A STUDY ON DISTANCE IN GRAPH THEORY AND ITS APPLICATION

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Abstract

Graph theory is applicable in the section of computer science. It relates to the multiple fields of engineering, and geographical fragmentation. The concept of distance and time with a relational strategy to road networking is discussed with proper evaluation. The purpose of the paper is to discuss and understand the impact of distance in graph theory and to evaluate the impact of graph theory in the road mapping framework.

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Introduction

In the domains of computers, the field of engineering, and physical research, graphs are used to represent a variety of interactions and processes. These are employed in a wide range of basic and applied science fields, including information systems, the social sciences, and a number of others. In a variety of scientific domains, researchers use graph topologies to model the difficulties they face.

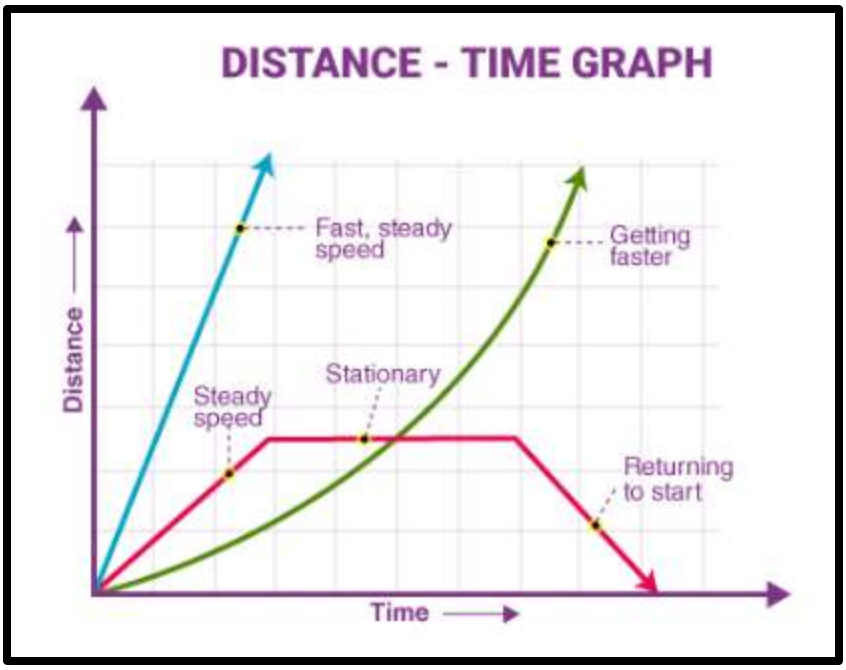

Figure 1: Concept of Distance and Time graph

(Source: Toppr, 2022)

Figure 1 states the concept of Distance and Time in Graph Theory with ease (Toppr, 2022). The slope line near the straight one depicts the speed of the elements. The uniformity in the motion is suggested by the straight line. The structure of a graph in which attributes are connected to the vertices and edges is referred to as a network of vertices. Image processing, optimizing, networking, recognition of patterns, and navigation often make use of distance in graphs.

The primary objectives of this research aim to make a representation of data that are essential for making a bond between dependent and independent variables.

RO1 To understand the conceptual context of distance and time relation in the component's journey

RO2 To evaluate the relation of graph theory in a road mapping scenario

RO3 To create the framework of graphical networking with the bond of speed and distance

RO4 To understand the area measurement in correspondence to distance traveling in a road network

The probable research questions of this topic include

RQ1 What are the conceptual thought processes of the distance and time relation in graph theory?

RQ2 What is the significance of graph theory in topographical road mapping structure?

RQ3 How can speed and distance impact the graphical representation in graph theory?

RQ4 What is the evaluation of understanding the area measurement in road networking?

