

# Cairo Traffic Congestion Study

## Phase 1

Final Report  
November 2010

This report was prepared by ECORYS Nederland BV and SETS Lebanon for the World Bank and the Government of Egypt, with funding provided by the Dutch - Egypt Public Expenditure Review Trust Fund.

The project was managed by a World Bank team including Messrs. Ziad Nakat, Transport Specialist and Team Leader, and Santiago Herrera, Lead Country Economist.

# Table of Content

<b>Executive Summary</b>	<b>xi</b>
Study motivation	xi
Study area	xi
Data collection	xi
Observed Modal Split	xii
Identification of Causes, Types and Locations of Traffic Congestion	xii
Estimation of Direct Economic Costs of Traffic Congestion in Cairo	xiv
<b>1 Introduction</b>	<b>17</b>
1.1 Background	17
1.2 Objective of the Study	18
1.3 Structure of this report	18
<b>2 Assessment of Information Needs and Collection of Additional Data</b>	<b>19</b>
2.1 Introduction	19
2.2 Task Description/Objectives	22
2.3 Study area	22
2.4 Assessment of Data and Information Needs	24
2.5 Floating Car Survey and Traffic Counts	25
2.5.1 Data Collection Objectives	25
2.5.2 Data Collection Techniques	25
2.5.3 Technical Plan Development Methodology	25
2.5.4 Development of Data Collection Technical Plan	29
2.5.5 Data Collection Operational Plan	32
2.6 Peak Hours	35
2.7 Traffic Composition in the Corridors	36
2.8 Modal Split in the Corridors	36
2.9 Daily Traffic Volume	45
2.10 Traffic Survey Results	49
2.11 Trend Analysis of Travel Characteristics (2005-2010)	62
2.11.1 Changes in Modal Split	62
2.11.2 Changes in Traffic Patterns	66
2.11.3 Changes in Peak Hours	71
2.12 Overview of additional existing data	71
<b>3 Identification of Causes, Types and Locations of Traffic Congestion</b>	<b>73</b>
3.1 Introduction	73
3.2 Principal corridor assessment	73
3.2.1 Principal Corridor Collective Assessment	73

3.2.2	Principal Corridor Individual Assessments	88
3.3	Network-wide qualitative assessment	106
3.3.1	Workshop Design and Process	106
3.3.2	Workshop Approach and Results	107
3.4	Integration / Comparison of the Floating Car Survey and Workshop Outcomes	112
<b>4</b>	<b>Estimation of Direct Economic Costs of Traffic Congestion in Cairo</b>	<b>115</b>
4.1	Introduction	115
4.2	Methods to Measure Direct Economic Costs of Congestion	115
4.2.1	Definition of congestion	115
4.2.2	How to measure congestion?	116
4.2.3	Economic Costs Elements and Calculation Method	117
4.3	Costs of Travel Time Delay	117
4.3.1	Estimation of Delay from Recurrent Traffic Congestion	118
4.3.2	Estimation of Delay from Nonrecurring Traffic Congestion	120
4.3.3	Total Delay Cost for 11 Corridors	122
4.4	Costs of Travel Time Unreliability	122
4.4.1	Observed Travel Time Unreliability	123
4.4.2	Cost of Unreliability for 11 Corridors	123
4.4.3	Unreliability in freight transport	124
4.5	Cost of Excess Fuel Consumption	124
4.6	Associated Cost of CO <sub>2</sub> Emissions due to Excess Fuel Consumption	125
4.7	Total Direct Costs of Traffic Congestion for 11 Corridors	127
4.8	Sensitivity analysis	129
4.9	Total Direct Cost of Traffic Congestion for GCMA	129
4.10	Breakdown of Traffic Congestion costs	140
4.11	Zonal Based Direct Economic Cost of Traffic Congestion	142
4.12	Reflection of the Applied Methodology	149
<b>5</b>	<b>Conclusions and some recommendations for Phase II</b>	<b>152</b>
	<b>Annex 1: References</b>	<b>154</b>
	<b>Annex 2: Glossary</b>	<b>159</b>
	<b>Annex 3: Overview of Existing Data</b>	<b>160</b>
	<b>Annex 4: Principal Corridors Collective and Individual Assessment, Estimation Procedures</b>	<b>195</b>
	<b>Annex 5: Origin Destination Matrices 2005 and 2012</b>	<b>196</b>
	<b>Annex 6: Non-classified Vehicle Counts</b>	<b>197</b>
	<b>Annex 7: Classified Vehicle Counts</b>	<b>198</b>

