entire network. This target is crucial for understanding the flow of people or vehicles between different locations, which can inform transportation network design, route planning, and demand forecasting.

Mobility networked time-series forecasting evaluations on all three targets simultaneously provide a thorough understanding of mobility patterns at different levels of granularity. Moreover, analyzing the performance of different forecasting models across these targets can provide insights into the strengths and weaknesses of each model in capturing various aspects of mobility patterns.

Table 5 presents the MAE results for a prediction length of 7 days across all datasets. We observe that the CNN-based TimesNet model achieves the lowest MAE in several datasets, particularly in the transportation domain. However, the performance of the models varies depending on the specific dataset and the forecasting target (total, node, or OD).

Table 6 extends the analysis to prediction lengths of 14 and 30 days. The results highlight the challenges associated with longer prediction horizons. Nevertheless, certain models, such as DLinear and TimesNet, maintain relatively lower MAE values even for extended prediction lengths.

Table 7 and Table 8 present the MSE results for the same experimental setup, providing additional insights into the models' performance. The MSE results follow similar trends to the MAE results, with TimesNet and DLinear exhibiting strong performance across all datasets and prediction lengths.

The experimental results show the diversity and complexity of the **MOBINS** dataset collection, as no single model consistently outperforms others across all scenarios. The datasets pose unique challenges, such as handling different transportation modes, capturing spatial dependencies, and modeling long-term temporal patterns. The inclusion of both domains further highlights the versatility of the **MOBINS** in supporting research on various application domains.

The benchmarking experiments serve as a valuable resource for the research community, providing a comprehensive evaluation of state-of-the-art forecasting models on a diverse set of mobility networked time-series datasets. The results can guide future research efforts in developing more advanced and specialized models that can effectively address the challenges presented by the **MOBINS**. Moreover, the experiments showcase the importance of considering multiple prediction lengths to gain a holistic understanding of the models' performance. The MAE and MSE results, along with the varying prediction horizons, provide a nuanced assessment of the models' capabilities in handling different aspects of mobility networked time-series forecasting.

In summary, the experimental results highlight the significance of the **MOBINS** dataset collection in advancing research on mobility forecasting. The diverse and challenging nature of the datasets encourages the development of innovative models and techniques that can effectively capture the complex spatiotemporal patterns and dependencies present in real-world mobility data. The benchmarking experiments serve as a foundation for future research, fostering collaboration and driving progress in this important domain.

Table 5: Prediction comparison between baselines in terms of **MAE** with prediction length of 7 days in all datasets. The best model across each dataset is highlighted in **bold**.

