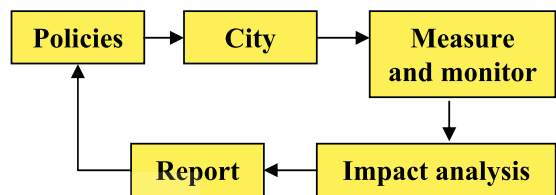# An Urban Management Approach Based on Socioeconomic Geo-statistical Modeling

- **Introduction**
- **Concepts and the Conceptual Framework**
- **Methodology and the Empirical Model**
- **Analysis**
- **Conclusions and Recommendations**

Policies → City → Measure and monitor

Report ← Impact analysis ← Measure and monitor

Report → Policies

Cities are Organic Entities

- Cities change , grow and shrink in response to interactions of a variety of forces
- Forces changing the cities
  - Social
  - Economic
  - Environmental
  - Cultural
  - Institutional
  - Technological

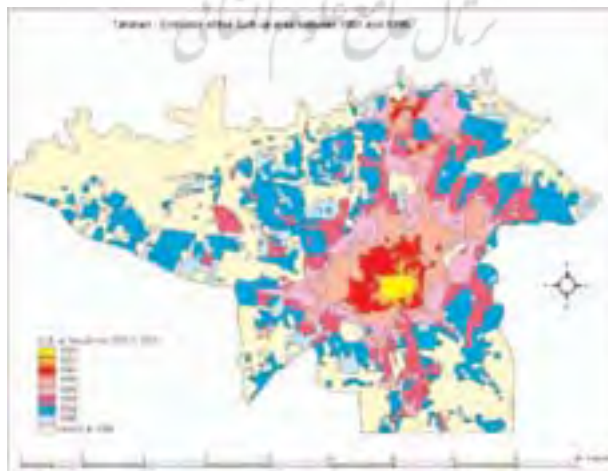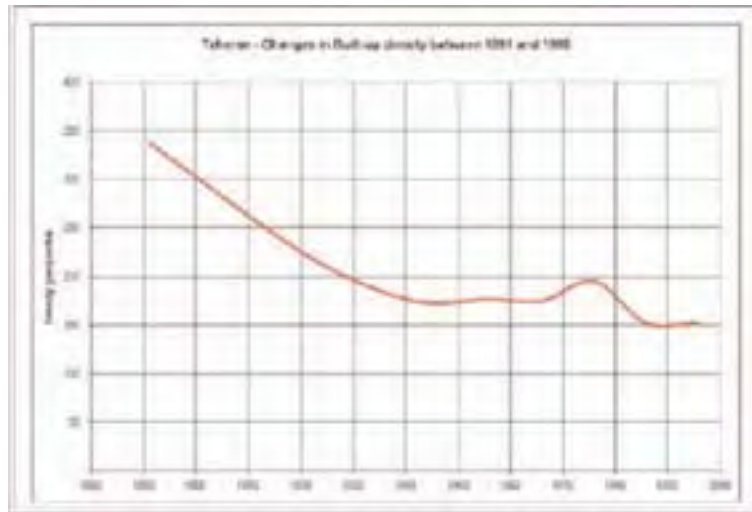### Tehran-Evolution of the built-up area between 1891 and 1996

Figure 1 : source TGIC

Tehran-changes in Built-up density between 1891 and 1996

Tehran-Population densities in Built-up Areas (1996 census)

Socioeconomics and Urban policy
- Economic Transformation around the world
- Globalization , privatization and deregulation seen as responsible for
  - An increase in spatial segregation
  - Social polarization and
  - Spatial inequalities (UNCHS 2001)
- Social polarization and deterioration of the built environment have given birth to the phenomena of so-called
  - Dual or divided cities (mega ,1995)
- This phenomenon is the spatial polarization / geographical inequalities of the city
- Spatial polarization and geographical inequalities occur in urban areas around the world (UNCHS 2001)

- In these cities , there is
  - Permanent state of growth And
  - Urban poverty vulnerability

Source : UNCHS (United Nations Committee on Human Settlements)

Divided city

What do all these problems have in common?

- Answer : A spatial dimension
  Since they all occur and tend to be concentrated in specific areas of the city
  - To describe socioeconomic variations / inequalities and
  - To be able to implement effective remedy policies
    It is necessary to establish monitoring studies
  - Due to spatial dimension of socioeconomic variations / inequalities
  - Geographic information systems (GIS) is a suitable tool for
    - Analysis and
    - Monitoring

