ANALYZING THE SPATIAL DISTRIBUTION OF PRIVATE UNIVERSITIES USING THE GRAVITY MODEL

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Abstract
This study assesses the spatial distribution of private universities using a Spatial Interaction Model (SIM) called Gravity Model (GM). It attempts to develop and validate a model that explains the prospective students' attractions and priorities to enroll in private universities in Jordan as a case study. Research methodology is a mixed methods embedded design that includes qualitative and quantitative data collection and analysis. It involves a survey for 608 students. Data collected from the survey are used in a proposed Production-Constrained Gravity Model. The results revealed that students' sensitivity to the distance (location) variable is considerably high. Similar method can be used as a tool to find out the best location for a proposed university in other countries worldwide. The importance of this research lies in the absence of the scientific methodological spatial studies related to the selection of universities locations. It also proposes a gravity model formula that can be used in evaluating the suitability of a certain site for the location of a new private university in Amman, Jordan. The same methodology can be used worldwide in the field of urban management.
Keywords: Gravity Model; Production-Constrained Gravity Model; Spatial Interaction Model; Private universities; Jordan.

1. INTRODUCTION

Private universities in Jordan have increased significantly in the last few decades compared with public universities especially when the government started allowing permission for the private sector investors to establish not-for-profit private universities in the early 1990s. This private educational market pressing demands resulted from the population rapid growth and the increased demand for higher education among young generation. It is also related to cultural influences that prefer university education over

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vocational training and community colleges. Finally, admission in public universities is highly competitive since they possess high reputation and are tuition free, therefore thousands of students could not obtain a preferred admission at any of these universities. This growing number of universities make site selection a dominant factor that determines the university's success or failure. The proper location of any university as this research assume is reachability which in return attract more students and encourage staff to work in that university. Public transportation and the availability of large vacant land for future expansion with reasonable prices are important in selecting a suitable site for the university are other factors in determining site selection as well (Perry et al. 2008).

Universities play a significant role in human capital development as well as in economic development. They employ large staff and purchase large amounts of goods from the local market (ICIC 2002; Hossain 2018).They also affect the spatial structure of cities. This research analyzes the locations of private universities in Amman, the capital of Jordan, using a spatial interaction model (SIM) called Gravity Model (GM). GM is widely used in geographic studies investigate the flow of trade between countries, immigration analysis or in studies about the relationships between mall-residential locations and consumer behavior. On the strategic planning level, GM is an essential tool that can be used for analysis, prediction and policy-making decisions (Al-Hashimi 2002). In this research, the researchers employed GM as an essential tool for studying and analyzing the spatial interaction between students' residential areas and the locations of private universities. It is a suggested systematic tool that can be used to help planners and investors in selecting the best location for a new university. This research studies, explores and analyzes how students choose their universities and its relative accessibility by public and private transportation. The importance of this research lies in the absence of the scientific methodological spatial studies related to the selection of universities locations and the relationship between universities locations and students' priorities.

Nowadays technology is used to make human lives easier. It is widely used in smart cities by governments to link municipal services with users or city residents. This research proposes a gravity model that can be used in evaluating the suitability of a certain site for the location of a new private university in Amman, Jordan. The same methodology can be used in the field of urban management in determining the best locations for different urban services and facilities; like schools, hospitals, supermarkets, malls, places of worship, petrol-stations, green space and many others. It can help municipalities in planning and updating the city's masterplan, and in managing the city's infrastructure. Using systematic approach in locating the multiple urban facilities and services help the traffic department in lowering traffic conjunction and in providing appropriate public transportation (Muksin et al. 2021; Vershitsky et al., 2021).

2. LITERATURE REVIEW

The primary role of universities lies in education, research and regional development. They also contribute to economic growth and affect the spatial structure of the city's-built environment (Perry et al. 2005). In addition, universities have a substantial impact on the social and economic development. Modern developed cities provide robust transportation infrastructure and foster the relationship between the private sector and higher education institutions. Providing the essential services for higher education institutions is then reflected in the human capital development that supports socio-economic development on the local and regional levels (Holley et al. 2016). They play great role on the real-estate development and land-use planning. For example, after World War II, universities policies were oriented toward more cooperation with the industrial sector to contribute in the industrial development. With the emerging of the knowledge economy, universities focused more on knowledge-based enterprises (Perry et al. 2008).

In "*Global Universities and Urban Development*", Perry et al. (2008) reviewed the relationship between urban development, higher education, and urban design in a number of universities all around the world. They concluded that the location of private universities is more associated with profit and economic factors since private universities tend to maximize their profits while lowering expenses. Universities occupy large area of lands therefore universities investors seek sites on the outskirts of major cities or small towns close to major cities. Location is very important to attract academic and administrative staff as well as enough students to achieve enough financial profits. That is why private universities tend to choose their campus sites on the periphery of big cities. Transportation is a vital issue in the location selection as infrastructure is very important to ease the mobility of students, employees, and lower costs (Hoover 1948; Perry et al. 2008). Sa' et al. (2004) argue that the location is crucial since it determines whether a student has to pay a rent for housing if he lives far away, or he can save that money staying at home if he registers in a near home university. The location of the university also determines how much is spent on other living costs like food and entertainment. It also determines the available urban structure and services, and multiple internal and external environments. Transportation is also related to a university's location as the availability of good transportation and discount on students' transportation tickets have a direct effect on students' comfort and time. They explored the effect of distance between a student's home and his university's location on his choice behavior. Sa' et al. (2004) research on demand for higher education in the Netherland showed that there was a negative distance deterrence effect (Sa' et al. 2004).