Target	Domain	Dataset	Linear-based		RNN-based SegRNN	Transformer-based			CNN-based TimesNet	GNN-based	
			DLinear	NLinear		Informer	Reformer	PatchTST		STGCN	MPNNLSTM
Total	Trans.	Seoul	0.3858	0.4021	0.7022	0.6463	0.5637	0.3995	0.3822	0.4053	0.6401
			(± 0.0068)	(± 0.0003)	(± 0.0363)	(± 0.0061)	(± 0.0315)	(± 0.0046)	(± 0.0062)	(± 0.0047)	(± 0.0009)
		Busan	0.5743	0.5898	0.9986	0.9511	0.7316	0.6411	0.6103	0.6945	0.9556
			(± 0.0056)	(± 0.0006)	(± 0.0087)	(± 0.0008)	(± 0.0075)	(± 0.0052)	(± 0.0642)	(± 0.0032)	(± 0.0035)
		Daegu	0.4677	0.4919	0.7876	0.7304	0.5338	0.4916	0.4902	0.4901	0.7337
	Epic.	Korea	0.4004	(± 0.0003)	(± 0.0597)	(± 0.0017)	(± 0.0014)	(± 0.0011)	(± 0.0087)	(± 0.0032)	(± 0.0018)
			0.4491	0.4460	0.9226	0.7183	0.5503	0.4687	0.3984	0.4601	0.6627
		NYC	(± 0.0011)	(± 0.0005)	(± 0.0462)	(± 0.0041)	(± 0.0036)	(± 0.0027)	(± 0.0024)	(± 0.0019)	(± 0.0015)
			0.5767	0.5828	0.5936	1.0179	0.7137	0.6014	0.4133	0.7427	0.7827
		NYC	(± 0.0031)	(± 0.0015)	(± 0.0072)	(± 0.0003)	(± 0.0320)	(± 0.0392)	(± 0.0058)	(± 0.0199)	(± 0.0062)
Node	Trans.	Seoul	0.4830	0.4666	0.4896	0.7334	0.5945	0.5026	0.3948	0.5794	0.6934
			(± 0.0016)	(± 0.0022)	(± 0.0179)	(± 0.0005)	(± 0.0165)	(± 0.0044)	(± 0.0033)	(± 0.0038)	(± 0.0062)
		Busan	0.3361	0.4877	0.8475	0.7452	0.6216	0.3812	0.4309	0.5128	0.7408
			(± 0.0075)	(± 0.0017)	(± 0.0420)	(± 0.0010)	(± 0.0381)	(± 0.0094)	(± 0.0139)	(± 0.0048)	(± 0.0078)
		Daegu	0.2491	0.2200	0.8835	0.8746	0.3895	0.2833	0.2944	0.3261	0.8563
	Epic.	Korea	(± 0.0051)	(± 0.0011)	(± 0.0065)	(± 0.0006)	(± 0.0063)	(± 0.0107)	(± 0.1290)	(± 0.0021)	(± 0.0245)
			0.2615	0.2306	0.8484	0.8694	0.3934	0.2913	0.2486	0.2893	0.8286
		NYC	(± 0.0040)	(± 0.0007)	(± 0.1097)	(± 0.0024)	(± 0.0061)	(± 0.0060)	(± 0.0207)	(± 0.0041)	(± 0.0246)
			0.2668	0.2063	0.8209	0.8159	0.4708	0.2639	0.1887	0.2168	0.5784
		NYC	(± 0.0020)	(± 0.0015)	(± 0.0043)	(± 0.0064)	(± 0.0181)	(± 0.0046)	(± 0.0102)	(± 0.0032)	(± 0.0037)
	Trans.	Seoul	0.1438	0.1537	0.1502	0.2914	0.4604	0.1424	0.2112	0.4145	0.4737
			(± 0.0016)	(± 0.0010)	(± 0.0171)	(± 0.0047)	(± 0.1112)	(± 0.0127)	(± 0.0089)	(± 0.0301)	(± 0.0284)
