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RESEARCH ARTICLE OPEN ACCESS

Economic Activity Nodes Allocation in Amman Master Plan: the Effect on Employment System Efficiency

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ABSTRACT
Market needs and national economic policies unavoidably affect the spatial allocation and linkage of economic activity nodes within cities and urban centers, yet optimizing the efficiency of a city's spatial configuration in serving its contained labor market remains a matter of debate between economists, with endeavors to minimize distances from resources, while preserving acceptable population sprawl.
The aim of this study is to explore and evaluate the efficiency of the current structure of job opportunities in the city in terms of urban allocation. The urban employment system in the city is excessively governed by a pure economic vision, and the future spatial structure under these conditions is hard to predict or control by urban planners. Numerical findings of analyzing the Amman 2004 Master Plan uncovered two findings: firstly, the dispersion index calculation showed an over agglomeration of residents around the Central Business District and insufficient population sprawl through the rest of the built-up area. Secondly, the planners' effort to steer the urban employment system through basic employment sector planning is ineffective, and a growing ratio of service employment sectors around the CBD is highly dependent on foreign investment instead of local industries.
Keywords – Amman, Economic Activity, Employment, Lowry Model

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I INTRODUCTION

According to Singh A. [1] "The ability of the urban economy to create sufficient job opportunities now and in the future, to make the cities as places where people can live with dignity, and indeed to transform them into proud emblems of humanity and civilization requires careful research and analysis."

By simplifying the 'organization' of the urban system, we can trace the movement of growth impulses from place to place, identifying the dependence of one center on another. What kinds of inputs and outputs characterize a particular city? What is the role of corporate linkages?

In developing countries, the economic basis of towns and cities is often still weak. Moreover, the service orientation found in towns and cities has historically been associated with a high proportion of precarious jobs [2]. Nowadays, many third world countries are still recovering from poverty and unemployment with a world rate of unemployment reaching 6.1% in 2009 [3]. Countries that lack financial resources, such as Morocco, Tunisia, Jordan, Syria, and Yemen have shifted their job creation agenda towards foreign private sector investment, and their major cities attract migrants and investors with a growing heavy demand on services like health and education [4]. The workforce management in these countries has never experienced such a high pace growing labor market before, and on the level of urban planning, the resulting patterns of urban employment have started to give higher weight to the scattered private sector firms with less dependency on basic industrial zones.

Economic growth rates accelerated significantly in Jordan over the second half of the past decade, before slowing significantly during the period 2008- 2010 at the heels of the global financial and economic crisis [5]. Amman provides an interesting example of examining the compatibility of the traditional theory for controlling the growth of economic activity based in industrial zones that are still adopted by the planning committee with these accelerating changes in the economic background of urban planning in the city. [6]

Mathematical and theoretical models have long been used to attempt to reduce complexity and encode a clear and concise understanding of some aspects of urban complexity structure and transportation [7]. The wide range of variables that affect the evaluation and decision-making process in urban planning, make a physical model able to represent only a small portion of the system to be

understood. Planners' ability to represent the actual behavior of an urban region in a theoretical abstract model is much more related to understanding and utilizing four essential characteristics of the urban system: containing a large number of variables, being dynamically self-modified by feedback loops, changing its nature with time and mostly following non-linear correlation patterns [8].

The theory of urbanism introduces the performance of an urban employment system, as one of the diagnosis tools that indicate the socio-economic quality of a community plan [9]. Such a perspective, which is inseparable from the complexity of the multidisciplinary planning process, raises the importance of developing abstract models that forecast the intra-urban employment system and its relation to residence location [10]. The Lowry model is the most consistent and direct tool for researchers in this field [8].In Jordan, both public and private sector economic activity contain very high percentages of service employment [11]. According to the Lowry prediction model, such employment typology could be a weak factor for the spatial planners' control over population growth scenarios. In such a model, the allocation of export base industry is the direct control tool and the service employment is dependent on that allocation with an expected degree of uncertainty, and the uncertainty increases when the ratio of service/basic employment increases.

Table (1) shows the number of employees in export-based industries in Amman according to Greater Amman Municipality, however, it does not accurately represent the real employment typology allocation in the city. For example, mechanical car maintenance workshops are considered to be an export-based industry although they do not produce any industrial value products, nevertheless, this information is considered acceptable in the calculation part of this research and the need for a correction factor is taken into consideration during the interpretation and conclusion phase.