Discussion on the concepts of the relation of distance and time in graph theory

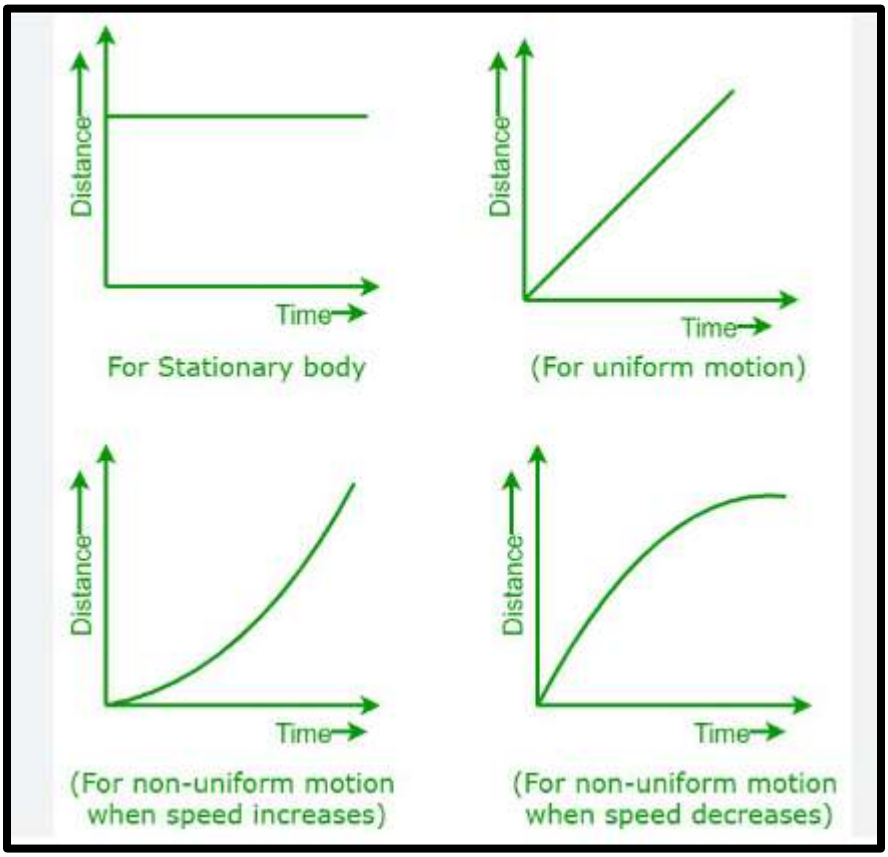

Figure 2: Relational concept of Time and Distance (Source: Geeksforgeeks, 2022)

Figure 2 represents the concepts of time and distance with physical measurements (Geeksforgeeks, 2022). This figure dictates the time span through the horizontal line and the distance through the vertical line. As stated by Nosirov, Norov & Tashmetov (2022) this visual representation of how far a body has traveled over a predetermined period of time is known as a distance-time graph. The Y-axis is used to represent the connection between space and time, while

the X-axis is employed to represent the passage of time. Understand the value of distance-time graphs first. As opined by Erb (2020) the formation of these actor's bonding can be depicted through different clusters. First, the stationary speed of the component; second, the elemental body moving at a uniform speed; third, moving elements with accelerating speed; and moving with a decreased speed of individual bodily elements.

Discussion on the significance of graph theory in topographical road mapping structure