		NYC	0.1058	0.0333	0.1297	0.4133	0.1809	0.1794	0.0232	0.2303	0.4781
			(± 0.0036)	(± 0.0007)	(± 0.0359)	(± 0.008)	(± 0.0536)	(± 0.0098)	(± 0.0005)	(± 0.0343)	(± 0.0245)
OD	Trans.	Seoul	0.3865	0.4008	0.6999	0.6448	0.5628	0.3998	0.3814	0.4037	0.6385
			(± 0.0068)	(± 0.0003)	(± 0.0363)	(± 0.0062)	(± 0.0314)	(± 0.0046)	(± 0.0061)	(± 0.0048)	(± 0.0010)
		Busan	0.5851	0.6021	1.0024	0.9537	0.7431	0.6530	0.6208	0.7067	0.9589
			(± 0.0056)	(± 0.0006)	(± 0.0088)	(± 0.0009)	(± 0.0077)	(± 0.0050)	(± 0.0621)	(± 0.0033)	(± 0.0044)
		Daegu	0.4744	0.5004	0.7856	0.7258	0.5384	0.4982	0.4981	0.4966	0.7306
	Epic.	Korea	(± 0.0004)	(± 0.0003)	(± 0.0580)	(± 0.0019)	(± 0.0013)	(± 0.0010)	(± 0.0083)	(± 0.0032)	(± 0.0025)
			0.4856	0.4939	0.9430	0.6987	0.5662	0.5096	0.4404	0.5088	0.6796
		NYC	(± 0.0011)	(± 0.0008)	(± 0.0546)	(± 0.0036)	(± 0.0041)	(± 0.0026)	(± 0.0017)	(± 0.0027)	(± 0.0014)
			0.6038	0.6096	0.6213	1.0634	0.7295	0.6301	0.4259	0.7632	0.8020
		NYC	(± 0.0032)	(± 0.0016)	(± 0.0070)	(± 0.0005)	(± 0.0317)	(± 0.0409)	(± 0.0064)	(± 0.0228)	(± 0.0083)
OD	Trans.	Seoul	0.5585	0.5532	0.5616	0.7974	0.6772	0.5672	0.4691	0.6492	0.7364
			(± 0.0012)	(± 0.0026)	(± 0.0144)	(± 0.001)	(± 0.0201)	(± 0.0037)	(± 0.0041)	(± 0.0056)	(± 0.0043)
		Busan	0.4744	0.5004	0.7856	0.7258	0.5384	0.4982	0.4981	0.4966	0.7306
			(± 0.0004)	(± 0.0003)	(± 0.0580)	(± 0.0019)	(± 0.0013)	(± 0.0010)	(± 0.0083)	(± 0.0032)	(± 0.0025)
		Daegu	0.4856	0.4939	0.9430	0.6987	0.5662	0.5096	0.4404	0.5088	0.6796
	Epic.	Korea	(± 0.0011)	(± 0.0008)	(± 0.0546)	(± 0.0036)	(± 0.0041)	(± 0.0026)	(± 0.0017)	(± 0.0027)	(± 0.0014)
			0.6038	0.6096	0.6213	1.0634	0.7295	0.6301	0.4259	0.7632	0.8020
		NYC	(± 0.0032)	(± 0.0016)	(± 0.0070)	(± 0.0005)	(± 0.0317)	(± 0.0409)	(± 0.0064)	(± 0.0228)	(± 0.0083)
			0.5585	0.5532	0.5616	0.7974	0.6772	0.5672	0.4691	0.6492	0.7364
		NYC	(± 0.0012)	(± 0.0026)	(± 0.0144)	(± 0.001)	(± 0.0201)	(± 0.0037)	(± 0.0041)	(± 0.0056)	(± 0.0043)

Table 6: Prediction comparison between baselines in terms of **MAE** on all prediction lengths of 14 and 30 days in all datasets. The best model across each dataset is highlighted in **bold**.