The Ministry of Higher Education (MoHE) was aware of the importance of locating universities in all Jordan's governorates to enable them to play a development role, especially in the weak governorates located geographically far away from Amman (north or south) (MoHE 2014) (Figure 1). Financial, human

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resources and infrastructure support were provided for these public universities as well. In Amman, public universities, such as the University of Jordan is located inside Amman, while private universities spread out to the north and south of Amman. Jordan's government does not support the transportation of private universities' students, so the cost of the study is increased by the cost of transportation to the university. The further a university is from a student's place of residence, the higher the cost of transportation. This means that the distance or location of a university has triple effects on the cost of education, time spent commuting, effort and comfort of students. On the other hand, Jordan suffers from a weak, insufficient public transportation system, poor road infrastructure, and traffic congestion, which lead to complicating the issue. Therefore, universities' spatial accessibility in Jordan needs to be investigated.

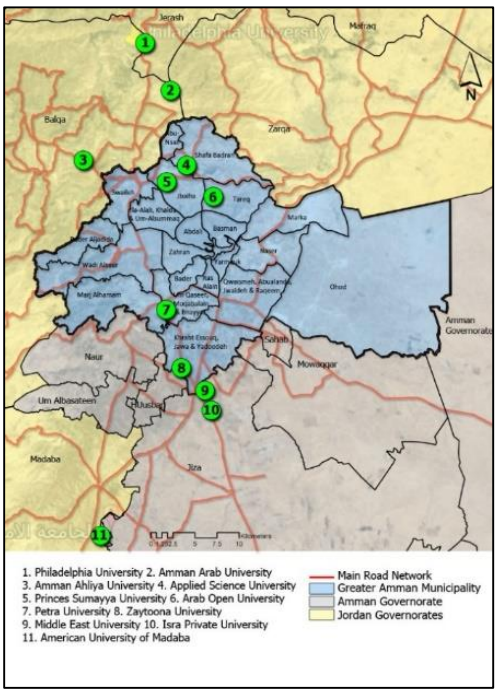

FIGURE 1 - LOCATION MAP FOR THE STUDIED UNIVERSITIES.
Source: MoMA (2018) edited by researchers

3. METHODOLOGY

3.1. Gravity model (GM)

This research suggests GM as a tool for investigation. GM is considered one of the oldest and most essential models used in spatial interaction measurement. It is an urban model that used to simulate the real world using mathematical symbols. It is widely used in many studies like immigration, the flow of trade, traffic flows or in studies about the mall-residential location and consumer behavior. It is an essential tool that can be used for analysis, prediction and policy-making (Khashman 1992; Al-Hashimi 2002).

The first use of gravity in analyzing students flow was conducted in 1941. John Stewart noticed that most of the students in Princeton University live at the same state or the neighboring states, while a small number of students came from far away states. He used a gravity model in his study, and concluded that there was a negative deterrent relationship between students' residential states and the distance from Princeton University (Khashman 1992) Wilson (1971) criticized previous gravity models. He pointed out that GM can be divided into four different models: Unconstrained Gravity Model, Production Constrained Gravity Model, Attraction Constrained Gravity Model and Production-Attraction Constrained Gravity Model. He called this family of models: "Spatial Interaction Models." (Haynes et al. 1984). In this research a Production Constrained Gravity Model (PCGM) is used with reference to both Lakshmanan and Hansen (Wilson 1971; Al-Hashimi 2002). It is a useful assessment tool for this research since the demand attraction are unknown but could be predicted.

In this research we refer to the number of students in residential areas as demand, and university services as attraction. Using this model, a new university can be added using the same number of students whom will be re-distributed on universities to estimate the spatial interaction or the expected number of students for the new university in an easy and practical way. Only one study was conducted in Jordan about universities in the field of urban planning. Khashman (1992) was the first researcher to study a university's location. He used a gravity model with data from statistics applied to a single public university only, the University of Jordan. The study concluded that the gravity model was an excellent tool to predict university students' enrollment and that the distance was not a significant factor in this case. The study recommended that new research should be conducted to include other universities, adding more variables in the assessment (Khashman 1992). Sa' et al. (2004) research on demand for higher education in the Netherland used a gravity model in its analysis. It explored the different factors affecting high school students in their choice of suitable higher education. The results show that the distance had a negative deterrence effect, the rent had a negative effect, the education quality had no effect and that the urban environment and facilities had positive effects (Sa' et al. 2004). Bruno et al. (2008) considered the gravity model as one of the best tools in evaluating and analyzing the university's location. They used a gravity model for prediction as an Italian university wanted to expand and build on a new location. The study was made to predict future students' enrollment and distribution between the two sites of the university. The results were compared with actual students flow data, which were very close to the results from the model with good estimation. Cullinan et al. (2016) also used a gravity model to study the flow of students from high schools to higher education institutions in Ireland. Positive and negative factors were studied. The result showed the significance of the spatial distance between school and university on students' flow,

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and that there is an inverse relationship between them. It also showed that the features of schools and universities had impacts on students flow as well.

3.2. Data Collection and Analysis

The study depends on a mixed-methods embedded design that includes qualitative and quantitative data. It starts with qualitative data collection and analysis, then it is followed by quantitative data collection and analysis. The primary data collection and analysis method is quantitative; whereas qualitative data are secondary (Creswell 2012). The qualitative part aims to give overview information about the studied universities, their locations and current laws and policies regarding university location. It includes conducting interviews and reviewing official documents. The central part of this research is the quantitative part. It aims to explore what attracts students to their universities and whether the location of a university is important for students when selecting a university to join. After that, the suitable gravity model for this case is proposed. Survey findings and results are then used in the gravity model's calculations. Its findings explain the spatial interaction between the locations of universities and the residential areas of their students.