of these location dependent S.E. variations

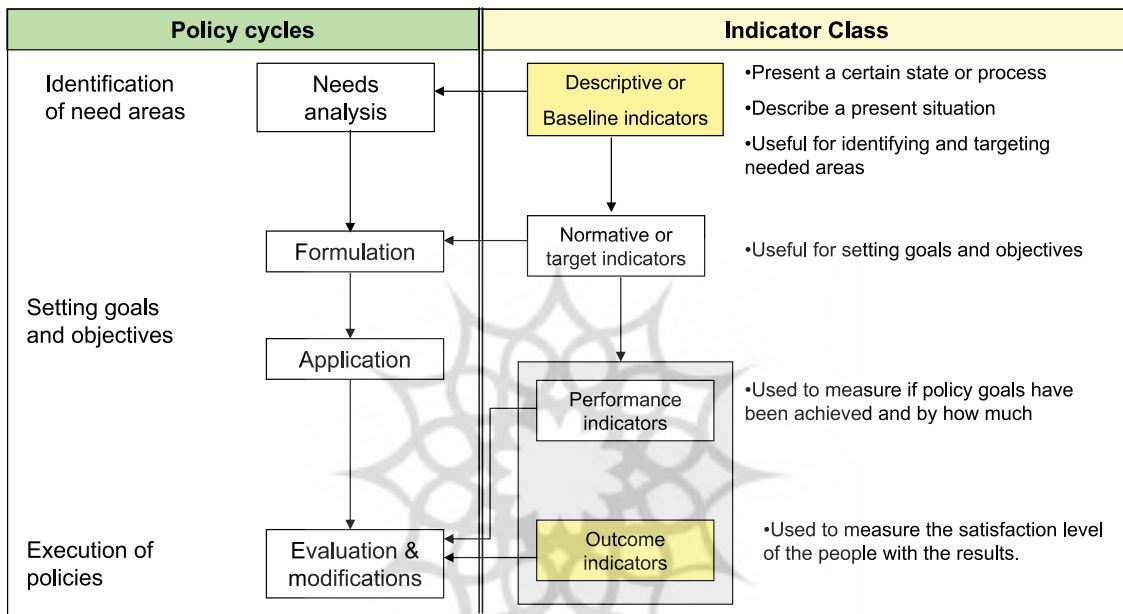## GIS indicators to support Urban Policy

- Indicators (due to their inherent function) are a tool that simplify complex phenomena into quantifiable measures that can be used for policy and decision making Process (Adrianse,1997)
- Therefore, indicators have three functions
  1-To simplify
  2-To quantify

3-To communicate (van delft,1997)

These three functions of indicators match , with the usually acknowledged advantages of GIS

1-Data integration /organization

2-Spatial Analysis

3-visualization (Gohse and Huxhold 2002)

The role of urban indicators

Policy cycles			Indicator Class	
Identification of need areas	Needs analysis		Descriptive or Baseline indicators	•Present a certain state or process •Describe a present situation •Useful for identifying and targeting needed areas
	Formulation		Normative or target indicators	•Useful for setting goals and objectives
Setting goals and objectives	Application		Performance indicators	•Used to measure if policy goals have been achieved and by how much
Execution of policies	Evaluation & modifications		Outcome indicators	•Used to measure the satisfaction level of the people with the results.

•Adapted from Adriaanse (1997,p.111) and Parnel and Poyser (2001)

•Reference Martinez Martin(2003,p.26)

Research objective

The main objective of this research is :

To develop a methodology that combines the use of Urban indicators and GIS as a diagnostic and prescriptive tool to generate policy relevant information on the complex and multidimensional aspects of socioeconomic variations / inequalities.

Research goals

1-To identify parameters and generate a set of indicators that reflects the different aspects of intra-urban socioeconomic variations at local municipality level .

2-To adopt the generated set of indicates to the Tehran municipality content of policy making

3-To develop a methodology that uses GIS to construct indicators . Taking in to account

- the relevant intra–urban scales and

- the different aspects of S.E. variations / inequalities

4-To gain a better understanding of S.E. variations and it's relation to spatial structure of the city

Concepts and the conceptual framework
Spatial Structure matters!
- The spatial structure of a city is very complex
- It is the physical out come of the subtle interactions over centuries between
    - Land markets
    - Topography
    - Social/cultural and physical Infrastructure
    - Regulations and
    - Taxation

Source: Tehran spatial structure(TGIC,2003)

Spatial structure impacts on
- Economic efficiency
- Quality of Urban environment/ urban life