Pred. day	Target	Domain	Dataset	Linear-based		RNN-based	Transformer-based			CNN-based	GNN-based	
				DLinear	NLinear	SegRNN	Informer	Reformer	PatchTST	TimesNet	STGCN	MPNNLSTM
14 days	Total	Trans.	Seoul	0.3878 (± 0.0047)	0.4072 (± 0.0003)	0.7183 (± 0.0071)	0.6453 (± 0.0043)	0.6310 (± 0.0105)	0.4006 (± 0.0028)	0.4015 (± 0.0312)	0.4182 (± 0.0257)	0.6399 (± 0.0013)
			Busan	0.5830 (± 0.0075)	0.5934 (± 0.0003)	0.9913 (± 0.0243)	0.9482 (± 0.0012)	0.7434 (± 0.0045)	0.6324 (± 0.0023)	0.6175 (± 0.0611)	0.6862 (± 0.0044)	0.9528 (± 0.0040)
			Daegu	0.4696 (± 0.0004)	0.4942 (± 0.0004)	0.8154 (± 0.0039)	0.7284 (± 0.0004)	0.5486 (± 0.0045)	0.4919 (± 0.0007)	0.4826 (± 0.0033)	0.4888 (± 0.0021)	0.7323 (± 0.0009)
			NYC	0.4579 (± 0.0023)	0.4501 (± 0.0004)	0.9027 (± 0.0237)	0.7229 (± 0.004)	0.5623 (± 0.0071)	0.4680 (± 0.0011)	0.3988 (± 0.0017)	0.4629 (± 0.0023)	0.6624 (± 0.0008)
	Epic.	Korea		0.6258 (± 0.0006)	0.6088 (± 0.0010)	0.6484 (± 0.0210)	1.0182 (± 0.0116)	0.8025 (± 0.0180)	0.6467 (± 0.0196)	0.4562 (± 0.0063)	0.7726 (± 0.0269)	0.8003 (± 0.0075)
			NYC	0.5008 (± 0.0008)	0.4784 (± 0.0016)	0.5341 (± 0.0298)	0.7046 (± 0.0402)	0.6012 (± 0.0169)	0.5100 (± 0.0048)	0.4026 (± 0.0033)	0.5855 (± 0.0069)	0.6970 (± 0.0095)
	Node	Trans.	Seoul	0.3398 (± 0.0060)	0.4994 (± 0.0011)	0.8797 (± 0.0048)	0.7466 (± 0.0017)	0.7248 (± 0.0214)	0.3803 (± 0.0060)	0.4622 (± 0.0533)	0.5215 (± 0.0140)	0.7436 (± 0.0034)
			Busan	0.2521 (± 0.0033)	0.2227 (± 0.0004)	0.8912 (± 0.0059)	0.8729 (± 0.0011)	0.4278 (± 0.0065)	0.2797 (± 0.0023)	0.2972 (± 0.0941)	0.3226 (± 0.0118)	0.8438 (± 0.0286)
			Daegu	0.2613 (± 0.0043)	0.2348 (± 0.0011)	0.8990 (± 0.0031)	0.8711 (± 0.0002)	0.4435 (± 0.0092)	0.2943 (± 0.0025)	0.2382 (± 0.0040)	0.2923 (± 0.0071)	0.8605 (± 0.0128)
			NYC	0.2736 (± 0.0028)	0.2116 (± 0.0015)	0.9098 (± 0.1112)	0.8188 (± 0.0098)	0.5264 (± 0.0191)	0.2592 (± 0.0056)	0.1821 (± 0.0054)	0.2215 (± 0.0101)	0.5805 (± 0.0029)
	Epic.	Korea		0.1705 (± 0.0008)	0.1808 (± 0.0014)	0.2124 (± 0.0596)	0.297 (± 0.007)	0.4644 (± 0.1329)	0.1635 (± 0.0090)	0.3266 (± 0.0270)	0.4691 (± 0.0473)	0.3386 (± 0.0136)
			NYC	0.1321 (± 0.0018)	0.0396 (± 0.0005)	0.1682 (± 0.0482)	0.3871 (± 0.0744)	0.1934 (± 0.0728)	0.1776 (± 0.0126)	0.0269 (± 0.0010)	0.2783 (± 0.0662)	0.4274 (± 0.0101)
	OD	Trans.	Seoul	0.3885 (± 0.0047)	0.4058 (± 0.0003)	0.7158 (± 0.0072)	0.6437 (± 0.0044)	0.6295 (± 0.0104)	0.4009 (± 0.0028)	0.4006 (± 0.0309)	0.4165 (± 0.0259)	0.6383 (± 0.0013)
			Busan	0.5941 (± 0.0076)	0.6058 (± 0.0003)	0.9946 (± 0.0250)	0.9507 (± 0.0013)	0.7539 (± 0.0044)	0.6441 (± 0.0024)	0.6282 (± 0.0601)	0.6984 (± 0.0045)	0.9565 (± 0.0049)
			Daegu	0.4764 (± 0.0004)	0.5027 (± 0.0004)	0.8126 (± 0.0041)	0.7237 (± 0.0004)	0.5521 (± 0.0045)	0.4984 (± 0.0006)	0.4906 (± 0.0035)	0.4952 (± 0.0020)	0.7281 (± 0.0013)
			NYC	0.4948 (± 0.0023)	0.4978 (± 0.0003)	0.9012 (± 0.0061)	0.7037 (± 0.0028)	0.5694 (± 0.0059)	0.5097 (± 0.0010)	0.4422 (± 0.0015)	0.5112 (± 0.0011)	0.6787 (± 0.0009)
	Epic.	Korea		0.6543 (± 0.0007)	0.6355 (± 0.0011)	0.6757 (± 0.0199)	1.0633 (± 0.0119)	0.8236 (± 0.0214)	0.6769 (± 0.0203)	0.4643 (± 0.0071)	0.7916 (± 0.0260)	0.8292 (± 0.0085)