Planning Area	Outer South	South West	North	West	Central	Inner South	Inner East	Outer East
Population (in 2004)	20,317	37,234	105,960	345,324	1,056,466	233,803	18,729	20,075
Gross Area (Dunum)*	446,803	170,051	87,817	121,148	102,720	192,918	117,278	421,470
Employment Zoned (D)	21,600	560	3,590	5,820	16,150	23,790	2,910	7,320
Used for Employment	160	0	340	1,130	3,730	3,040	350	0
Industrial Use	160	0	340	770	3,100	3,040	350	0
Office Use	0	0	0	30	210	0	0	0
Commercial Use	0	0	0	330	420	0	0	0
Mining	470	0	0	0	0	0	0	0
Quarries	0	0	0	0	0	0	170	10
Use for other purpose	0	0	10	540	1,250	370	50	0
Un-Used	20,970	560	3,240	4,150	11,140	20,350	2,340	7,310

Table 1. Numerical description for the urban employment in Amman [6] . *1 Dunum = 1000 m²

II. METHODS AND APPLICATION

2.1 Virtual Scenario Drawing

Three main spatial economic growth scenarios are used for interpreting the graphical behavior of statistical variables:

The natural central tendency of urban economy: this scenario predicts a single-core dominated city economy, with exaggerated central agglomeration of economic activity nodes, caused by private sector firms for profit-maximizing-reasons like; economies of scale, pursuing consumers in high-density central districts, direct interrelation with other centrally located businesses and the need for adequate infrastructure mostly unavailable in the suburbs. (Fig. 1)

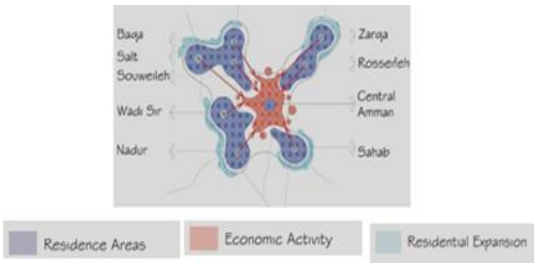

Figure.1 Scenario (1) Central Core Domination [researcher illustration].

Polar (multi-core dominated) city economy: the dominancy of this scenario is inversely proportional with the ease and low cost of the transportation network (Fig.2).

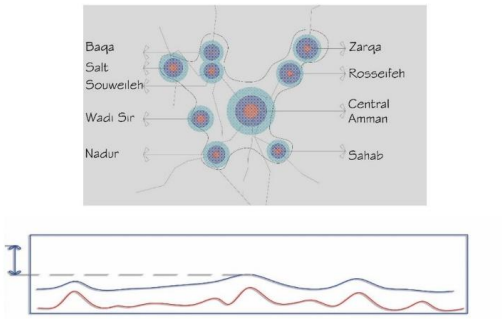

Figure.2 Scenario (2) Polar System [researcher illustration]

The gravity model: : $T_{ij} = K\frac{x_j s_i}{\cdot x} \ldots$ [12]· This equation is assumed to be valid for studying the attraction behavior of economic nodes in urban areas. Where (K)&(^x) are

experimentally calculated constants, (i) and (j) are the economic activity nodes; considering that (X) is the number of job opportunities and (S) is the population. The ability for jobs in center (i) to attract residents of center (j) decreases when the distance increases, this in turn enhances the tendency for separation between the two centers and keeps their independent entities without merging and the results show parallel growth for multi-cores.

It is worth mentioning here that $d_{ij}$is not necessarily a physical measurement of the distance; it might be a function of transportation cost, ease of access, time period of the journey or any other method needed to reach (i) from (J). (Figure 3).

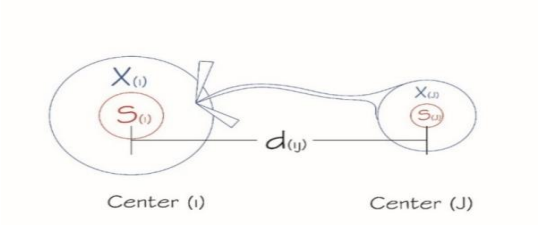

Figure 3 Gravity Model (researcher illustration)

In the third scenario an urban web is assumed to contain the economic activity nodes and these expand in parallel with residential strips of neighborhoods, this is the virtual planning alternative for keeping the minimal length of journey to work, controlling land prices, refining population density and providing a future expandable decentralized employment system (Fig. 4).