<b>Annex 8: June 6th Workshop: List of Participants, Invitation, Objectives and Program</b>	<b>199</b>
<b>Annex 9: Measuring Congestion, Reliability Costs and Selection of Calculation Method Direct Costs</b>	<b>200</b>
Congestion indicators	200
Commonly used performance measure(s) that reflects congestion levels on roads	205
Travel Time Reliability	208
Commonly used travel time reliability indicators	208
Selection of Performance Measures for GCMA	209
<b>Annex 10: Equations used for Direct Cost Calculation</b>	<b>212</b>
Travel Time Delay	212
Delay Estimation Causing By Recurrent Congestion	212
Delay Estimation due to Nonrecurring Events	214
Economic Cost of Unreliability	217
Cost of Excess Fuel Consumption	218
Emission Cost	221
<b>Annex 11: Detailed Direct Economic Cost of Traffic Congestion</b>	<b>223</b>
A- Delay Cost	223
B- Unreliability Cost	229
C- Excess Fuel consumption and Cost	232
D- Emission Cost	238
<b>Annex 12: Overview of Data Used for the Calculation of Direct Cost of Congestion</b>	<b>241</b>

## List of Tables

Table 2.1: New Cities around Greater Cairo- Type and Population <sup>2</sup>	19
Table 2.2: Study Data and Information Needs	24
Table 2.3: Floating Car Survey Detailed Routes	33
Table 2.4: Number of Runs on Each Route during the Floating Cars Survey	34
Table 2.5: Traffic Counts Detailed Observation locations	35
Table 2.6 Traffic peak periods in the Greater Cairo Metropolitan Area	35
Table 2.7: Modal split summary in the eleven corridors (by percentage)	44
Table 2.8: The percentage of traffic volumes in peak hours	45
Table 2.9: Traffic counts in the eleven corridors (2005)	47
Table 2.10: Traffic counts in the eleven corridors (estimated for 2010)	48
Table 2.11: Traffic Survey Results- AM	50
Table 2.12: Traffic Survey Results-PM	50
Table 2.13: Comparable Traffic Count Locations	67
Table 2.14: Comparison between 2005 and 2010 Traffic Count Surveys Data:	67
Table 2.15: Comparison between 2005 and 2010 Traffic Count Surveys Data:	68
Table 2.16: Comparison of Peak Hour Factors at Traffic Count Locations	70
Table 3.1: Aggregate Qualitative Observations on Traffic influencing Events	88
Table 3.2: Daily Traffic Influencing Events, Route 1	89
Table 3.3: Daily Traffic Influencing Events, Route 2	90
Table 3.4: Daily Traffic Influencing Events, Route 3	92
Table 3.5: Daily Traffic Influencing Events, Route 4	93
Table 3.6: Daily Traffic Influencing Events, Route 5	95
Table 3.7: Daily Traffic Influencing Events, Route 6	97
Table 3.8: Daily Traffic Influencing Events, Route 7	99
Table 3.9: Daily Traffic Influencing Events, Route 9	101
Table 3.10: Daily Traffic Influencing Events, Route 10	104
Table 3.11: Daily Traffic Influencing Events, Route 11	105
Table 3.12: List of traffic congestion causes	109
Table 3.13: List of grouped “operational” causes	111
Table 3.14: Localized congestion causes mapped into congestion categories	112
Table 4.1: Vehicle occupancy factor for diverse vehicular modes (passenger)	121
Table 4.2: Truck Load capacity (Ton)	121
Table 4.3: Value of time for diverse transport user classes (adjusted for 2010)	122
Table 4.4: Excess fuel cost in the Greater Cairo because of traffic congestion	125
Table 4.5: The emission rate for diverse vehicular modes	127
Table 4.6: Direct cost components of traffic congestion (approach 1)	127
Table 4.7: Direct cost components of traffic congestion (approach 2)	127
Table 4.8: Breakdown of traffic congestion costs for the entire GCMA (Approach 1)	141