TABLE 1 - STUDIED UNIVERSITIES AND SAMPLE SIZE

No	University Name	Year	Location	No. of enrolled students	No. of enrolled bachelor students	Distributed forms	Collected forms	Sample size (No. of enrolled bachelor x 0.013)
1	Philadelphia University	1991	Jerash	5,858	5,779	95	90	75
2	Amman Ahliya University	1990	Balqa	5,925	5,770	100	93	75
3	Petra University	1991	Amman	7,081	6,931	115	104	90
4	Applied Science University	1991	Amman	5,992	5,771	100	81	75
5	Isra Private University	1991	Amman	5,065	4,703	85	83	61
6	Princess Sumayya University	1991	Amman	2,719	2,545	45	57	33
7	Zaytoona University	1993	Amman	7,155	6,837	116	116	89
8	Amman Arab University	1999	Balqa	2,618	1,962	45	44	26
9	Arab Open University	2002	Amman	2,623	2,341	45	42	30
10	Middle East University	2005	Amman	3,324	2,796	55	55	36
11	American University of Madaba	2009	Madaba	1,393	1,393	44	44	18
	Total			**49,753**	**46,828**	**845**	**809**	**608**

Source: MoHE (2018); sample size by researches, 2019

The spatial scope of this research covers Amman governorate that includes GAM divided into 22 districts and eight small municipalities. It also includes other governorates where studied universities' students live. The social scope of this research includes all enrolled bachelor students in eleven private universities, located in and around Amman Table 1. The target population of the survey includes all enrolled bachelor students in eleven private universities. A sample size of 608 is taken for this study with a confidence rate of 95% and a margin of error of 5% (Saunders et al. 2009). This sample is taken from enrolled bachelor students. For each university, the sample was determined to reflect the total number of its bachelor students to be able to compare it with other universities. The survey questionnaire is distributed to 845 students and the collected forms were 809. After removing forms that are not suitable for analysis, if the rest are larger than the needed sample size, then the first forms are taken without selection and the rest are ignored to ensure that the sample is random Table 1.

The first part of the survey consists of demographic and qualitative questions. It includes general information about the respondents: university name, academic level, academic program and academic year. Respondents were asked about their used means of transportation, its frequency, commuting time, place of residence before/after joining the university. The second part of the survey consists of quantitative questions. Respondents were asked to determine, using a scale, how much the following variables were essential when deciding what university to join among study program, cost, academic quality, university location, availability of transportation, students' services, university reputation/branding and housing availability.

The first part of data analyzed by the Statistical Package for Social Science (SPSS). The demographic profile of the survey's respondents and the qualitative questions were analyzed based on descriptive statistics using the frequency test for all questions. Results show that most students use university buses or their own cars rather than public transportation. The majority of them use their individual vehicles and the commute trip takes an hour as most of the students live in GAM borders.

The demographic profile of the survey was analyzed with descriptive statistics using a descriptive test for the mean value that was done for questions 10-27. These questions were constructed with a Likert scale from 1 to 5, where 1 means strongly disagree and 5 means strongly agree. Then the mean value is calculated using SPSS. The following scale is used to determine the level of importance of each question:

- The difference between the highest value and the lowest value is (5-1 = 4)
- The length of the period is (4/5 = 0.8). So, they are as follows:
- Very low if the value is (1-1.80)
- Low if the value is (1.81 to 2.60)

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- Moderate if the value is (2.61-3.40)
- High if the value is (3.41-4.20)
- Very high if the value is (4.21-5.00)

The results show that the availability of preferred study program and the variety of study programs are of high importance on a student's decision, whereas the cost of the study program is of moderate importance. The academic quality of a university is measured in three different parameters in this survey: quality of the educational environment, quality of teachers and quality of administration staff. All these variables are of high importance on a student's decision to join a university. It is clear that the short distance between a university and a student's home and the commuting time to a university are both of high importance. Transportation to a university is measured in three different parameters in this survey: transportation availability to university, transportation efficiency of university buses, and public transportation availability from a student's home to his university. The results show that the first variable is of high importance, while the other two variables are of moderate importance. The internal university environment, is of high importance, while the external university environment, is of moderate importance for a student when selecting a suitable university to enroll. University reputation and branding are both of high importance. Finally, housing availability and its cost are of low importance to a student in choosing his university.

We conclude that the significant variables in selecting a university to attend according to students' point of view are: the preferred study program, variety of programs, quality of educational environment, quality of teachers, quality of administration, university location, travel time, transportation availability by university, internal university environment, university's excellent reputation and university's branding.

4. DEVELOPING AND APPLYING THE GRAVITY MODEL: MODEL ESTIMATION AND RESULTS

The three main requirements for building the gravity model for the case of this study are:

1. Demand (Ci): It means to evaluate how many university students live in residential areas.
2. Supply/attraction (Fj): It means to evaluate a university's ability to attract students from where they live to its location.
3. Distance (dij): It means to evaluate the effect of the space or distance separating the residential areas (demand) from the university location (supply). Distance in the gravity model is calculated in four different ways: straight distance, road network distance, cost of mobility, or time spent on mobility (Sa' et al. 2004; Eyre 1999; Hiari 2016).

4.1. Estimating the Number of Students' Variables (S_{ij}, C_i)

For each university, the sample was determined as a percentage that can reflect the total number of its students, to be compared with other universities. It means that the same percentage of students is taken from each university.

S_{ij}: is the number of students living in area i, studying at university j, taken from the main survey.

C_i: is the number of students living in area i, who go to all private universities, taken from the survey. It means that:

$$C_i = \sum_{j=1}^{n} S_{ij} \quad \text{..... (1)}$$

These data are organized in an Excel sheet to be used later in the gravity model. For example, four students responded to the survey, live in Basman district who join Philadelphia University. So, Sij for Philadelphia and Basman is four (Sij = 4).