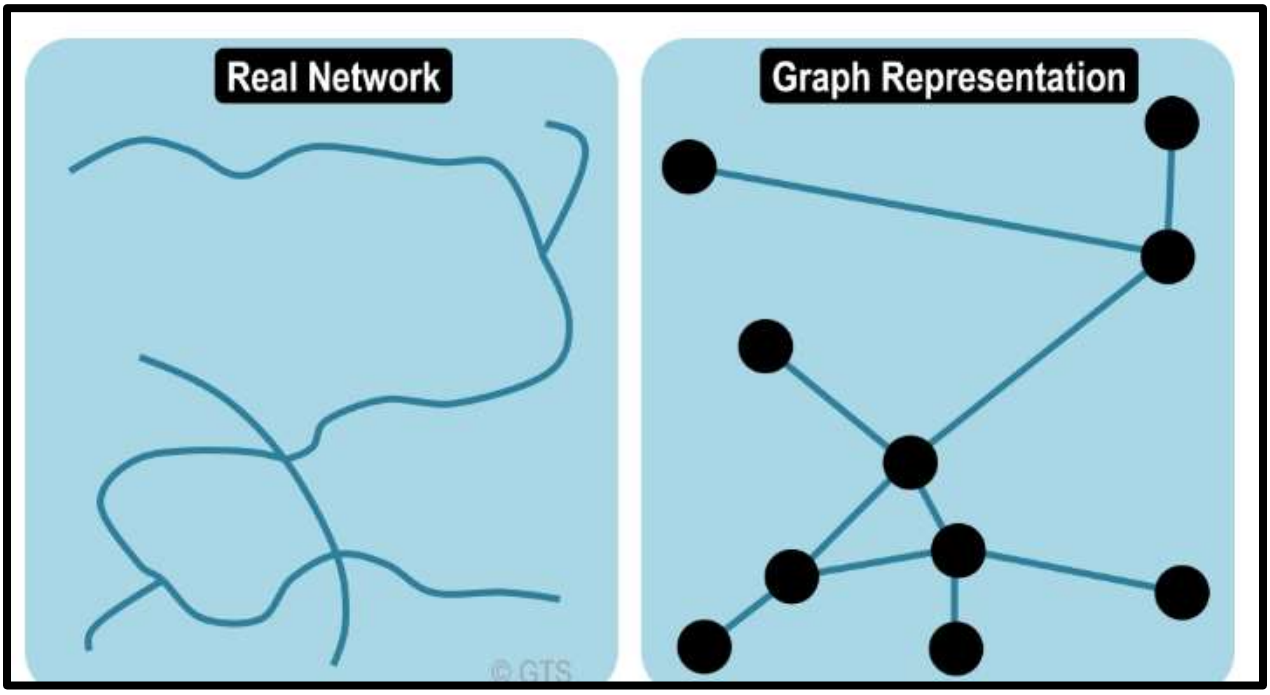

Figure 3: Graphical representation of a road network (Source: Transportgeography, 2023)

Figure 3 represents the graphical structure of a road structure for real (Transportgeography, 2023). The process of converting a planner graph into practical networking has to go through some significant processes. The primary point of networking is to make nodes at every juncture or intersection of the terminal. The later part of the process deals with joining and linking the nodes with straight segments of lines in a road network. As viewed by Guze (2019) the outcome of this abstraction is the network's actual structure, which appears in the above image. Depending on the level of detail, the real network can be challenging to understand when it involves connected frameworks. The easiest approach to understanding a network's interaction is through a graph representation.

The attributes of road network	**Activities of Nodes**
Non-junctional node	It can represent the segments of shifting in 2-lane to 4-lane road mapping
Dummy node	A dummy node can be used for creative justification. It helps to compare the shape of the graphical project with the practical network.

Table 1: Road networking attributes and Node's activities

(Source: Influenced by Saleem & Weng, 2022)

Table 1 discusses the geographical attributes of road networking along with node joints (Saleem & Weng, 2022). It is possible for each node's relative location to stay close to that of its counterpart in reality. Comprehending the geographical context of the network and the counterpart of road network mapping the attributes are important.

Evaluation of the significance of area measurement in Topological graph theory

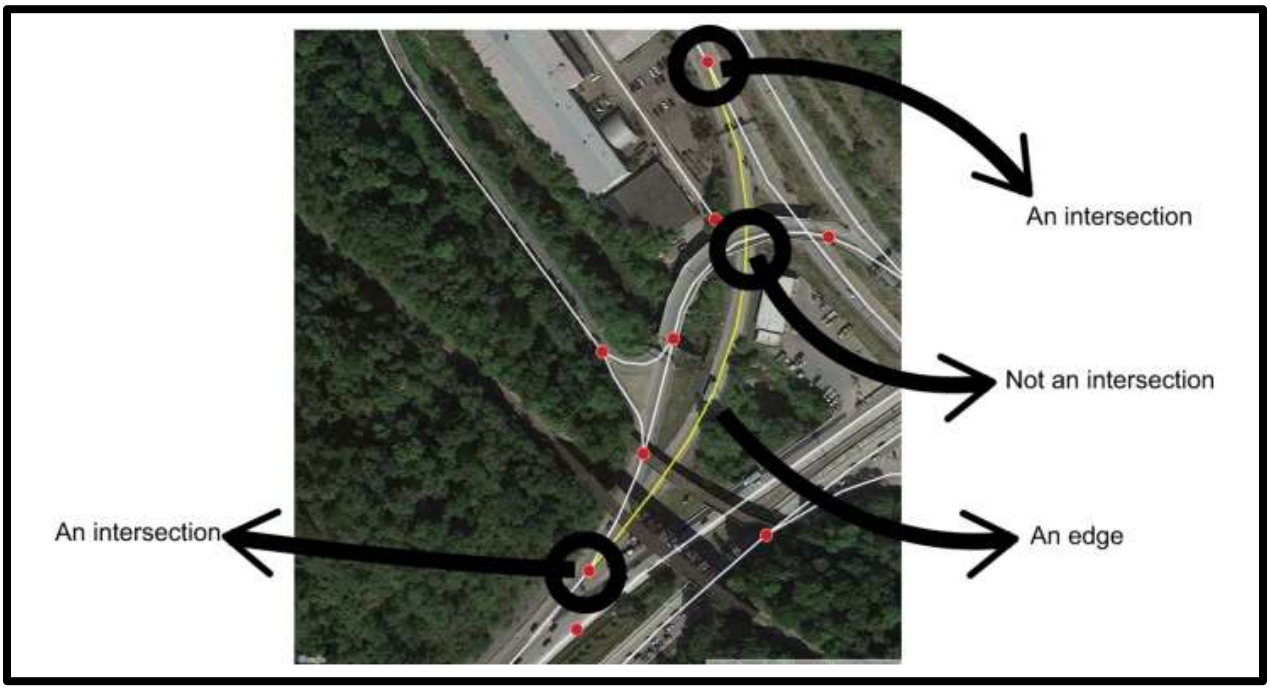

Figure 4: Area measurement theory in Topological graph

(Source: Anas, 2020)