Table 4.9: Breakdown of traffic congestion costs for the entire GCMA (Approach 2):	141
Table 4.10: GCMA zones network types	145
Table 4.11: Predominant Land Use of GCMA	148
Table 4.12: Traffic congestion cost in traffic zones in the GCMA	148
Table 4.13: Traffic congestion cost in suburban traffic zones in the GCMA	149
Table A3.1: No. of licensed vehicles by type of vehicles & governorate up to Dec 2008	161
Table A3.2: Public Transport Daily Trip Generation	164
Table A3.3: Public Transport Daily Trip OD Unit 1,000 trips	165
Table A3.4: Public transport Capacity in Cairo	166
Table A3.5: Public transport Capacity in Alexandria	166
Table A3.6: Public transport Capacity in Inside Cities	167
Table A3.7: Public transport Capacity in Outside Cities	169
Table A3.8: Public transport Capacity the Cairo – 6th of October Transport Corridor	169
Table A3.9: Fleet age and composition in Cairo	170
Table A3.10: Fleet age and composition in Alexandria	170
Table A3.11: Fleet age and composition Inside Cities	171
Table A3.12: Fleet age and composition Outside Cities	172
Table A3.13: Distribution of Bus and Microbus Following both Public and Private Licenses (2005)	173
Table A3.14: Public transport accident in Cairo	175
Table A3.15: Public transport accident in Alexandria	176
Table A3.16: Public transport accident in Inside Cities	176
Table A3.17: Public transport accident in Outside Cities	177
Table A3.18: Accident Seriousness Rate (Dead or Injured / Accident) by A.R.E Governorates (2008)	178
Table A3.19: The Most Vehicles Causing Accidents on Highways by Type (2008)	179
Table A3.20: Percentage Distribution of Accidents Causes on Highways (2008)	179
Table A3.21: Car Accidents by Causes (2008)	179
Table A3.22: Estimated Unit Vehicle Operating Cost	181
Table A3.23: Quantity, Value and Type of Fuel Used in Operation in Cairo - Value by 1000 2007/2008	183
Table A3.24: Quantity, Value and Type of Fuel Used in Operation in Alexandria - Value by 1000 L.E 2007/2008	183
Table A3.25: Quantity, Value and Type of Fuel Used in Operation in Inside Cities- Value by 1000 2007/2008	184
Table A3.26: Quantity, Value and Type of Fuel Used in Operation in Outside Cities -Revenues by 1000 L.E. 2007/2008	185
Table A3.27: The average household income by Household Income Group (2007)	186
Table A3.28: Socio-Economic Framework in the Study Area	187
Table A3.29: Average Monthly Income and Hourly Income per Worker	187
Table A3.30: Estimated Hourly Time Value for Transport Users from 2007 to 2027	188
Table A3.31: Monthly Income Indicator and Car Ownership per household (2007)	188
Table A3.32: Percentage of 16 hour traffic volume in the peak hour (2005)	190
Table A3.33: Peak Hour Traffic Volumes on Main Bridges and Arterial Roads (2005)	191

Table A3.34: Characteristics of Observed Traffic Volume at Different Count Stations in 2005	193
Table A3.35: Passenger Car Units (PCU)	194
Table A3.36: Vehicle Occupancy Factors (Passengers/Vehicle)	194
Table A10.1: TTI incident delay factor	215
Table A10.2: The Emission rate for diverse vehicular modes	221