However;
The evolution of urban form shaped by complex interactions between market faces, Public investment and regulations
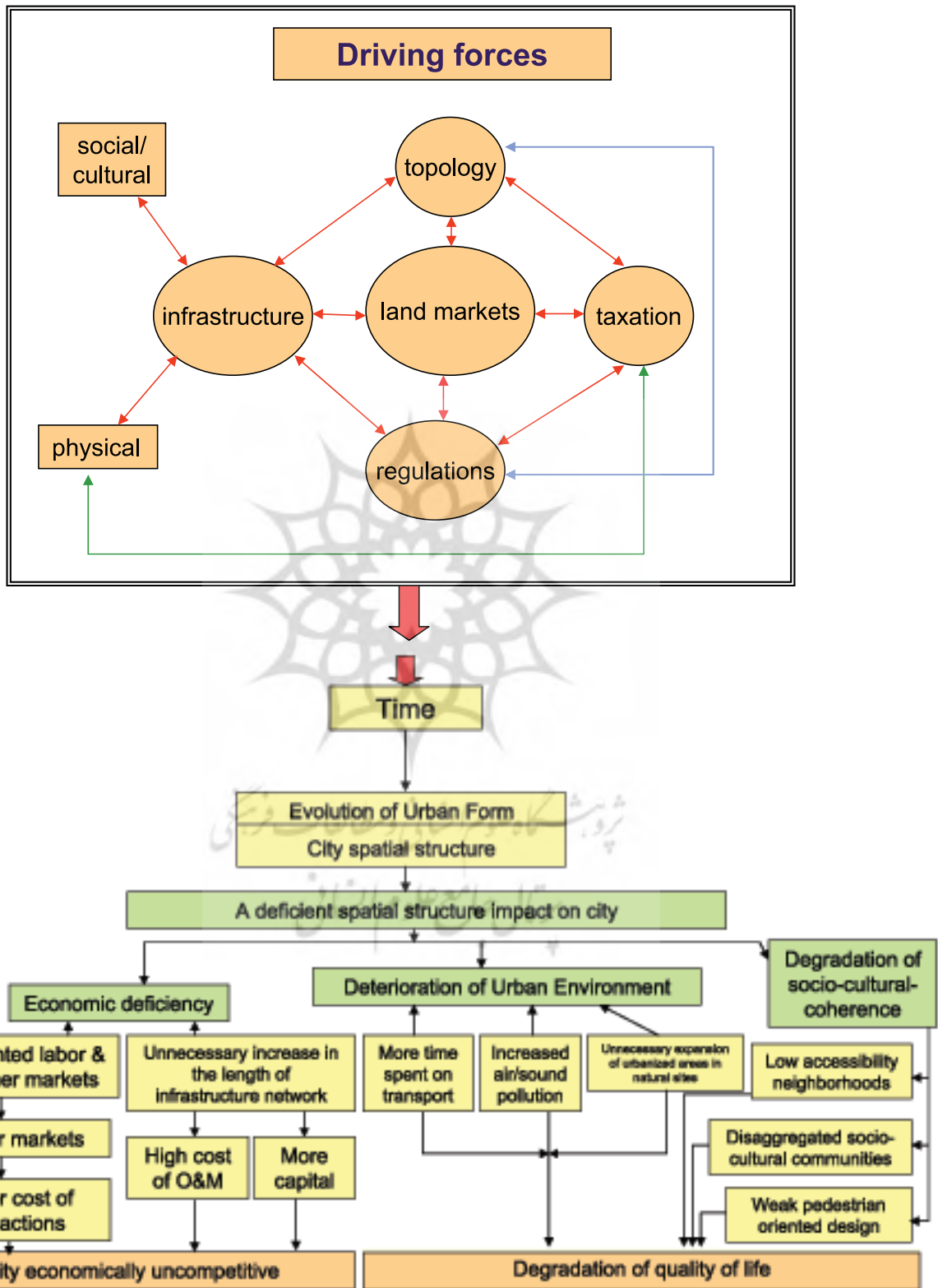**Is not often monitored!**

From on economic point of view
- A city is a large labor and consumer market
- A deficient spatial structure
    - Fragments labor and consumer markets into smaller less efficient markets
    - Contributes to higher transaction costs by increasing distance between people and places.
- Increases infrastructure capital and operating cost, by increasing the length of the city infrastructure network .
- A deficient spatial structure can render a city economically uncompetitive .

From an environmental point of view
- A deficient spatial structure
- Decrease quality of life by
    - Increasing the time spent on transport
    - Contributing to increased air/sound pollution
    - Contributing to unnecessary expansion of urbanized areas in natural sites.

Why Spatial structure matters ?

Driving forces

- social/cultural
- topology
- infrastructure
- land markets
- taxation
- physical
- regulations

Time

Evolution of Urban Form
City spatial structure

A deficient spatial structure impact on city

Economic deficiency

- Fragmented labor & consumer markets
- Smaller markets
- Higher cost of transactions
- Unnecessary increase in the length of infrastructure network
  - High cost of O&M
  - More capital

City economically uncompetitive

Deterioration of Urban Environment

- More time spent on transport
- Increased air/sound pollution
- Unnecessary expansion of urbanized areas in natural sites

Degradation of socio-cultural-coherence

- Low accessibility neighborhoods
- Disaggregated socio-cultural communities
- Weak pedestrian oriented design

Degradation of quality of life

Area-based policies
- Socio economic variations/inequalities are location dependant and result in spatial segregation of certain segments of the population (langlois 2001)
- Actions to control S.E. variations or counteract spatial injustice/inequality are usually addressed through area-based on policies ,targeting specific areas of the city.
- The recognition of area based policies to address socio-economic variation / inequalities became important in 1990s.
- Some concepts in geographically targeted policies are
  - There are identifiable geographical areas that suffer disproportional amount of problems
  - Problems overlap in space and are made worse when they coexist.
  - Proportional resource allocation depending on targeted goals for each area.
  - Working in partnership with key local stake holders for a more effective identification of problems and delivery of solutions.

The need to monitor (intra-urban) Socioeconomic variations / inequality
- A city's spatial structure is constantly evolving
- Lack of political consensus or a clean vision on
  - spatial development
  - land use regulations and
  - infrastructure investments

Are often inconsistent and their combined effects might contradict each other

Shaping the urban spatial structure
In markets economies ,municipalities can influence the shape of urban development ,not through direct design ,but by implementing a coherent and consistent system of land use regulations , infrastructure investment and land related types.

S.E variations/inequality & spatial scale
- Spatial S.E variation / inequalities are found at different levels
- "Gaps" can be observed at different geographical scales
  - global level (between countries)
  - …
  - local or intra-urban level (between neighborhoods)

Monitoring S.E variations
- The planning department of municipalities need to constantly monitor the evolution of the spatial structure of their city .
- The municipalities should able to measure the impact of changes in the city's spatial structure on S.E variation / inequalities

International concern
The concern about spatial disparities and spatial injustice is reflected in different reports and initiatives of international organizations that are stressing the importance of monitoring spatial S.E. variation/inequalities within cities.