Figure 4 depicts the area perspective of geographical locations in a topological view (Anas, 2020). It depicts that it leads to the introduction of graph theory and the subsequent genre of the branch of geographical topology. As opined by Anna (2022) Topological Data Analytics (TDA) is a mixture of mathematical and geographical methodology that represents a useful computational framework and high dimensional data structure. Numerous spatially interconnected groups of constituents make up many geographical systems. As stated by Ma et al. (2020) therefore, by viewing these studies through the lens of graphs and networks, one can shed light on many intricate aspects of the elements that are built upon them, from analyzing and understanding human activities to studying the relationship between different urban regions.

Methodology

The research survey follows the primary quantitative data collection. As opined by Saleem & Weng (2022) the significance of collecting fresh data is the first and foremost duty for analysis. The data is based on the responses of 80 participants around different geographic locations. The targeted participants of the project are the engineers of road networking frameworks. This

methodology helps the research to get primary data for solving all topic-related objectives and questions. In this research Positivism philosophy and Deductive approach are followed for the methodology part. The whole process of analysis goes through the calculative methods of SPSS software. All the responses are analyzed in the SPSS software with proper steps and complex mathematical processes. As opined by Roy & Kesselman (2021) the hypothesis process is justified by the successful result as the outcome. All the collected data has helped a lot in the evaluation of the study.

Findings

Hypothesis testing

Hypothesis 1

H1. Distance Graph theory helps to provide the natural motion of objects at the time

H0. Distance Graph theory does not help to provide the natural motion of objects at time

Hypothesis 2

H1 Distance graph theory can provide proper information regarding the velocity of particles

H0 Distance graph theory cannot provide proper information regarding the velocity of particles

Hypothesis 3:

H1 Distance graph theory helps to analyze road mapping network

H0 Distance graph theory does not help to analyze road mapping network

Demographic data

Gender

1. What is your Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		10	11.1	11.1	11.1
	Female	36	40.0	40.0	51.1
	Male	31	34.4	34.4	85.6
	Prefer not to say	13	14.4	14.4	100.0
	Total	90	100.0	100.0	

Table 2: Gender Analysis (Source: SPSS)

Table 1 shows the classification of gender for the research analysis. This division shows gender division in cumulative and valid percentages.