			NYC	0.5746 (± 0.0006)	0.5661 (± 0.0019)	0.6072 (± 0.0265)	0.7681 (± 0.0336)	0.6828 (± 0.0098)	0.5765 (± 0.0036)	0.4778 (± 0.0039)	0.6470 (± 0.0083)	0.7509 (± 0.0098)
30 days	Total	Trans.	Seoul	0.3924 (± 0.0020)	0.5949 (± 0.0001)	0.7503 (± 0.0708)	0.6425 (± 0.0006)	0.6446 (± 0.0059)	0.4082 (± 0.0034)	0.4082 (± 0.0095)	0.4215 (± 0.0075)	0.6431 (± 0.0016)
			Busan	0.5985 (± 0.0023)	0.6038 (± 0.0004)	0.9622 (± 0.0453)	0.9365 (± 0.0024)	0.7654 (± 0.0241)	0.6424 (± 0.0028)	0.5969 (± 0.0126)	0.6759 (± 0.0015)	0.9402 (± 0.0001)
			Daegu	0.4750 (± 0.0004)	0.5006 (± 0.0004)	0.8132 (± 0.0057)	0.7285 (± 0.0021)	0.5849 (± 0.0124)	0.4957 (± 0.0017)	0.4846 (± 0.0023)	0.4923 (± 0.0017)	0.7315 (± 0.0012)
			NYC	0.4747 (± 0.0019)	0.4592 (± 0.0004)	0.9075 (± 0.0185)	0.723 (± 0.0013)	0.5709 (± 0.0122)	0.4811 (± 0.0022)	0.4054 (± 0.0040)	0.4627 (± 0.0045)	0.6598 (± 0.0005)
	Epic.	Korea		0.7035 (± 0.0028)	0.6479 (± 0.0012)	0.7318 (± 0.0504)	1.0122 (± 0.0077)	1.1443 (± 0.0469)	0.7268 (± 0.0197)	0.5049 (± 0.0118)	0.8537 (± 0.0500)	0.8247 (± 0.0172)
			NYC	0.5304 (± 0.0014)	0.4875 (± 0.0010)	0.5272 (± 0.0286)	0.7243 (± 0.0138)	0.6370 (± 0.0121)	0.5408 (± 0.0068)	0.4068 (± 0.0044)	0.6154 (± 0.0189)	0.6932 (± 0.0104)
	Node	Trans.	Seoul	0.3578 (± 0.0037)	0.5325 (± 0.0049)	0.9008 (± 0.0345)	0.7472 (± 0.0002)	0.7465 (± 0.0014)	0.3990 (± 0.0064)	0.4718 (± 0.0157)	0.5271 (± 0.0067)	0.7432 (± 0.0061)
			Busan	0.2634 (± 0.0033)	0.2318 (± 0.0006)	0.8908 (± 0.0043)	0.8718 (± 0.0008)	0.4956 (± 0.0363)	0.2922 (± 0.0081)	0.2568 (± 0.0270)	0.3260 (± 0.0040)	0.8744 (± 0.0007)
			Daegu	0.2742 (± 0.0041)	0.2426 (± 0.0007)	0.8999 (± 0.0021)	0.8687 (± 0.0009)	0.5099 (± 0.0177)	0.3077 (± 0.0113)	0.2386 (± 0.0048)	0.3038 (± 0.0048)	0.8511 (± 0.0066)
			NYC	0.2901 (± 0.0011)	0.2249 (± 0.0018)	0.9590 (± 0.0535)	0.8207 (± 0.0041)	0.5501 (± 0.0229)	0.2727 (± 0.0075)	0.1926 (± 0.0052)	0.2227 (± 0.0140)	0.5590 (± 0.0018)
	Epic.	Korea		0.2081 (± 0.0021)	0.2325 (± 0.0014)	0.2838 (± 0.0395)	0.3082 (± 0.0099)	0.4080 (± 0.0333)	0.2044 (± 0.0055)	0.4044 (± 0.0427)	0.4385 (± 0.0211)	0.3545 (± 0.0523)
			NYC	0.1819 (± 0.0029)	0.0526 (± 0.0011)	0.1380 (± 0.0764)	0.4089 (± 0.0085)	0.3094 (± 0.1230)	0.2218 (± 0.0178)	0.0372 (± 0.0007)	0.4003 (± 0.1689)	0.6057 (± 0.0555)
	OD	Trans.	Seoul	0.3929 (± 0.0020)	0.5959 (± 0.0000)	0.7479 (± 0.0714)	0.6409 (± 0.0006)	0.6431 (± 0.0060)	0.4084 (± 0.0033)	0.4072 (± 0.0095)	0.4198 (± 0.0075)	0.6415 (± 0.0017)
			Busan	0.6096 (± 0.0023)	0.6162 (± 0.0004)	0.9645 (± 0.0467)	0.9387 (± 0.0025)	0.7744 (± 0.0237)	0.6541 (± 0.0027)	0.6082 (± 0.0121)	0.6875 (± 0.0015)	0.9424 (± 0.0001)
			Daegu	0.4816 (± 0.0003)	0.5090 (± 0.0004)	0.8104 (± 0.0059)	0.7239 (± 0.0022)	0.5874 (± 0.0122)	0.5019 (± 0.0014)	0.4927 (± 0.0023)	0.4984 (± 0.0018)	0.7276 (± 0.0015)
			NYC	0.5116 (± 0.0024)	0.5060 (± 0.0007)	0.8972 (± 0.0116)	0.7034 (± 0.0015)	0.5228 (± 0.0104)	0.5228 (± 0.0022)	0.4480 (± 0.0042)	0.5107 (± 0.0027)	0.6799 (± 0.0004)
	Epic.	Korea		0.7344 (± 0.0029)	0.6739 (± 0.0012)	0.7598 (± 0.0515)	1.0562 (± 0.0079)	1.1903 (± 0.0501)	0.7594 (± 0.0206)	0.5112 (± 0.0130)	0.8797 (± 0.0527)	0.8541 (± 0.0210)
			NYC	0.6000 (± 0.0011)	0.5745 (± 0.0013)	0.6050 (± 0.0197)	0.7874 (± 0.0149)	0.7026 (± 0.0118)	0.6047 (± 0.0047)	0.4807 (± 0.0054)	0.6584 (± 0.0115)	0.7107 (± 0.0022)