4.2. Estimating the University's Attractions Variable (F_j)

Fj is a measure of the attractiveness of university j. University's attractions are essential factors that resemble human behavior in selecting a university to enroll. For the use in the gravity model, and after reviewing the results of the students' survey, the following variables are selected for the calculations of the attractiveness of universities:

- Preferred study program
- Cost of study
- Average of quality of the educational environment, teachers and administration
- Internal university environment
- Average of the university's reputation & branding

Calculations of the gravity model are done three times with different Fj values. The first scenario considered university attraction variables extracted from the main survey. The second scenario considered all the previous variables and included two more extracted from MoHE (2018). The last scenario considered university attractions to be equal to one, in order to assess the effect of distance alone on the spatial interaction. F_j values are measured in the following three scenarios:

First Scenario: For F_j = F1

Preferred study program (P1), cost (C), the average of quality (Q1, Q2, Q3), Internal university environment (E1), university's reputation & branding (B1&B2) values are taken from **Table2**. Their values are out of five. These values are multiplied together as in the following equation:

$$F1 = P1\ C\ \bar{Q}\ E1\ \bar{B} \quad \text{..... (2)}$$

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Second Scenario: For F_j = F2

All previous variables are taken, combined with two more variables: student-teacher ratio (ST) and the number of bachelor programs (BP). They are detailed in **Table 2**. To be able to combine the last two variables with the old ones, a change is made on them. The largest number of bachelor programs is 30, so all values are divided by six, in order to get values out of five. As the largest value of the student-teacher ratio is 52.46, all values are divided by twelve, in order to get values out of five. Then it is subtracted from five to get a positive value. Finally, all these values are multiplied together. F_j is calculated based on the following equation:

$$F2 = F1\ ST\ BP \quad \text{..... (3)}$$

or

$$F2 = P1\ C\ \bar{Q}\ E1\ \bar{B}\ ST\ BP \quad \text{..... (4)}$$

TABLE 2 - MAIN UNIVERSITY ATTRACTIONS CALCULATED FROM THE MAIN SURVEY, STUDENT-TEACHER RATIO, NO. OF BACHELOR PROGRAMS CALCULATIONS.

No	University name	Preferred Study Program	Cost	Average of Quality	Internal University Environment	Reputation & Branding	Student: Teacher	Student: Teacher 5-(x/12)	No. of Bachelor Programs	No. of Bachelor Programs (/6)
1	Philadelphia University	4.21	3.36	3.41	2.98	3.67	19.2:1	3.4	30	5.00
2	Amman Ahliya University	4.22	2.72	3.88	3.68	3.98	22.27:1	3.14	29	4.83
3	Petra University	4.4	2.98	4.11	4.0	4.16	24.67:1	2.94	28	4.67
4	Applied Science University	4.38	2.69	3.99	3.64	4.07	22.61:1	3.12	25	4.17
5	Isra Private University	4.16	3.78	3.9	3.29	3.31	24.71:1	2.94	24	4.00
6	Princess Sumayya University	4.45	2.87	3.83	3.51	4.35	25.65:1	2.86	12	2.00
7	Zaytoona University	3.94	3.48	3.91	3.55	3.93	23.01:1	3.08	28	4.67
8	Amman Arab University	3.96	3.69	3.40	2.61	3.35	18.97:1	3.42	21	3.50
9	Arab Open University	4.0	3.63	3.72	2.57	3.81	52.46:1	0.63	7	1.17
10	Middle East University	4.3	3.25	4.1	3.61	3.52	19.21:1	3.40	18	3.00
11	American University of Madaba	3.94	1.9	3.55	2.89	3.85	18.82:1	3.43	18	3.00

Source: MoHE (2018);, edited by researchers (2019)

Third Scenario: For $F_j = 1$

In this scenario, the effect of university attraction is eliminated, in order to examine the effect of distance alone on the spatial interaction between residential areas and universities' locations. The following equation is used:

$$F_j = 1 \quad \text{..... (5)}$$

The results of calculating universities' attractions for the three scenarios are shown in Table 3.

4.3. Estimating the Distance Variable (dij)

dij is the distance from residential location i to university location j. β is the average coefficient of distance or the sensitivity of students to distance. In this research, the distance is calculated in time per minutes. Time consumed in the journey from a university to a student's place of residence is estimated using Google Maps mobile application. The procedure is done during peak hours from 2.00-4.30 pm since the commuting time for students is mainly at peak hours. Peak hours embed waiting time or longer journey time associated with the traffic congestion in some streets in Amman.

4.4. The Gravity Model Equation

The proposed production constrained gravity equation used in this research is developed by Wilson (1971) and Lakshmanan and Hansen (Al-Hashimi 2002):

$$S_{ij} = \frac{C_i \frac{F_j^{\propto}}{d_{ij}^{\beta}}}{\sum_{j=1}^{n} \frac{F_j^{\propto}}{d_{ij}^{\beta}}} \quad \text{..... (6)}$$

Where:

Sij: is the number of students living in i studying at university in j

Ci: is the number of students living in i (demand)

Fj: is a measure of the attractiveness of university j (supply)

dij: is the distance from location i (demand) to university location j (supply)

n: is the total number of universities

α: is the average coefficient of university's attractions, or the sensitivity of students to a university's attractions. It is assumed to be (1) in this research.

β: is the average coefficient of distance or the sensitivity of students to distance.

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4.5. MATLALB Iterative Optimization

MATLAB, an abbreviation for Matrix Laboratory, is a computer-based programming platform. It is used by scientists and engineers. It enables the use of a matrix for complicated mathematics and statistics. It has an embedded programming language that includes matrix and array mathematics at the same time. MATLAB is used for data analysis, algorithms creation, and model building. It makes it easier for a researcher to inspect many approaches in order to find the best result in a short time (Mathworks 2018). In this research; MATLAB is used to build the gravity model and analyze data using statistics that were obtained from the main survey questionnaire. The iterative optimization method is used for applying the gravity model equation. Iteration means to repeat a process many times in order to get the optimum solution. An iteration is a vital tool in solving non-linear equations, like the gravity equation. Repeating the process aims to achieve the best possible target. It means that iteration is used for optimizing the results (Mathworks 2018).