- UNCHS,1995
- The Word Bank ,1996
- European Commision,2000
- European Communities,2000
- UNDP,2000
- UNCHS,2001
- UNDP,2001
- UN-HABITAT,2003 b

Source :(Martinez,2005,P.19)

Master plan and spatial structure

Briefly reiterating

- Monitoring S.E spatial variations / inequalities has become an international concern in both developing and developed countries
- A city's spatial structure has impacts on
  - Economic competitiveness
  - Urban environment
  - Socio-cultural coherence
  - Quality of life
- Municipalities can influence the shape of urban development by implementing a coherent and consistent system of land use regulations, infrastructure investments and land related taxes.
- Monitoring and descriptive studies are needed to facilitates implementation of area - based policies
- Area-based policies should use proportional allocation of resource based on S.E variations/inequalities ratings.
- Lack of political consensus or a clear vision on spatial development , land use regulations and infrastructure investments are often inconsistent and their combined effect might contradict each other

Tehran municipality 2001 master plan

Priority	Goals	Objectives
1	Clean city	pollution control
2	Smoothly moving city	an efficient intra city traffic and transportation
3	Green city	expansion of green areas
4	A high cultured city	expansion of cultural and educational space
5	Dynamic city	needs of citizens for administrative services are met as quickly as possible
6	Modern traditional texture	realization of an intermixed urban fabric of traditions modernism

■All the above objectives have direct implications for the development of the spatial structure of Tehran Metropolitan Area (TMA).

■First four priority are particularly relevant to spatial development

■First two objectives are infect a precondition to the economic prosperity of the TMA.

Conceptual framework

In the case of Tehran, the municipality has clearly formulated its priority objectives

Questions:

1-What type of changes will have the most chance to achieve the Municipal objectives?

    Regulatory changes?

    Infrastructure investments ?

    Taxations reform?

2-What should be monitored or measured to guide the municipality in coping with the inter-active dynamic changes within the city(external driving forces and results of local policy applications) and to navigate / coordinate next steps ?

3-How do we measure and at What scale ,once we have identified what is important?

An urban management approach based on socio-economic geo-statistical modeling
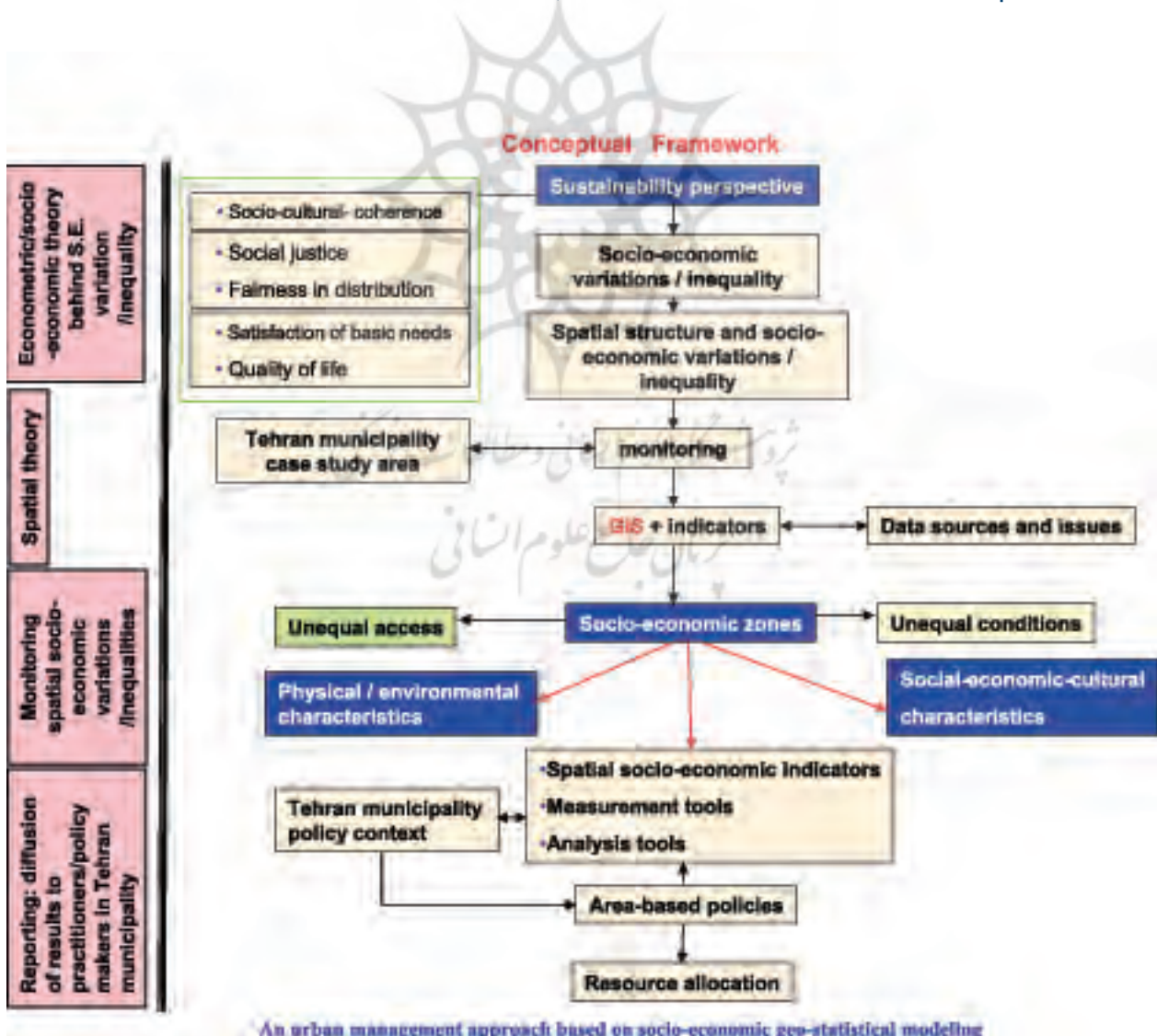
Methodology and the Empartical model
- Research follows Six Sigma methodology framework
- What is Six Sigma?
  A methodology that makes use of information management by facts and statistical analysis to define , measure and improve an organization's
  - operational performance
  - practices
  - systems