Table 7: Prediction comparison between baselines in terms of **MSE** with prediction length of 7 days in all datasets. The best model across each dataset is highlighted in **bold**.

Target	Domain	Dataset	Linear-based		RNN-based SegRNN	Transformer-based			CNN-based TimesNet	GNN-based	
			DLinear	NLinear		Informer	Reformer	PatchTST		STGCN	MPNNLSTM
Total	Trans.	Seoul	0.4683 (± 0.0046)	0.4915 (± 0.0001)	1.0726 (± 0.0683)	0.9204 (± 0.0018)	0.7600 (± 0.0456)	0.4982 (± 0.0028)	0.4579 (± 0.0080)	0.4751 (± 0.0028)	0.8940 (± 0.0343)
			1.8058 (± 0.0493)	1.7632 (± 0.0051)	3.3191 (± 0.0354)	3.4773 (± 0.0031)	2.9105 (± 0.0160)	2.2448 (± 0.0703)	1.8302 (± 0.3993)	2.7304 (± 0.0121)	3.4267 (± 0.0607)
		Busan	0.8814 (± 0.0035)	0.9225 (± 0.0003)	1.5019 (± 0.0147)	1.3885 (± 0.0038)	1.0217 (± 0.0069)	0.9391 (± 0.0039)	0.8677 (± 0.0074)	0.9007 (± 0.0025)	1.3329 (± 0.0317)
		Daegu	0.5552 (± 0.0010)	0.5715 (± 0.0005)	1.5550 (± 0.0589)	0.9147 (± 0.007)	0.7086 (± 0.0050)	0.5782 (± 0.0022)	0.4986 (± 0.0013)	0.5844 (± 0.0033)	0.8168 (± 0.0029)
		NYC									
	Epic.	Korea	0.6468 (± 0.0041)	0.6798 (± 0.0033)	0.7147 (± 0.0156)	1.7884 (± 0.0013)	0.9047 (± 0.0613)	0.7118 (± 0.0675)	0.3920 (± 0.0112)	0.9667 (± 0.0472)	1.0456 (± 0.0244)
		NYC	0.6251 (± 0.0003)	0.6783 (± 0.0061)	0.6396 (± 0.0033)	1.0627 (± 0.0015)	0.7461 (± 0.0297)	0.6164 (± 0.0030)	0.5648 (± 0.0056)	0.7250 (± 0.0155)	0.8578 (± 0.0148)
Node	Trans.	Seoul	0.3369 (± 0.0070)	0.7280 (± 0.0078)	1.3204 (± 0.0816)	1.0823 (± 0.0053)	0.8089 (± 0.0688)	0.4013 (± 0.0089)	0.6133 (± 0.0306)	0.6791 (± 0.0082)	1.0563 (± 0.0443)
			0.2087 (± 0.0052)	0.1687 (± 0.0014)	1.3088 (± 0.0249)	1.2207 (± 0.0034)	0.3780 (± 0.0132)	0.2330 (± 0.0124)	0.3099 (± 0.2639)	0.2767 (± 0.0024)	1.1689 (± 0.0634)
		Busan	0.2428 (± 0.0043)	0.1903 (± 0.0005)	1.3689 (± 0.0164)	1.2103 (± 0.0099)	0.4103 (± 0.0119)	0.2717 (± 0.0088)	0.1958 (± 0.0167)	0.2493 (± 0.0043)	1.1054 (± 0.0622)
		Daegu	0.2221 (± 0.0017)	0.1544 (± 0.0010)	1.3245 (± 0.0120)	0.9741 (± 0.0105)	0.5100 (± 0.0258)	0.1965 (± 0.0064)	0.1041 (± 0.0038)	0.1335 (± 0.0038)	0.5093 (± 0.0091)
		NYC									
	Epic.	Korea	0.0450 (± 0.0008)	0.0538 (± 0.0009)	0.0476 (± 0.0132)	0.1743 (± 0.0028)	0.3786 (± 0.1641)	0.0456 (± 0.0079)	0.0989 (± 0.0088)	0.2870 (± 0.0311)	0.3962 (± 0.0419)
		NYC	0.0126 (± 0.0008)	0.0023 (± 0.0001)	0.0200 (± 0.0092)	0.1777 (± 0.0067)	0.0504 (± 0.0281)	0.0341 (± 0.0035)	0.0012 (± 0.0001)	0.0938 (± 0.0323)	0.2736 (± 0.0401)
OD	Trans.	Seoul	0.4703 (± 0.0046)	0.4878 (± 0.0002)	1.0688 (± 0.0683)	0.9179 (± 0.0017)	0.7592 (± 0.0453)	0.4998 (± 0.0028)	0.4555 (± 0.0079)	0.4719 (± 0.0029)	0.8915 (± 0.0342)
			1.8590 (± 0.0508)	1.8163 (± 0.0052)	3.3861 (± 0.0358)	3.5525 (± 0.0031)	2.9949 (± 0.0162)	2.3118 (± 0.0724)	1.8808 (± 0.4039)	2.8122 (± 0.0125)	3.5020 (± 0.0606)
		Busan	0.9023 (± 0.0035)	0.9465 (± 0.0003)	1.5063 (± 0.0147)	1.3944 (± 0.0036)	1.0418 (± 0.0068)	0.9610 (± 0.0037)	0.8897 (± 0.0072)	0.9221 (± 0.0025)	1.3403 (± 0.0307)
		Daegu	0.6218 (± 0.0011)	0.6549 (± 0.0007)	1.6011 (± 0.0683)	0.9028 (± 0.0063)	0.7483 (± 0.0031)	0.6545 (± 0.0021)	0.5775 (± 0.0018)	0.6746 (± 0.0033)	0.8783 (± 0.0021)
		NYC									
	Epic.	Korea	0.6844 (± 0.0043)	0.7189 (± 0.0035)	0.7564 (± 0.0167)	1.8893 (± 0.0015)	0.9376 (± 0.0623)	0.7534 (± 0.0712)	0.4103 (± 0.0119)	1.0091 (± 0.0518)	1.0862 (± 0.0284)
		NYC	0.7475 (± 0.0005)	0.8135 (± 0.0073)	0.7635 (± 0.0037)	1.2397 (± 0.0025)	0.8852 (± 0.0370)	0.7328 (± 0.0039)	0.6775 (± 0.0068)	0.8513 (± 0.0206)	0.9746 (± 0.0162)