## List of Figures

Figure 2.1: Location of the new cities around Greater Cairo	20
Figure 2.2: Administrative and Planning Boundaries in the Study Area (CREATS, 2003)	23
Figure 2.3: Greater Cairo Region Major Districts (CREATS, 2003)	24
Figure 2.4: Greater Cairo Region Roadway classification (CREATS, 2003)	26
Figure 2.5: Traffic counts observation locations (JICA, 2005)	27
Figure 2.6: Peak hour traffic volumes (JICA, 2005)	27
Figure 2.7: Traffic counts observation locations (JICA, 2007)	28
Figure 2.8: Cairo Ring Road Study, 2009	28
Figure 2.9: Preliminary Routes for the Floating Car Survey	30
Figure 2.10: Final Routes for Floating Car Survey	31
Figure 2.11: Traffic counts observation locations	31
Figure 2.12: Traffic counts observation locations	49
Figure 2.13: P1 - Ring Road / Between El Khosoos & Cairo-Alex Agr.Rd	51
Figure 2.14: P2 – Gesr El-Suez/between Ring Road and Ainshams Street	52
Figure 2.15: P3 – Suez Desert Road / Between KM 4.5 and Ring	52
Figure 2.16: P4 – Suez Desert Road / Between KM 4.5 and Ring Road	53
Figure 2.17: P5 – Ring Road / Above Cairo-Alex Desert Road	54
Figure 2.18: P6 – 26th July / Between Railway and Ring Road	54
Figure 2.19: P7 – Al-Ahram Street / Electricity Station	55
Figure 2.20: P8 - Middle of Abbas Bridge	56
Figure 2.21: P9 - 6 October Bridge between Zamalk and Agozah	56
Figure 2.22: P10 - Ahmed Helmy Str./ Before Abou Wafya Bridge	57
Figure 2.23: P11 – Ramses St. between Ghmara and Ahmed Said St. (One Way to Abasia)	58
Figure 2.24: P12 - Lotifi Al Said St. between Abasia and Ghamrah (One Way to Ramses Square)	58
Figure 2.25: P13 - Salah Salem Str./Between Elfangary and Abbasey	59
Figure 2.26: P14 – Kornish El-Nil /Between 15th May & El-Sahel Brdg	59
Figure 2.27: P15 – Gamal Abd El-Naser (El-Nile str)/Cornishe El- Agouza	60
Figure 2.28: Modal Split according to the Classified Vehicle Counts	62
Figure 2.29: Modal Split according to 2005 Survey on Suez Desert Road	63
Figure 2.30: Modal Split according to 2010 Survey on Suez Desert Road (P3)	64
Figure 2.31: Modal Split according to 2005 Survey on Salah Salem Street	64
Figure 2.32: Modal Split according to 2010 Survey on Salah Salem Street (P13)	65
Figure 2.33: Average Modal Split – 2005	66
Figure 2.34: Modal Split - 2010	66
Figure 3.1: Morning Peak Sample Travel Speed	76
Figure 3.2: Evening Peak Sample Travel Speeds	76