Sub-Methodologies

DMAIC
Is an improvement system for *existing* processes and looking for incremental improvement.
DMADV
Is applied for developing *new* processes or products.

Six Sigma DMADV sub-methodology

➢ **D**efine :the problem and customer's requirements

➢ **M**easure :Exiting results / defects and Document current (as-is) processes

➢ **A**nalyze and assess the design for the process ,product or service.

➢ **D**esign and implement the new process ,product or service.

➢ **V**erify results and maintain performance.

D
What type of changes will have the most chance to achive the municipality's objectives?
How does Tehran's spatial structure impact the physical ,Environmental ,cultural and socioeconomic domains of the city and its citizens?
What are the indicators of interest for policy impact monitoring?
What methodologies and technical process are needed?

M
➢ Define the conceptual framework
➢ Design of data collection instruments
➢ Identification of required data sources
➢ Data collection and processing

Six Sigma DMADV sub-methodology

➢ **D**efine :the problem and customer's requirements

➢ **M**easure :Exiting results / defects and Document current (as-is) processes

➢ **A**nalyze and assess the design for the process ,product or service.

➢ **D**esign and implement the new process ,product or service.

➢ **V**erify results and maintain performance.

A
➢ Define analytical framework / process
➢ Perform statistical analysis
➢ Perform Geo-statistical analysis

D
➢ Design / model individual indicators
➢ Design /model aggregated (single) socioeconomic indicator
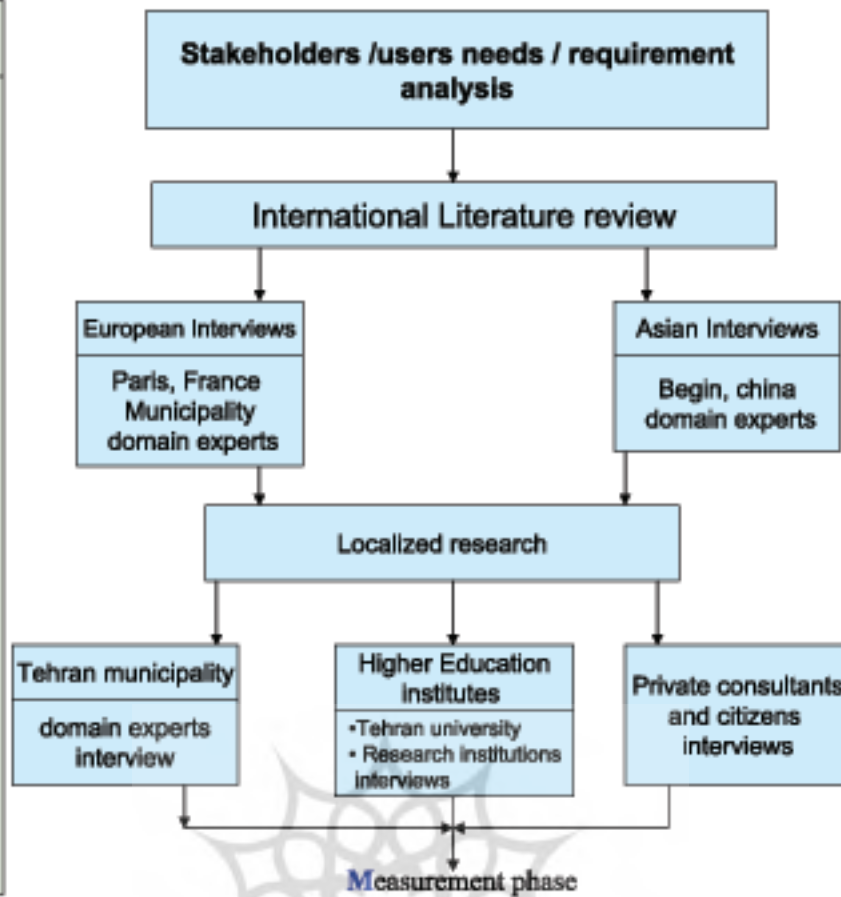➢ Apply final indicator and create pilot study area's socioeconomic variations/inequity zones (Index map)