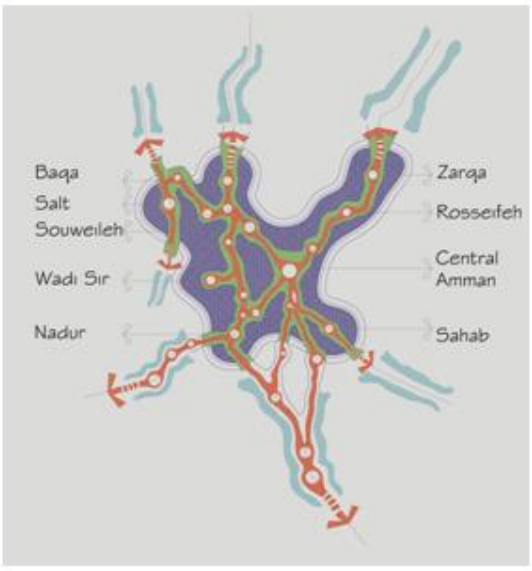

Figure 4 Expandable Urban Web (researcher illustration)

The following findings are obtained from the previous phase of the research:

The position of the Amman Master Plan in (2004) through these drawn virtual scenarios is clear by comparing the characteristics of scenarios with the results of factual statistical indicators.

The target status of (2025) for GAM planners is to be evaluated and compared with (2004) as measurement tool for the effectiveness of planning efforts dedicated for meeting requirements of the urban employment system, and the degree of success in establishing guidance constrains to ensure specific desired controllable patterns of economic spatial organization

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2.2 Prediction Models for Urban System Behavior

Most of the urban models are concerned primarily with residential location even though they seek to explain urban spatial structure in general. To the extent that they deal with employment location, this is either assumed to be exclusively in the CBD or distributed according to the requirements of housing construction and transportation, [13].

The model construction technique is a creative scientific approach for dealing with branches of inquiry that include strict limitations over the experimental approach. According to Lee [8], a model is a representation of reality.

2.2.1 Lowry Model

Other urban prediction models such as ‘linear” and “gravity” models deal with specific sub-aspects of urban systems but are unable to deal with the whole complexity of factors affecting the

economic activity node allocation. These models provide the simple vocabulary for building more comprehensive models trying to encapsulate the planning issues, but still without a single model claiming to gather all related factors.

The Lowry family of urban land use simulation models is one of the most widely used, both as an aid in scientific investigation, and as a tool for making predictions concerning growth and change in the distribution and intensity of land use activities [14]. The model contains three variables: Population, Employment and Communication (transport infrastructure represented by journey times).

Brief illustration for the Lowry model:

$\mathbf{E} = B + S$ & $P = x\,E$

$\overset{\text{where}}{\Longrightarrow} P = x\,(B + S)$ ……..(1)

And at the same time: $S = \beta\,P$……..(2)

$P1 = x\,B$

$D1 = \beta P1 \overset{\text{where}}{\Longrightarrow} P2 = x\,D1$ .....…(3)

$D2 = \beta P2 \overset{\text{where}}{\Longrightarrow} P3 = x\,D2$ … etc …….(4)

Where:

E: Total Employment (number of employees)

P: Total Population number.

B: basic employment (export based)

S: Service employment

β: Constant ration.

P1: number of people dependent on basic employment (employees and their households)

D1: demand for service employment generated by population number of P1

N is defined when Pi value becomes insignificant (very small compared with the total population).

The Lowry model assumes that the actual allocation of total employment is dependent on the basic employment sector determined by export-based industry job opportunity locations in a region of the independent national economy.

However, the derived basic Lowry formula for predicting population of (J) center is[15]:

$P_j = G \sum_{i=1}^{n} \frac{E_i}{d}$ …..(5)

The more recent formula which considers the competitive effect of other centers on the force of gravity between i and j is:

$P_i = x \sum_{i=1}^{n} T_{ij}$ …..(6)

Where:

G: Arithmetic constant.