Figure 3.3: Principal Corridors Average Speeds- AM Direction 1- Routes 1 to 6	77
Figure 3.4: Principal Corridors Average Speeds- AM Direction 1- Routes 7 to 11	78
Figure 3.5: Principal Corridors Average Speeds- AM Direction 2- Routes 1 to 6	78
Figure 3.6: Principal Corridors Average Speeds- AM Direction 2- Routes 7 to 11	79
Figure 3.7: Principal Corridors Average Speeds- PM Direction 1- Routes 1 to 6	79
Figure 3.8: Principal Corridors Average Speeds- PM Direction 1- Routes 7 to 11	80
Figure 3.9: Principal Corridors Average Speeds- PM Direction 2- Routes 1 to 6	80
Figure 3.10: Principal Corridors Average Speeds- PM Direction 2- Routes 7 to 11	81
Figure 3.11: Principal Corridors Speed Indices	83
Figure 3.12: Principal Corridors Speed COVs, Direction 1	84
Figure 3.13: Principal Corridors Speed COV, Direction 2	84
Figure 3.14: Principal Corridors Buffer Index, Direction 1	85
Figure 3.15: Principal Corridor Buffer Index, Direction 2	86
Figure 3.16: Traffic Influencing Events Frequencies	87
Figure 3.17: Route 1 Schematic	88
Figure 3.18: Route 2 Schematic	90
Figure 3.19: Route 3 Schematic	91
Figure 3.20: Route 4 Schematic	93
Figure 3.21: Route 5 Schematic	95
Figure 3.22: Route 6 Schematic	97
Figure 3.23: Route 7 Schematic	98
Figure 3.24: Route 8 Schematic	100
Figure 3.25: Route 9 Schematic	101
Figure 3.26: Route 10 Schematic	103
Figure 3.27: Route 11 Schematic	105
Figure 3.28: Ranking of the Operational Causes	111
Figure 3.29: Congestion causes frequencies of occurrences	113
Figure 4.1 Total annual direct cost due to traffic congestion in 11 corridors (approach 1)	128
Figure 4.2 Total annual direct cost due to traffic congestion in 11 corridors (approach 2)	128
Figure 4.3 Distribution of total annual direct cost due to traffic congestion in GCMA (approach 1)	131
Figure 4.4 Distribution of total annual direct cost due to traffic congestion in GCMA (approach 2)	131
Figure 4.5 Local road types in GCMA	143
Figure 4.6 Traffic Network types in GCMA	144
Figure 4.7 Number of Lanes in Main corridors of GCMA	146
Figure 4.8 Land use and Network classes in the GCMA	147
Figure A10.1 Car's age distribution in Egypt	219
Figure A10.2 Relative distribution of cars' engine size between 2002-2006 in Egypt	220
Figure A11.1 Annual recurring and nonrecurring delay costs for passenger car users	223
Figure A11.2 Annual recurring and nonrecurring delay costs for motorcyclists	224
Figure A11.3 Annual recurring and nonrecurring delay costs for taxi users	224
Figure A11.4 Annual recurring and nonrecurring delay costs for transit users	225

Figure A11.5	Annual recurring and nonrecurring delay costs for freight transportation	225
Figure A11.6	Annual recurring and nonrecurring delay costs for all road users	226
Figure A11.7	Annual recurring and nonrecurring delay costs for passenger car users	226
Figure A11.8	Annual recurring and nonrecurring delay costs for motorcyclists	227
Figure A11.9	Annual recurring and nonrecurring delay costs for taxi users	227
Figure A11.10	Annual recurring and nonrecurring delay costs for transit users	228
Figure A11.11	Annual recurring and nonrecurring delay costs for freight transportation	228
Figure A11.12	Annual recurring and nonrecurring delay costs for all road users	229
Figure A11.13	Annual unreliability associated costs for passenger car users	230
Figure A11.14	Annual unreliability associated costs for motorcyclists	230
Figure A11.15	Annual unreliability associated costs for taxi and shared taxi Users	231
Figure A11.16	Annual unreliability associated costs for transit Users	231
Figure A11.17	Annual unreliability associated costs for all road users (Excluding freight transporters)	232
Figure A11.18	Annual excess gasoline consumption in the Greater Cairo (1st approach)	233
Figure A11.19	Annual excess Diesel consumption in the Greater Cairo (1st approach)	233
Figure A11.20	Annual excess gasoline costs as result of traffic congestion (1st approach)	234
Figure A11.21	Annual excess diesel costs as result of traffic congestion (1st approach)	234
Figure A11.22	Annual total excess fuel costs as result of traffic congestion	235
Figure A11.23	Annual excess gasoline consumption in the Greater Cairo (2nd approach)	235
Figure A11.24	Annual excess Diesel consumption in the Greater Cairo (2nd approach)	236
Figure A11.25	Annual excess gasoline costs as result of traffic congestion (2nd approach)	237
Figure A11.26	Annual excess diesel costs as result of traffic congestion (2 <sup>nd</sup> approach)	237
Figure A11.27	Annual total excess fuel costs as result of traffic congestion (2 <sup>nd</sup> approach)	237
Figure A11.28	Annual total excess CO <sub>2</sub> emission weight due to traffic congestion (approach 1)	238
Figure A11.29	Annual excess CO <sub>2</sub> emission costs due to traffic congestion (approach 1)	239
Figure A11.30	Annual total excess CO <sub>2</sub> emission weight due to traffic congestion (approach 2)	239
Figure A11.31	Annual excess CO <sub>2</sub> emission costs due to traffic congestion (approach 2)	240