V
➢ Test model and verify model outputs

Diffusion of results to practitioners /policy makers in Tehran Municipality

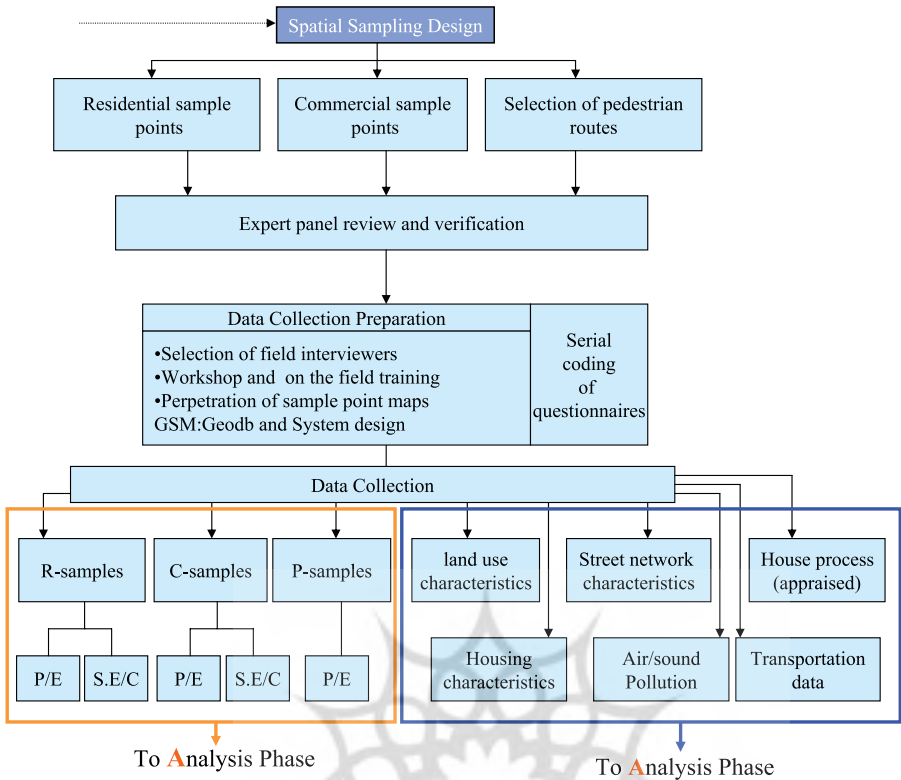***** T.M monitoring and improvement processes

* Not in research scope

Six Sigma	Research
Definition phase	•Literature review •International and localized research

Stakeholders /users needs / requirement analysis

↓

International Literature review

European Interviews	Asian Interviews
Paris, France Municipality domain experts	Begin, china domain experts

Localized research

Tehran municipality	Higher Education institutes	Private consultants and citizens interviews
domain experts interview	•Tehran university • Research institutions interviews	

Measurement phase

Six Sigma	Research
Measurement Phase	•Questionnaires Design (measurement instrument)

Definition phase

↓

Preliminary Indicators /variables selection

↓

Questioners design

Residential	Commercial
Open questions	Open questions

First stage pilot data collection

↓

Expert panel review of results

↓

Closed questionnaires design

Residential	Commercial	Pedestrian

Second stage pilot data collection

↓

Expert panel review
-Verification of Questionnaires design ⟶ continued
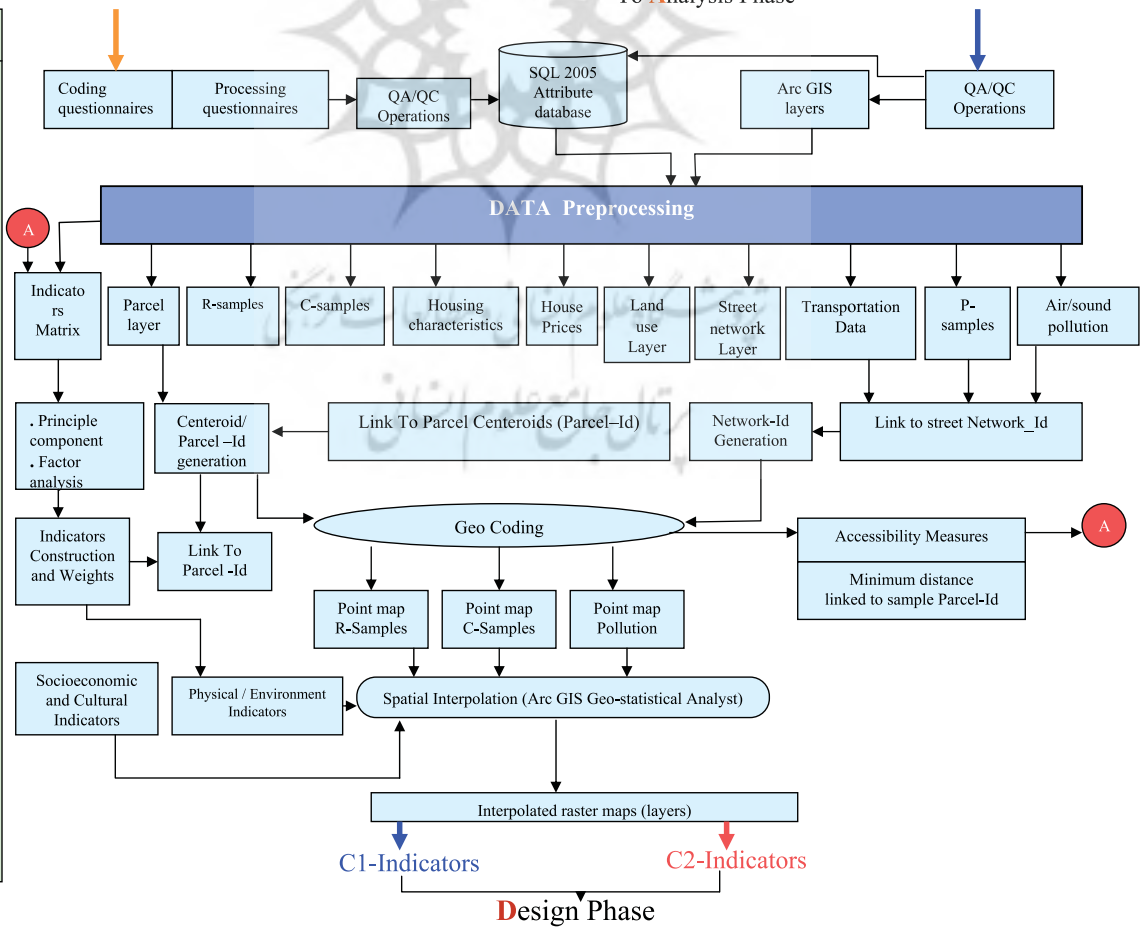
Six Sigma | **Research**