4.6 The MATLAB Function Used in Model Calculations

Data from eleven universities and 32 residential areas result in a matrix of 11 x 32 = 352 gravity equations. MATLAB is set to repeat/iterate 10,000 times in order to get the optimum result. The previously mentioned gravity model equation (6) is repeated 12 times for each of the 352 equations. The 12 results were identical, which means that it is accurate. The MATLAB function is used in the gravity model calculations to find the β value.

TABLE 3 - RESULTS OF CALCULATING UNIVERSITIES' ATTRACTIONS FOR THE THREE SCENARIOS AND THE COEFFICIENT OF DISTANCE (β) CALCULATED USING THE GRAVITY MODEL.

No.	University name	F_j = F1	β when F_j = F1	F_j = F2	β when F_j = F2	F_j = 1	β when F_j = 1
1	Philadelphia University	527.54	1.92	8968.24	2.06	1	2.03
2	Amman Ahliya University	652.29	2.85	9892.83	2.94	1	2.84
3	Petra University	896.73	2.22	12311.99	2.11	1	2.33
4	Applied Science University	696.46	2.45	9061.2	2.57	1	2.56
5	Isra Private University	667.84	2.91	7853.82	2.94	1	2.96
6	Princess Sumayya University	746.86	3.62	4272.02	3.50	1	3.47
7	Zaytoona University	747.95	1.79	10758.23	1.54	1	1.83
8	Amman Arab University	434.4	3.23	5199.72	3.13	1	3.34
9	Arab Open University	528.89	2.88	389.85	2.90	1	2.98
10	Middle East University	777.73	3.25	7932.88	3.06	1	3.43
11	American University of Madaba	295.69	3.77	3042.65	3.82	1	3.79
	Average β for Amman's private universities		**2.81**		**2.78**		**2.87**

Source: researchers (2019)

The results of the MATLAB code were organized in a matrix of (11 x 32) β values for each university and every residential area. It is calculated three different times depending on the three scenarios of Fj as explained earlier. Then, an average value was estimated for each university as shown in Table 3. Values obtained when Fj = F2 are preferred and will be used in this study from now on because it considers the effect of a broader range of university attractions like the student-teacher ratio and the number of study programs.

Table 3 shows that the Average of the coefficient of distance (β) values for Amman's private universities is **2.78**. β values or the coefficient of distance reflect the sensitivity of students to the distance to their universities. As it is larger than one, it means that the distance factor is essential and significant. Moreover, as it is larger than two, it means that spatial interaction decreases very quickly or sharply when the distance increases. So, the longer the distance between a student's residence from a university, the lower the possibility that he will choose to enroll in that university, and vice versa. As we can see from **Table 3**, the values of the coefficient of distance are close among the three different scenarios, whether we include the attractions of the universities or not. It indicates that the effect of distance is much more significant than university attractions. **Figure 2 & 3** show the coefficient of distance (β) values for the studied universities calculated using the gravity model with MATLAB. As shown, the coefficient of distance is not consistent for all studied universities. It varies between 1.54 to 3.82 among Amman's private universities.

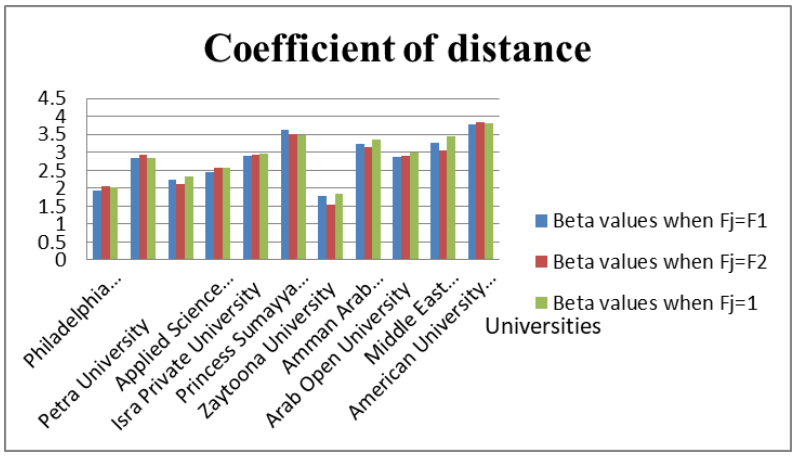

FIGURE 2 - COEFFICIENT OF DISTANCE (β) CALCULATED USING THE GRAVITY MODEL IN MATLAB.
Source: researchers (2019)

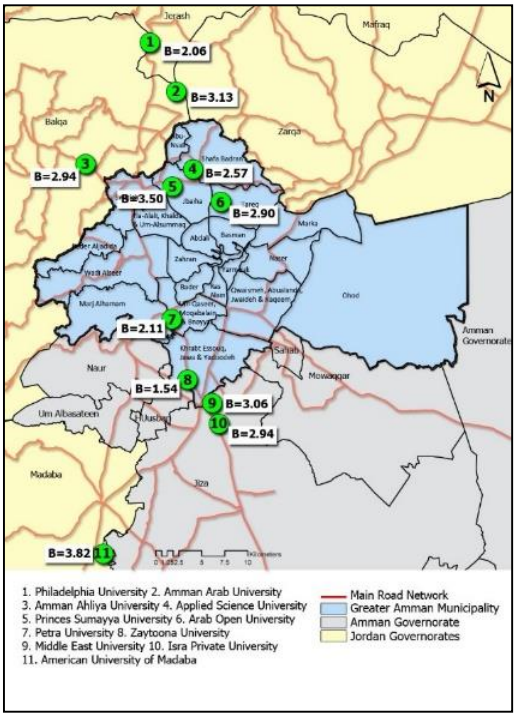

FIGURE 3 - COEFFICIENT OF DISTANCE (β) VALUES WHEN FJ=F2 CALCULATED USING A GRAVITY MODEL FOR AMMAN'S PRIVATE UNIVERSITIES
Source: researchers (2019)

5. ANALYSIS OF THE RESEARCH FINDINGS

After reviewing the official documents, we find that there are no governmental regulations or guidelines concerning the location of universities. Based on the interviews conducted with the founders of the studied universities, the location selection is solely the job of a university's investors based on his perspective and his good judgment. When they were interviewed, some of them were aware of the significance of the location, and followed good planning strategies, especially universities that lie along the Airport Highway, where site selection was based on:

- Amman's growth direction was to the south at the time when they were selecting a suitable location for their new universities, as an indicator to the direction of the city's growth.
- The Airport Highway has better municipal services than other areas of Amman. It also has a reliable transportation infrastructure.
- They located at a close distance to many governorates like Amman, Madaba, Zarqa, Karak and Balqa. So, it is easier for many students from these governorates to join.