E_i: Employment demand of center (i).

d_{ij}: Distance between center (i) & (j).

n: Number of employment nodes.

T_{ij}: Explained inspection Virtual Scenario Drawing

2.3 The structure of Jordan workforce, natural resources and employment planning targets

Public and private sector employment in Jordan contain very high percentage of service employment if compared with export based employment [11]. According to Lowry prediction model this bias of employment typology is a weakening factor for the spatial planners' control over population growth scenarios. Export Base Industry Allocation Model is the direct control tool with an expected degree of uncertainty; that increases when the ratio of service/basic employment increase.

According to GAM[16], the number of employees in export-based industry in Amman does not represent the real employment typology allocation in the city; for example, mechanical car maintenance workshops are considered export-based industry. Nevertheless, this information is considered acceptable in the calculation part of this research and the need for correction factor is taken into consideration during interpretation and conclusion phase.

Employment Type	Employed Current	Employed - 2025
Export Based	135,499	508,601
Population-Serving	346,191	1,332,506
Total	481,690	1841107

Table 2 Employment in Jordan [11]

III RESULTS AND DISCUSSION

3.1. Indicator Analysis and dispersion index calculation

It is significant to define a measurement method for the socio-economic performance of the spatial organization of an urban center or city, this action would help in comparing cities with different areas, population densities, economic activity size, and allocation, in order to find out their relative efficiency in minimizing the average length of daily journey to work, and consequentially maximize the operational efficiency of an employment system. Watson suggests the dispersion index method saying:

Procedure followed for calculating the dispersion index:

The relation between population number and the employment used land area in the Amman Master Plan is plotted on two liner curves aiming to recognize the number of gravity centers. The finding is a mono-centric curve with the origin point in the central district (Fig.5).

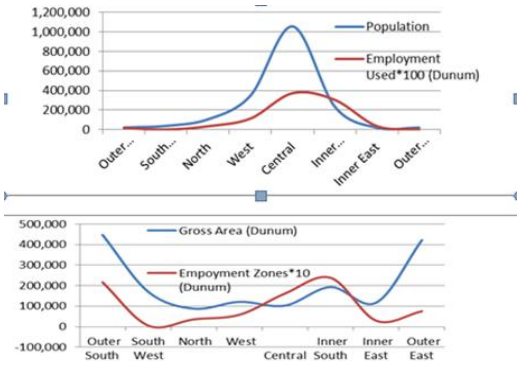

Figure.5 Graphical illustrations based on (table 1) showing that even in the target status of 2025, the employment zones are still dominant in the central district, which keeps its mono-centric growth.

The distance of the approximate center of each neighborhood is calculated from the center proposed in Fig.6:

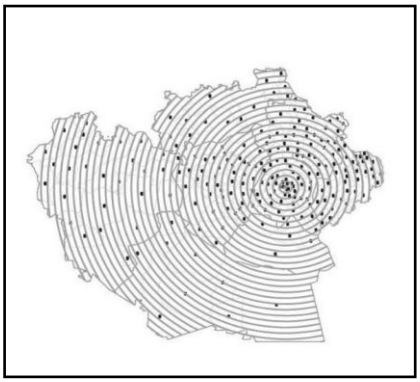

Figure.6 Calculation of the average distance of Amman population from the CBD [based on GAM [16]. (modified by researcher using PDF2CAD converter software)

The total built-up area is estimated through calculating the area of a surrounding boundary plotted with AutoCAD with reference to [6] the estimated BUA=424 km2. (Fig. 7)

Figure. 7. Estimation of built up area in Amman using AutoCAD (16).

The average distance population distance from gravity center (indicating the average length of journey to work) is calculated using the formula:

$$d_{(average)} = \frac{\int_o^R 2\pi x^2 \ d_x}{\int_o^R 2\pi x \ d_x} = \frac{\frac{2}{3}\pi r^3}{\frac{2}{2}\pi r^2} = \frac{2}{3}r$$

And πr^2= built up area = 424

$\overset{\text{Then}}{\Longrightarrow}$ r= $\sqrt{\frac{424}{\pi}}$ = 11.6 $\overset{\text{Then}}{\Longrightarrow} \frac{2}{3}r$ = 7.73

Arithmetic conclusion:

$(d_{(average)}\ Amman = 6.64)$

$(d_{(average)}\ circle = 7.73)$

$$\mathbf{d}(\text{average}) = \frac{\sum_{i=1}^{38} N(i) * d(i)}{N\ (total)}$$

Where **N**: population Number, ι: neighborhood

Ms Excel calculation formula is used and the resulting d (average) = 6.64.