Design Phase | Descriptive — Analysis — Explanatory /Spatial Data Analysis

C1 - Indicators
Socioeconomic/cultural

C2 - Indicators
Physical/Environmental

Residential | Commercial

Residential | Commercial

GIS_based indicators (Map Overlay Operations)

Socio economic Zones at district and neighborhood levels

C1
Socio economic /Cultural

C2
Physical /Environment

- S.E variations / inequality
- Quality of life
- Accessibility to Services
- Socio-Cultural cohesion

-Factor Analysis

-Cluster Analysis

Spatial differentiation

Descriptive-statistics

Indicators weights

Correlation bi-variant analysis

Gaps/uneven Geography

Unequal conditions

Unequal access

ANALYSIS

Components / Indicators / Variables	
Number of components: 2	c1 & c2
Number of indicator: 19	c1-1 trough c1-8 c2-1 trough c2-11
Number of variable : 273	115 physical/environment variables 158 socio-economic/cultural variables

Components Indicators / Variable Hierarchy
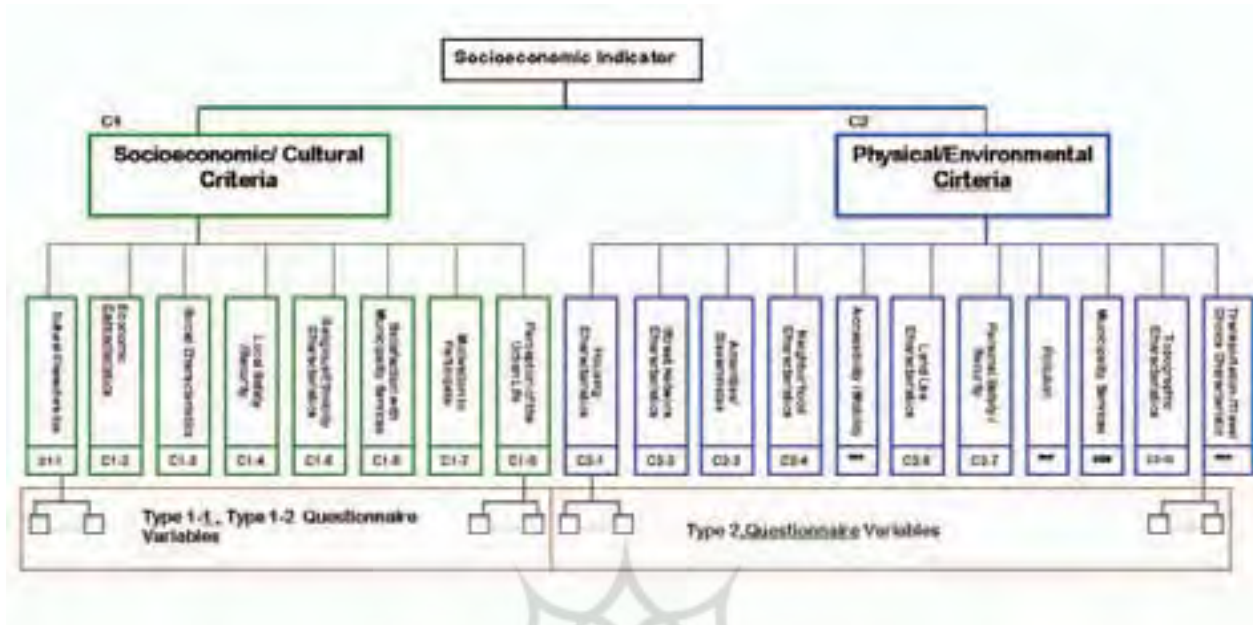
Questionnaires

Questionnaires	Type	Selected variables
Physical/Environmental	2	115
Socio-economic	1-1	91
Socio-economic	1-2	67
.		
.		
.		