- Their closeness to the Airport makes the location more attractive to international students. Private universities in the north of Amman considered the following factors for their location determination:
- Their location on a major highway (Al-Urdon Highway), which makes them more accessible.
- Their location is close to many governorates like Amman, Zarqa, Jerash and Balqa.As most students spend less than an hour on their trip, it indicates that university closeness makes an important issue for them. They do not find student housing important. Most students live in Amman meaning they live near their universities. It indicates that students target universities near their homes because the distance away from the university is crucial for them. When asked about the significance of the short distance between a university and a student's home on his decision to join, the result was of high importance. The conclusion is that the location of a private university matter to students.

All private universities in Amman were aware of the importance of transportation. Most of them selected a site that is located on a major road which is well serviced by public transportation. At the same time, they have provided their students with university buses, to make their journey more comfortable. Most students use either university buses or their cars, which is related to the weak public transportation system and infrastructure. Figure 4 shows the density of students in residential areas. The highest density of students are found in Tla Al-Ali, Khalda and Um Summaq district and Jubaiha district.

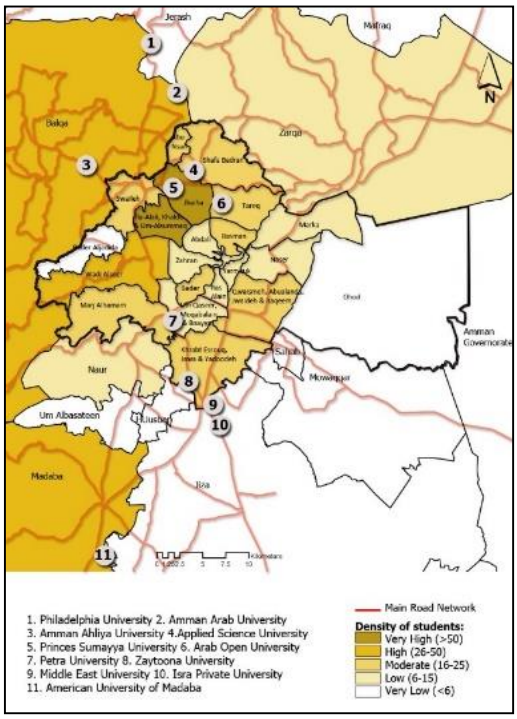

FIGURE 4 - DENSITY OF STUDENTS IN RESIDENTIAL AREAS RESEARCHERS (2019)

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5.1. Private Universities' Attractions

Based on the survey, the significant variables in selecting a university to attend according to students are the preferred study program, variety of programs, quality of the educational environment, teachers and administration, university location, travel time, transportation availability by the university, internal university environment, university's excellent reputation and university's branding. These results go well with the concept of the gravity model. Students join the closest private university that has a good reputation and provides the program they prefer at a reasonable cost, with high quality and excellent services. They do not care much for the external environment or the availability of student housing on or near a private university. The spatial interaction between a university and residential areas relies both on the distance separating the university from residential areas along with the attractions of that university. The results reflect rational and investment choice rather than consumption choice when selecting a university to join.

5.2. The Coefficient of Distance (β values)

The coefficient of distance is usually between 1-3 (Bruno et al. 2008). It is usually higher in developing countries than in developed ones. It was about 1.34 for higher education in the Netherlands (Sa et al. 2004) , and around 0.89 for higher education in Ireland (Cullinan et al. 2016). The average coefficient of distance for Amman's private universities is 2.78. Long distance prevents students from joining a faraway university. If a university is located near the locations of residential areas, it will gain a high number of students. The sensitivity of students to distance in Jordan is higher than the case of the two developed countries. This difference could be related to:

- •The weak transportation network and infrastructure
- •The high rate of car ownership
- •The high rates of traffic congestion

All these factors increase the effect of the distance. The decision to go on a trip needs much thinking about how to overcome that distance. The attractions of a university might overcome that obstacle, resulting in more students who enroll.

5.3. The Different Scenarios of the Coefficient of Distance

In order to study the effect of distance alone, we used Fj = F1. It means that we assumed that the university attractions are equal to one. Table 3 shows (β) values calculated using a gravity model. The average of the coefficient of distance for Amman's private universities is 2.87 when Fj = 1 (the baseline scenario). As it is higher than one, it means that the distance has a negative impact. High distance prevents students from going to these universities. The reason is that of the time and effort consumed and money spent on the trip. Lower distances do not require student housing, lowering the costs too.

Table 3 shows (β) values calculated in three different scenarios, where all three have close results. The small difference between considering the university attractions or not indicates the following:

- International students rent housing near the University of Jordan.
- Most of the studied universities have a wide range of study programs and similar education quality. They are located near each other. The result is that they have somehow similar or close attractions except for Princess Sumayya University (because it is technology-based) and Arab Open University (because it relies on e-learning) and the AUM (because it is too far from the targeted students).