3.2. Scenario drawing discussion

Scanning through different projects and interventions that are recently taking place in the Amman Master Plan, this research highlights the fact that there is no single clear vision adopted by these projects, indeed each of the three scenarios drawn in the methodology of this research encourages different type of urban interventions.

The mono-centric model scenario has the lion's share of the future empowering interventions, with many large-scale projects under construction of such type, while seven industrial zones of basic employment of the Polycentric model type.

The third scenario of the urban web is obviously supported by the planner's tendency towards organizing many commercial and mixed-use

areas to take the shape of urban strips of corridors like the Airport Corridor, Queen Rania Street and Al- Madina Street, however; these interventions are mostly more concerned in commercial use that could be detailed by further research.

3.3. **Planning Contribution Analysis**

Gravity Analysis for industrial zones allocation (Export Based Employment)

Equations 1-6 (Lowry Model section) are applied to the used areas in the industrial zones of the Amman Master Plan (Fig. 8), the calibration process and calculation assumptions are clarified as follows:

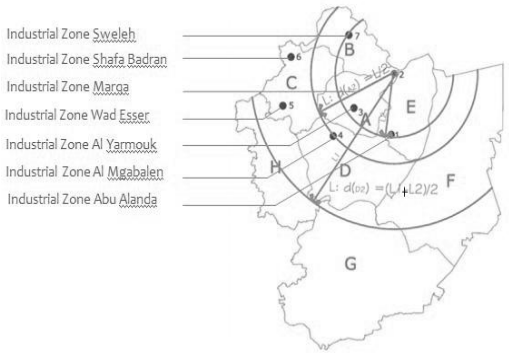

Figure.8 *Locations of basic employment zones in the Amman Master Plan 2004, the figure illustrates the method used by the researcher to estimate the distance between Marqa and planning area D as a sample for calculations of Table 2.*

The employment capacity variable (E_i) is assumed to be a function of the area of used employment land.

The distance variable (d_{ij}) is assumed to be a function of the physical distance because the current transportation system is relatively fairly distributed.

For estimating the exponent (d) in equation (5) Fig.8 is drawn and the value of (d) is estimated to be =3.

From the Lowry model equations and Figure(6):

X= P/ E = 1841107/481690= 3.8221

And β= (S/P)= 346191/1841107=0.188

Planning Area	Outer South	South West	North	West	Central	Inner South	Inner East	Outer East
Population (in 2004)	20,317	37,234	105,960	348,324	1,056,466	233,803	18,729	20,075
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Commercial Use	0	0	0	330	420	0	0	0
Mining	470	0	0	0	0	0	0	0
Quarries	0	0	0	0	0	0	170	10
Use for other purpose	0	0	10	540	1,280	370	50	0
Un-Used	20,970	560	3,240	4,150	11,140	20,380	2,340	7,510

*1 Dunum = 1000 m²

Table3. The estimated distances of each planning area from the industrial zones(sample calculations shown in appendix 1)

The basic employment-population core clarifies the fact that population distribution in the Amman Master Plan is practically running out of planners' control for many reasons; such as the low occupancy of the planned industrial zones and the low economic productivity of the type of industries.

Residents are more motivated to The inner east area that contains the predicted core is a low-density planning area within the built-up region, and the proposed core works on increasing the land occupancy; which means that the industrial land use allocation of the 2004 Master Plan works very correctly according to the dispersion index requirement, but the real planning problem is suggesting new industrial zones outside the built-up area, and starting their operation before the stage of complete occupancy is reached in the other zones.