Table 8: Prediction comparison between baselines in terms of **MSE** on all prediction lengths of 14 and 30 days in all datasets. The best model across each dataset is highlighted in **bold**.

Pred. day	Target	Domain	Dataset	Linear-based		RNN-based	Transformer-based			CNN-based	GNN-based	
				DLinear	NLinear	SegRNN	Informer	Reformer	PatchTST	TimesNet	STGCN	MPNNLSTM
14 days	Total	Trans.	Seoul	0.4754 (± 0.0055)	0.5009 (± 0.0004)	1.0857 (± 0.0331)	0.925 (± 0.0009)	0.8965 (± 0.0269)	0.4987 (± 0.0028)	0.4841 (± 0.0332)	0.4939 (± 0.0406)	0.9083 (± 0.0087)
			Busan	1.8659 (± 0.0731)	1.7816 (± 0.0017)	3.2825 (± 0.0452)	3.3829 (± 0.0062)	2.9151 (± 0.0175)	2.1587 (± 0.0444)	1.8270 (± 0.3332)	2.6599 (± 0.0305)	3.3065 (± 0.0740)
			Daegu	0.8847 (± 0.0034)	0.9288 (± 0.0003)	1.4976 (± 0.0097)	1.3923 (± 0.0005)	1.0727 (± 0.0049)	0.9431 (± 0.0024)	0.8663 (± 0.0032)	0.9032 (± 0.0048)	1.3752 (± 0.0163)
			NYC	0.5649 (± 0.0018)	0.5774 (± 0.0007)	1.8069 (± 0.2805)	0.9205 (± 0.0101)	0.7254 (± 0.0114)	0.5809 (± 0.0033)	0.5012 (± 0.0035)	0.5813 (± 0.0049)	0.8117 (± 0.0011)
	Epic.	Korea		0.7446 (± 0.0016)	0.7321 (± 0.0029)	0.8168 (± 0.0229)	1.7883 (± 0.0356)	1.1092 (± 0.0454)	0.7999 (± 0.0367)	0.4522 (± 0.0119)	1.0317 (± 0.0591)	1.1092 (± 0.0226)
			NYC	0.6477 (± 0.0005)	0.7043 (± 0.0021)	0.8118 (± 0.0403)	0.9835 (± 0.1062)	0.7496 (± 0.0134)	0.6357 (± 0.0051)	0.5877 (± 0.0053)	0.7307 (± 0.0089)	0.8832 (± 0.0167)
	Node	Trans.	Seoul	0.3483 (± 0.0076)	0.7406 (± 0.0040)	1.3799 (± 0.0100)	1.0898 (± 0.0048)	1.0394 (± 0.0516)	0.4033 (± 0.0101)	0.6238 (± 0.0338)	0.6987 (± 0.0327)	1.0758 (± 0.0147)
			Busan	0.2125 (± 0.0031)	0.1705 (± 0.0008)	1.3251 (± 0.0383)	1.2115 (± 0.0059)	0.4655 (± 0.0170)	0.2336 (± 0.0075)	0.2938 (± 0.1905)	0.2728 (± 0.0192)	1.1346 (± 0.0755)
			Daegu	0.2429 (± 0.0049)	0.1942 (± 0.0005)	1.3540 (± 0.0099)	1.2187 (± 0.0009)	0.5036 (± 0.0159)	0.2745 (± 0.0052)	0.1873 (± 0.0058)	0.2548 (± 0.0105)	1.1866 (± 0.0320)
			NYC	0.2296 (± 0.0025)	0.1620 (± 0.0016)	1.7131 (± 0.4097)	0.9794 (± 0.018)	0.6224 (± 0.0353)	0.1955 (± 0.0071)	0.1047 (± 0.0049)	0.1372 (± 0.0086)	0.5201 (± 0.0071)
	Epic.	Korea		0.0639 (± 0.0006)	0.0729 (± 0.0015)	0.0595 (± 0.0176)	0.1814 (± 0.0065)	0.5117 (± 0.2590)	0.0599 (± 0.0066)	0.2356 (± 0.0336)	0.3511 (± 0.0517)	0.1904 (± 0.0165)
			NYC	0.0200 (± 0.0006)	0.0031 (± 0.0001)	0.0753 (± 0.0297)	0.1628 (± 0.0538)	0.0599 (± 0.0388)	0.0344 (± 0.0045)	0.0015 (± 0.0001)	0.1525 (± 0.0756)	0.1999 (± 0.0147)
	OD	Trans.	Seoul	0.4774 (± 0.0055)	0.4971 (± 0.0004)	1.0812 (± 0.0335)	0.9224 (± 0.0009)	0.8943 (± 0.0265)	0.5002 (± 0.0029)	0.4819 (± 0.0332)	0.4907 (± 0.0407)	0.9057 (± 0.0086)
			Busan	1.9210 (± 0.0754)	1.8353 (± 0.0018)	3.3477 (± 0.0455)	3.4553 (± 0.0062)	2.9968 (± 0.0175)	2.2228 (± 0.0459)	1.8781 (± 0.3380)	2.7394 (± 0.0312)	3.3789 (± 0.0739)
			Daegu	0.9058 (± 0.0034)	0.9529 (± 0.0003)	1.5023 (± 0.0098)	1.398 (± 0.0005)	1.0914 (± 0.0046)	0.9651 (± 0.0023)	0.8886 (± 0.0031)	0.9245 (± 0.0046)	1.3813 (± 0.0158)
			NYC	0.6320 (± 0.0018)	0.6605 (± 0.0010)	1.8257 (± 0.2547)	0.9087 (± 0.0085)	0.7460 (± 0.0075)	0.6580 (± 0.0027)	0.5805 (± 0.0037)	0.6702 (± 0.0043)	0.8700 (± 0.0014)
	Epic.	Korea		0.7872 (± 0.0016)	0.7733 (± 0.0030)	0.8641 (± 0.0247)	1.8887 (± 0.0374)	1.1465 (± 0.0513)	0.8461 (± 0.0386)	0.4657 (± 0.0134)	1.0743 (± 0.0598)	1.1666 (± 0.0247)