5.4. The Coefficient of Distance and the Distance

- From the Gravity model (6), there is a relationship between (β) and the distance (dij). In Table 4, there are differences in (β) values among the multiple studied universities. Low (β) value for a university means that this university is more accessible and serves a larger area. It can attract students on a regional level and from wider areas or longer distances. As an example, Philadelphia University and Zaytoona University have a considerably low (β) values. They can attract many students from many governorates which have long distances. On the other hand, high (β) value for a university means that this university is less accessible and or serves smaller residential areas. It can attract students on a local level and from tighter areas or shorter distances. Princess Sumayya University has a considerably high (β) value. It has a tight catchment area. It cannot attract many students from long distances. Also, the American University of Madaba has a high (β) value. It attracts a small number of students from tight and limited residential areas.

TABLE 4. NO. OF STUDENTS, THE COEFFICIENT OF DISTANCE, AVERAGE DISTANCE AND UNIVERSITY ATTRACTIONS

No	University name	No. of Students (Sample Size)	β value when F_j = F2	Average d_{ij} (minutes)	F_j = F2
1	Philadelphia University	75	2.06	38.19	8,968.24
2	Amman Ahliya University	75	2.94	23.24	9,892.83
3	Petra University	90	2.11	19.14	12,311.99
4	Applied Science University	75	2.57	16	9,061.2
5	Isra Private University	61	2.94	32.64	7,853.82
6	Princess Sumayya University	33	3.50	16.79	4,272.02
7	Zaytoona University	89	1.54	25.42	10,758.23
8	Amman Arab University	26	3.13	24.15	5,199.72
9	Arab Open University	30	2.90	24.93	389.85
10	Middle East University	36	3.06	27.22	7,932.88
11	American University of Madaba	18	3.82	51.44	3,042.65
	Average for Amman's private universities		**2.78**		

Source: researchers (2019)

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5.5.The Coefficient of Distance and the University's Attractions

From the previous model (6), there is a negative relationship between the coefficient of distance (β) and the university's attractions (Fj). It means that when a university has many attractions, it can attract more students from far away to join. This means that when a university is strong, the effect of distance becomes weak or small. As shown in Table 4, lower (β) values are related to more massive university attraction (Fj). Zaytoona, Petra, Applied Science and Philadelphia universities have a low (β) and have big attractions at the same time. Their great attractions enable them to draw more students making the effect of distance considerably weak. Where high (β) value for a university means that this university is less attractive, it could be because of the small number of programs, high cost or lower quality. The Arab Open University, American University of Madaba, Princess Sumayya, and Amman Arab universities have a high (β) value and have low attractions at the same time. Their low attractions disable them to attract many students making the effect of distance considerably strong.

5.6. The Coefficient of Distance and the Number of Students

In Table 3, there are differences in (β) values among the multiple studied universities. These variations indicate that students are willing to travel to some universities more than others. From the previous model (6), there is a negative relationship between the coefficient of distance (β) and the number of students (S_{ij}). It means that when a university has a low (β), it can attract a large number of students and vice versa. Zaytoona, Philadelphia, and Petra Universities have a considerably low (β) values. They can attract many students to register at their institutions. While high (β) value for a university means that it can attract a small number of students, the American University of Madaba, Amman Arab University, Arab Open University and Princess Sumayya University have high (β) values. They attract only small numbers of students.

5.7.The Proposed Gravity Model

As the average coefficient of distance (β) for Amman's private universities is 2.78. The following model is proposed:

$$S_{ij} = \frac{C_i \frac{F_j}{d_{ij}^{2.78}}}{\sum_{j=1}^{n} \frac{F_j}{d_{ij}^{2.78}}} \quad \text{..... (7)}$$

Where:

Sij: is the number of students living in i studying at university in j

Ci: is the number of students living in i

Fj: is a measure of the attractiveness of university in j

dij: is the distance from location i to university location j

n: is the total number of universities

This model can be used as a planning tool for:

- Analysis of the current situation for a number of universities.
- Evaluation of the appropriateness of a potential site for the location of a new private university in Amman.
- Prediction for the expansion of an existing university. When a university wants to add more programs or provide more services, it would be beneficial to check the effect of these changes on its prospected students.
- Future planning studies done by the planning authorities.

5.8. Using the Proposed Gravity Model for Optimal Site Location for a new private university

As a practical example, we can use the previous proposed gravity model in order to select between two sites for a new university. The first one is in Al-Kursi, Wadi Assir, GAM and the second is at Al-Jiza, Amman Governorate. The two options are shown in Figure 5.

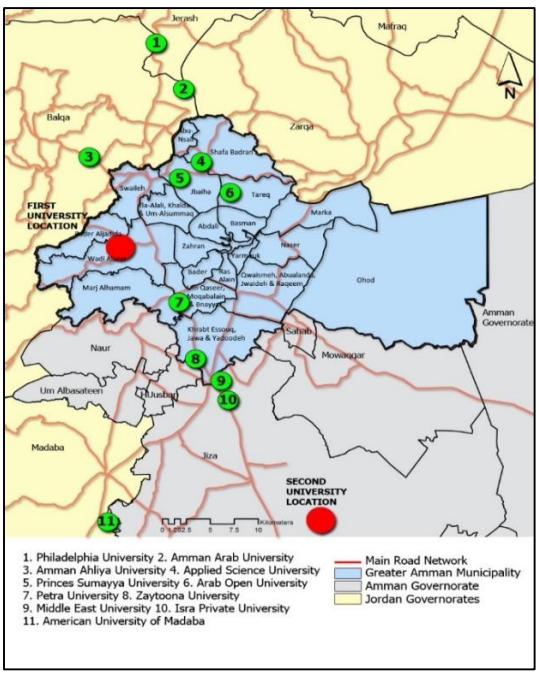

FIGURE 5 - TWO DIFFERENT PROPOSED LOCATIONS FOR A NEW UNIVERSITY.
Source: researchers (2019)

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In order to predict whether those locations were suitable for a new university, we must estimate the number of prospected students for each location. The following assumptions are made:

- The coefficient of distance (β) value = 2.78
- C is the total number of students = 608, which means that the demand is constant.
- F_j is a measure of the attractiveness of university located in j, Fj = F2 and values are shown in Table 5.
- University attractions (F_j) is assumed to be = 12,000 for both proposed university locations.
- For the distance, we compensate with the Average d in minutes. Their values are shown in Table 5.