In conclusion, the built-up area is growing much faster than it should be (Figure 9)

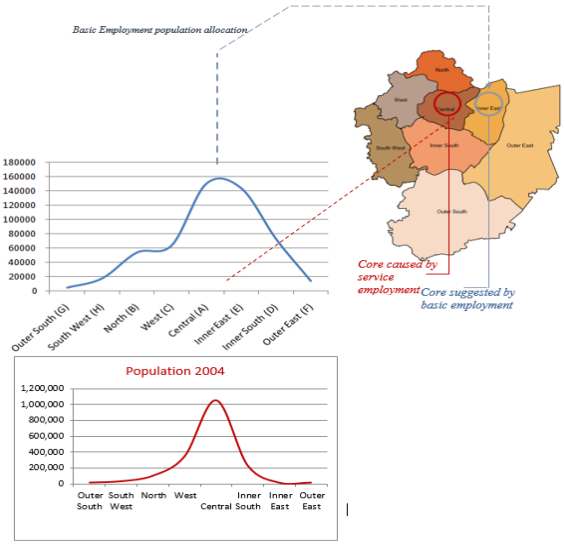

Figure.9 Comparing the actual population core with the basic employment allocation based on the Lowry prediction model.

3.4. **Gravity Evaluation for new population service Employment interventions**

For the purpose of brevity, the gravity calculations are not repeated in each case to evaluate the effect of an intervention, but the sense of gravity is used to illustrate the expected effects on the Master Plan. The BRT, although not an employment project, but taken here to notify that such projects have a direct effect on the employment structure by increasing the gravitational properties of central areas, an effect that requires quantitative studies (Fig. 10).

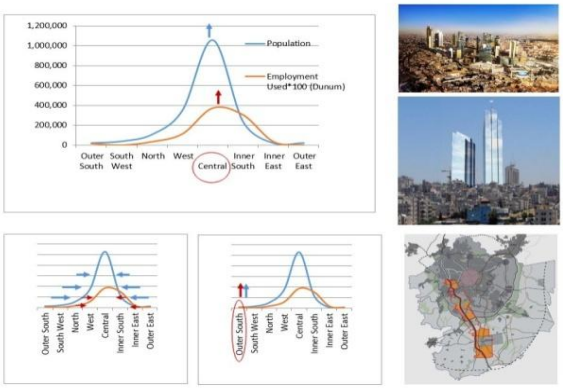

Figure 10 Graphical illustrations for the gravitational effect of different recent employment interventions in Amman [picture are taken from GMA [16].

IV CONCLUSIONS

The rapid increase in the employment demand and patterns of behavior of Amman's growing population made planners overestimate this demand by suggesting the establishment of new employment zones outside the built-up area, and at the same time underestimate the efficiency requirement for the previously planned industrial zones. According to the result of the dispersion index calculation, there is an urgent need for re-arranging priorities of Amman planners by giving more attention to the rate of occupancy and configurational quality of the already existing basic employment zones.

Comparing the average trip lengthen Amman with the calculated dispersion index indicates a mono-centric socio-economic issue revealed by the first scenario drawn in the methodology, while the way that basic employment zones are allocated reveals an existing planning effort, to release some of the central load by defining a competing center in the inner east area, in order to start the shift towards the second poly-centric scenario. However, these efforts were found to be unable to reallocate the economic activity in the city, because they are based on the traditional assumption that basic employment is the core of urban business society. The invalidity of this assumption, in the case of Amman is clear through the evident difference of the Lowry model predictions from the actual statistical facts.

The inadequacy of institutional cooperation between governmental committees responsible for both spatial and economic planning results in impoverishment of the spatial planners' control tools in Amman, and this explains the fact that service employment allocation is of low dependency on the planned basic employment sector zones and more dependent on pure economists' visions for development.

In this study, a cooperative approach is suggested between the Greater Amman Municipality and the Ministry of Industry and Trade for restructuring the future business society in the city. Three practical steps draw the major characteristics of this approach: first, establishing a reliable database in GAM by illustrating the current typology, size and allocation of private and public sector economic activity on the Master Plan. Second, adjusting the business license obtaining criteria in the Ministry of Industry and Trade, by adding a new condition that requires the agreement of GAM on the type and size of the new business based on the surrounding site saturation degree of the same economic activity.

This work is an attempt to bridge the gap of uncertainty about the efficiency of the urban employment system in Amman, and rethink the whole governmental conception for dealing with unemployment and improving the sustainability measurements in the city Master Plan. This research

recommends the insertion of quantitative model analysis in the practice of different phases of master planning, implementation, monitoring and updating. It is also useful to consider the significance of this planning tool as assistance for the planners' decisions related to organizing locations and linkage of the new large scale service employment projects that are becoming major characteristics of the modern Amman economy.

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