			NYC	0.7732 (± 0.0006)	0.8445 (± 0.0025)	0.8579 (± 0.0425)	1.1476 (± 0.1169)	0.8876 (± 0.0108)	0.7560 (± 0.0069)	0.7049 (± 0.0064)	0.8464 (± 0.0153)	1.0198 (± 0.0179)
30 days	Total	Trans.	Seoul	0.4856 (± 0.0028)	1.2057 (± 0.0001)	1.1977 (± 0.2379)	0.9256 (± 0.0004)	0.9238 (± 0.0058)	0.5096 (± 0.0030)	0.5124 (± 0.0253)	0.4978 (± 0.0089)	0.9131 (± 0.0121)
			Busan	1.9863 (± 0.0209)	1.8554 (± 0.0017)	3.1961 (± 0.0418)	3.2106 (± 0.0075)	2.8411 (± 0.0368)	2.2609 (± 0.0437)	1.7123 (± 0.0178)	2.4957 (± 0.0076)	3.1581 (± 0.0009)
			Daegu	0.9059 (± 0.0038)	0.9444 (± 0.0004)	1.5050 (± 0.0141)	1.3895 (± 0.0031)	1.1261 (± 0.0171)	0.9566 (± 0.0040)	0.8728 (± 0.0047)	0.9098 (± 0.0029)	1.3662 (± 0.0076)
			NYC	0.5831 (± 0.0017)	0.5939 (± 0.0007)	1.9310 (± 0.1419)	0.921 (± 0.0057)	0.7393 (± 0.0222)	0.5909 (± 0.0016)	0.5156 (± 0.0051)	0.5723 (± 0.0062)	0.8016 (± 0.0009)
	Epic.	Korea		0.9131 (± 0.0053)	0.8057 (± 0.0022)	0.9781 (± 0.0985)	1.7655 (± 0.0238)	2.1262 (± 0.1555)	0.9837 (± 0.0417)	0.5348 (± 0.0193)	1.2454 (± 0.1215)	1.1744 (± 0.0614)
			NYC	0.6840 (± 0.0009)	0.7176 (± 0.0014)	0.7549 (± 0.0265)	1.0384 (± 0.0414)	0.7901 (± 0.0095)	0.6696 (± 0.0053)	0.5900 (± 0.0080)	0.7990 (± 0.0470)	0.8943 (± 0.0330)
	Node	Trans.	Seoul	0.3834 (± 0.0050)	0.8492 (± 0.0049)	1.4603 (± 0.1539)	1.0963 (± 0.0003)	1.0921 (± 0.0097)	0.4347 (± 0.0067)	0.6461 (± 0.0219)	0.7091 (± 0.0110)	1.0770 (± 0.0231)
			Busan	0.2267 (± 0.0042)	0.1828 (± 0.0010)	1.3197 (± 0.0376)	1.2076 (± 0.0069)	0.5904 (± 0.0555)	0.2510 (± 0.0111)	0.2016 (± 0.0326)	0.2765 (± 0.0073)	1.1551 (± 0.0035)
			Daegu	0.2619 (± 0.0058)	0.2060 (± 0.0009)	1.3716 (± 0.0124)	1.2129 (± 0.0057)	0.6033 (± 0.0280)	0.2927 (± 0.0116)	0.1918 (± 0.0064)	0.2694 (± 0.0059)	1.1687 (± 0.0145)
			NYC	0.2457 (± 0.0035)	0.1775 (± 0.0011)	1.9009 (± 0.1848)	0.9829 (± 0.0093)	0.6855 (± 0.0447)	0.2069 (± 0.0085)	0.1194 (± 0.0072)	0.1455 (± 0.0108)	0.5052 (± 0.0032)
	Epic.	Korea		0.0971 (± 0.0015)	0.1201 (± 0.0015)	0.1254 (± 0.0250)	0.1937 (± 0.0084)	0.2629 (± 0.0407)	0.0938 (± 0.0067)	0.3802 (± 0.0742)	0.3172 (± 0.0233)	0.2234 (± 0.0737)
			NYC	0.0382 (± 0.0011)	0.0052 (± 0.0002)	0.0291 (± 0.0263)	0.1727 (± 0.0068)	0.1585 (± 0.0989)	0.0549 (± 0.0076)	0.0029 (± 0.0001)	0.4336 (± 0.3489)	0.7204 (± 0.1752)
	OD	Trans.	Seoul	0.4872 (± 0.0028)	1.2113 (± 0.0000)	1.1936 (± 0.2393)	0.923 (± 0.0004)	0.9211 (± 0.0057)	0.5108 (± 0.0029)	0.5103 (± 0.0255)	0.4945 (± 0.0089)	0.9106 (± 0.0119)
			Busan	2.0449 (\pm)	1.9112 (± 0.0017)	3.2587 (± 0.0433)	3.2774 (± 0.0075)	2.9162 (± 0.0362)	2.3279 (± 0.0450)	1.7627 (± 0.0174)	2.5696 (± 0.0076)	3.2248 (± 0.0008)
			Daegu	0.9270 (± 0.0037)	0.9686 (± 0.0004)	1.5094 (± 0.0141)	1.3952 (± 0.003)	1.1433 (± 0.0168)	0.9784 (± 0.0037)	0.8951 (± 0.0047)	0.9308 (± 0.0028)	1.3727 (± 0.0073)
			NYC	0.6506 (± 0.0025)	0.6772 (± 0.0010)	1.9370 (± 0.1334)	0.9086 (± 0.005)	0.7500 (± 0.0180)	0.6677 (± 0.0009)	0.5948 (± 0.0056)	0.6577 (± 0.0053)	0.8609 (± 0.0006)
	Epic.	Korea		0.9641 (± 0.0055)	0.8486 (± 0.0023)	1.0314 (± 0.1035)	1.8638 (± 0.0251)	2.2427 (± 0.1661)	1.0393 (± 0.0440)	0.5445 (± 0.0211)	1.3034 (± 0.1286)	1.2339 (± 0.0691)
			NYC	0.8131 (± 0.0010)	0.8601 (± 0.0017)	0.9000 (± 0.0346)	1.2116 (± 0.0483)	0.9164 (± 0.0152)	0.7926 (± 0.0072)	0.7074 (± 0.0096)	0.8721 (± 0.0149)	0.9290 (± 0.0052)