TABLE 5 - THE AVERAGE DISTANCE AND UNIVERSITY ATTRACTIONS FOR THE STUDIED UNIVERSITIES.

No	University name	Average d (minutes)	F_j = F2
1	Philadelphia University	38.19	8,968.24
2	Amman Ahliya University	23.24	9,892.83
3	Petra University	19.14	12,311.99
4	Applied Science University	16	9,061.2
5	Isra Private University	32.64	7,853.82
6	Princess Sumayya University	16.79	4,272.02
7	Zaytoona University	25.42	10,758.23
8	Amman Arab University	24.15	5,199.72
9	Arab Open University	24.93	389.85
10	Middle East University	27.22	7,932.88
11	American University of Madaba	51.44	3,042.65
12	University location 1- Al-Kursi, Wadi Assir	Estimated 32.56	Assumed 12,000.00
13	University location 2- Al-Jiza	Estimated 46.13	Assumed 12,000.00

Source: researchers (2019)

- Estimations:

The average distance from all residential areas to the first location is calculated using Google Maps application on mobile. It is approximately = 32.56 minutes. While for the second location, it is approximately = 46.13 minutes.

Using the proposed gravity model equation (7) and a simple calculator or Excell, we can get the spatial interaction S for the first location to be approximately = 18.58. For the second location, it is approximately = 6.97. Dividing the results by 0.013 we can estimate the real number of students.

The predicted number of students for a new university located near Al-Kursi, Wadi Assir (first location) is about 1,429 students. Whereas the predicted number of students for a new university located near Al-Jiza (second location) is about 536 students.

It is clear that the shorter distance average is associated with an increased number of students, while longer distance is related with a much smaller number of predicted students. Distance here is a deterrent factor for students. Students are very sensitive to the long distance from a university, which make them avoid distant universities and prefer close ones. So, the first location in Al-Kursi, Wadi Assir has a shorter distance average. It means it is near the residential areas of most students. That makes it a better location for a new university because it can attract more students than the second proposed location in Al-Jiza.

6. CONCLUSIONS

The results of this research can be summarized in the following points:

1. There are no governmental regulations or guidelines regarding the locations of universities; governmental laws and policies do not address the planning of private universities. The location selection is based on the investor judgment. Some of them were aware of the significance of the location, and they followed good planning strategies such as Amman's direction of growth, availability of good municipal services and transportation, closeness to many governorates, and location on a major road or highway.
2. 2- The location of private universities is crucial for students. The distance to university and time spent are essential, as students prefer to spend less time on transportation. Most students live in Greater Amman Municipality area live close to their universities. When students were asked about the university location in terms of distance and commuting time, their respond revealed that distance and commuting time are very important.
3. According to the results, the average coefficient of distance (β) is 2.78 which means that the distance factor is essential and significant. Moreover, as it is larger than two, it means that spatial interaction decreases very quickly or sharply when the distance increases. In other words, students have high sensitivity to the distance (location) factor and the distance here is considered as a deterrent factor. So, the longer the distance between a student's residence from a university, the lower the possibility that he will choose to enroll in that university, and vice versa.
4. The spatial interaction between a university and residential areas relies on the distance separating the university from residential areas along with the attractions of that university. Most students join the closest private university that has a good reputation and provides the program they prefer at a reasonable cost, with high quality and excellent services.

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5. The significant variables in selecting a university to enroll in according to students are the preferred study program, variety of programs, quality of education, teachers and administration, university location, travel time, transportation availability by the university, internal university environment, university's excellent reputation and university's branding.

6. The average coefficient of distance (β) for Amman's private universities is 2.78. The sensitivity of students to distance in Jordan is higher than the case of the developed countries. It is related to the weak transportation network and infrastructure, the high rate of car ownership and the high rates of traffic congestion as all these factors increase the effect of the distance.

The following gravity model is suggested:

$$S_{ij} = \frac{C_i \frac{F_j}{d_{ij}^{2.78}}}{\sum_{j=1}^{n} \frac{F_j}{d_{ij}^{2.78}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where:

S_{ij}: is the number of students living in i, and studying at university j

C_i: is the number of students living in i

F_j: is a measure of the attractiveness of university j

d_{ij}: is the distance from i to university j

n: is the total number of universities

7. RECOMMENDATIONS

The location of a university is essential to students. A university that is located far away from the residential areas attracts fewer numbers of students. The research recommends the following:

1- The Ministry of Higher Education is encouraged to set specifications and guidelines for the locations of universities. These specifications should include the minimum distance between two universities and the minimum parking spaces. This is because the agglomeration of universities causes traffic congestion. It also increases the competition forces between universities, leading to lowering students' enrollment.

2- They can also use the proposed gravity model **(7)** as a planning tool before the accreditation of a new university to help evaluate the suitability of its location and the satisfaction of its attractions

and services. The tool is also beneficial for their studies about the future of public and private universities in Amman and Jordan. The MoHE is encouraged to do a holistic study on Jordan's public and private universities in order to make a strategic plan for the future development of higher education in Jordan. They need to do that study while connecting the demand for higher education with the appropriate locations. Coordination with GAM is advised in this case.

3- Greater Amman Municipality is also encouraged to set specifications for the locations of new universities that include the minimum distance between two universities.

4- They can use the proposed model and research findings in developing better infrastructure that suits the needs of the existing and future universities, or as a planning tool for predicting best locations for new universities. Then, these suggested new locations can be implemented in developing the future master plan for Amman. Coordination with MoHE is advised in this case.

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