Statistics
Questionnaire Design
- Internal homogeneity
  Type 2 (physical / environmental)100%
  Type 1-1 (socio-economic/cultural)%90
  Type 1-2 (socio-economic/cultural)%90

Sampling design
Used multistage stratified systematic sampling
       sample size   6300 type – 2 samples
                      3750 type 1-1 + type 1-2 samples
                      1800 p- samples

Descriptive Statistics

- All completed and quality controlled questionnaire's data were statistically checked for skewness and kurtosis .
- Also Mean , Median , Mode , variance and standard deviation of all responses were calculated.
- Missing values were also controlled for
- Total sample size :   11,850
- Total qualified sample size : 10,981
- Number of rejected samples :868 (%7.33 reject rate)

Exploratory / Spatial data analysis

- Indicator matrix construction
- PCA (component / indicator verification)
- Factor Analysis (Indicator / component weights)
- Spatial Interpolation (Indicator raster surfaces)
- Map overlay (creating composite surfaces)

## Socioeconomic zones of the study area
- Physical / environment layer
- Socio-economic /cultural layer
- Combined into a single GIS-based indicator.

Extractable information
- 19 separate GIS-based indicators
  - 8 separate socio-economic GIS-based indicators
  - 11 separate physical/environmental GIS-based indicators
- Different combination of indicators composite/integrated are possible

Socioeconomic zones Gap Analysis
- Socioeconomic variation/inequality spatial differentiation
- Quality of life
- Accessibility to resources / services
- Socio-cultural cohesion
- Other indicators / GIS-based indicator are possible
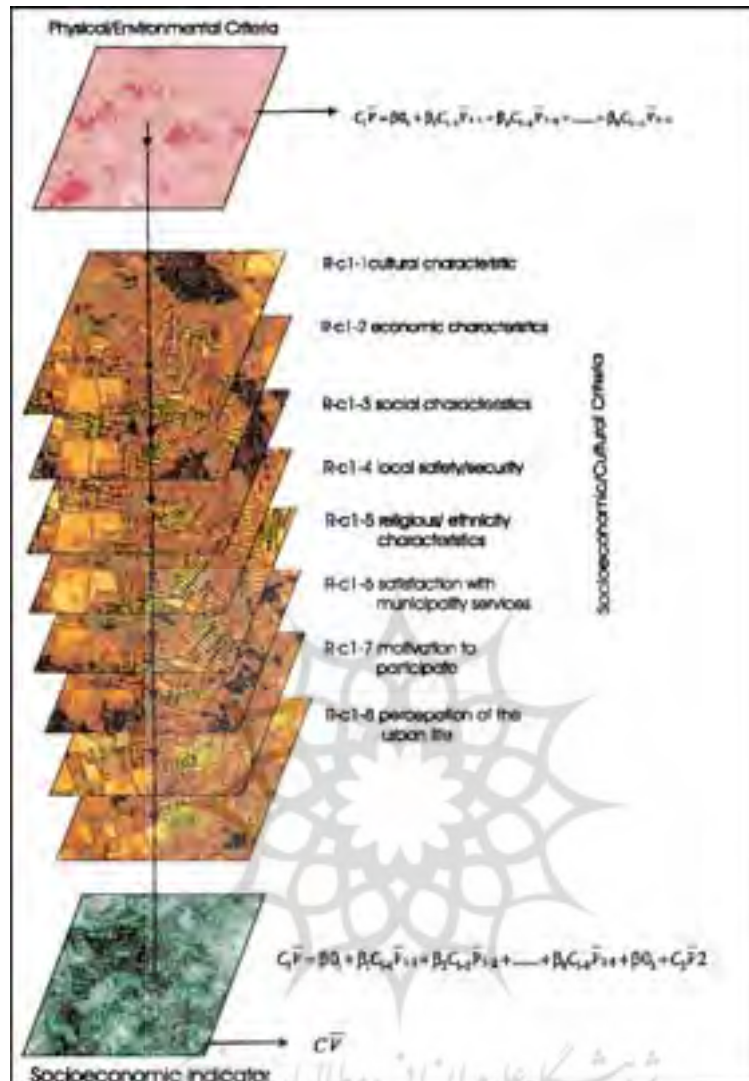
Conclusions and recommendation

Conclusions

- Municipalities need to monitor and analyzes the impacts of policies on the city's spatial structure and its consequences an socioeconomic ,environmental and cultural domains routinely.
- GIS is a suitable tool for data organization and Integration ,analysis and visualization to be used in different stages of the municipality's policy cycles.
- Using best practices within the domain of information management and process design / improvement, analytical approaches using a combination of statistical and geo-statistical operations can be integrated into the municipality's workflows for modeling socioeconomic variations / inequalities .

Recommendations

▪The exceptional spatial structure of Tehran creates opportunities and constraints, which will have to be taken into account in developing the strategies to fulfill the municipal objectives.

▪Cities are dynamic entities and Tehran metropolitan Area (TMA) like any other city in the world is exposed to external forces (e.g. changes in world oil prices , the possibility of regional international trade or progress in communication technology) , which can not be predicted but which will effect the welfare and development of Tehran .

▪Therefore Tehran municipality should consider, and encourage monitoring studies which will enable it to monitor the effects of external forces as well as the impacts of the local policies on Tehran spatial structure and its relation to socio-economic spatial variations.

▪In 2020 TMA will constitute the largest concentration of urban population in the region between Istanbul and Mumbai

▪Establishment of monitoring bodies within Tehran municipality ,with appropriate staff trained in the fields of econometrics , GIS, statistics and geo-statistical analysis will be a valuable investment for improving T.M capabilities in the management of such a large metropolis that if managed with coherent policies could bring Tehran sustainable economic prosperity.