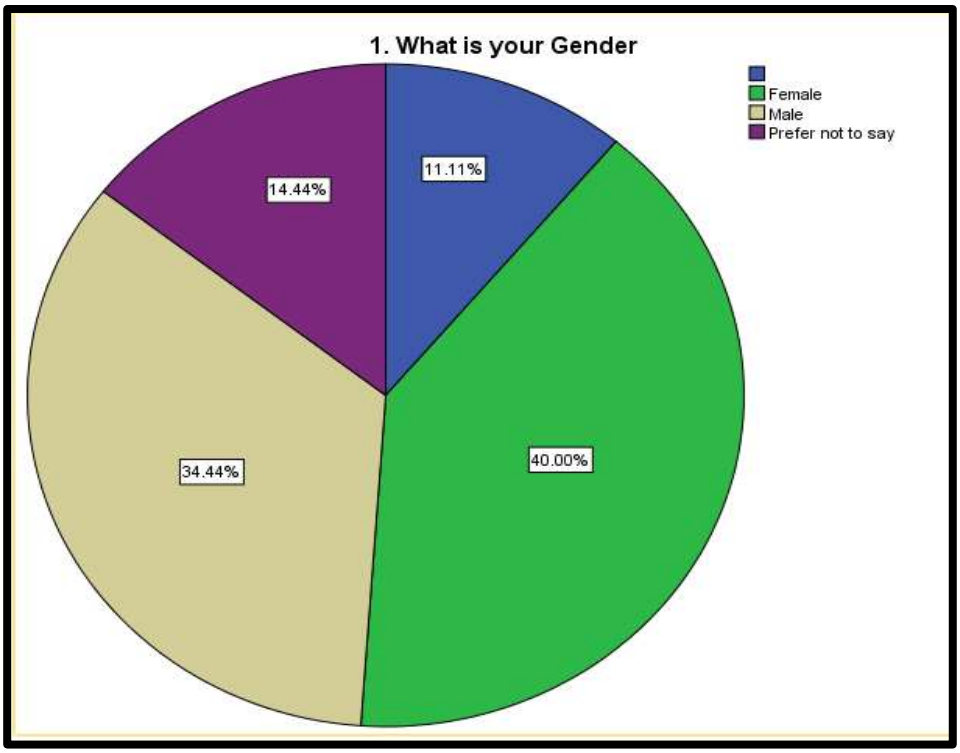

Figure 5: Gender Analysis (Source: SPSS)

Figure 5 describes the sectional division of ages of the respondents of the survey. The female section holds 40% of the responses of all the participants. Whereas the male section covers 34.44% and 14.44 % of the respondents do not want to share their gender. As discussed by Yeh

(2021), this pie chart describes the participation of individual gender that helps to maintain harmony in this analysis.

Age

2. What is your age?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		10	11.1	11.1	11.1
	10 to 20	18	20.0	20.0	31.1
	20 to 35	23	25.6	25.6	56.7
	35 to 50	21	23.3	23.3	80.0
	Above 50	18	20.0	20.0	100.0
	Total	90	100.0	100.0	

Table 3: Age analysis (Source: SPSS)

Table 3 consists of the grouping of age of the participants with the percentile nature classifies the age group in a valid and cumulative format.

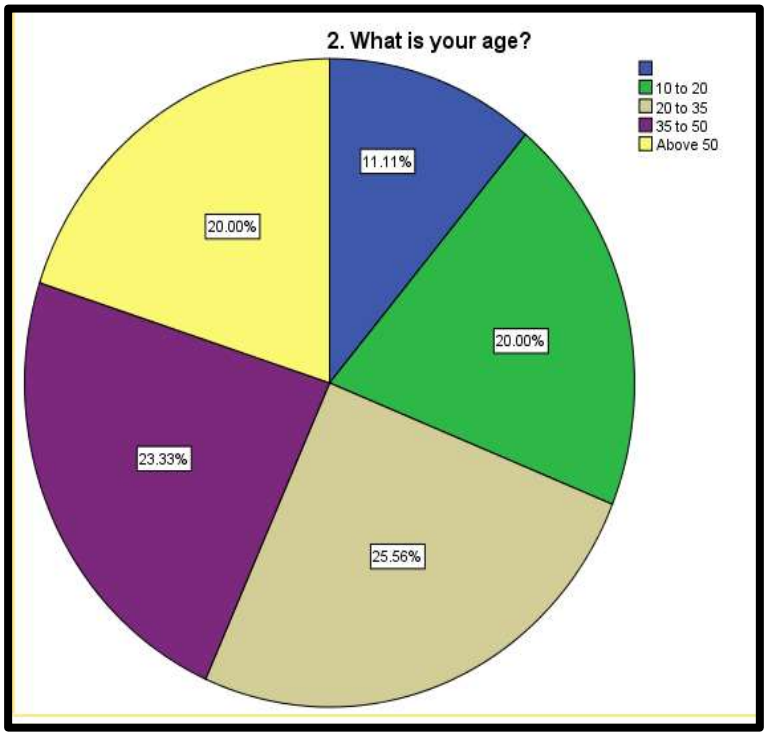

Figure 6: Age analysis (Source: SPSS)

Figure 6 discusses the age group of the respondents of the analysis. The age analysis is divided into four different stages of age starting from 10 to gradually ascending order of 50 above. People with the age group of 20-35 holds 25.56% of the overall respondents. The group of people between the ages of 35 to 50 presents 23.33% of the analysis. In addition the people of both the group of 10 to 20 and above 50 ages holds 20% each. As per the opinion of Peer (2021) the age analysis of each individual is divided into adolescence and adulthood. This approach assists researchers in keeping the focus on age differences in the context of the hypothesis.

Monthly Income

3. What is your monthly Income?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		10	11.1	11.1	11.1
	20000 to 35000	23	25.6	25.6	36.7
	35000 to 50000	39	43.3	43.3	80.0
	Above 50000	18	20.0	20.0	100.0
	Total	90	100.0	100.0	

Table 4: Analysis of monthly income (Source: SPSS)

Table 4 describes the monthly income of the participants of the research analysis. The segmentation shows the results in cumulative and valid percentages of hypothesis.

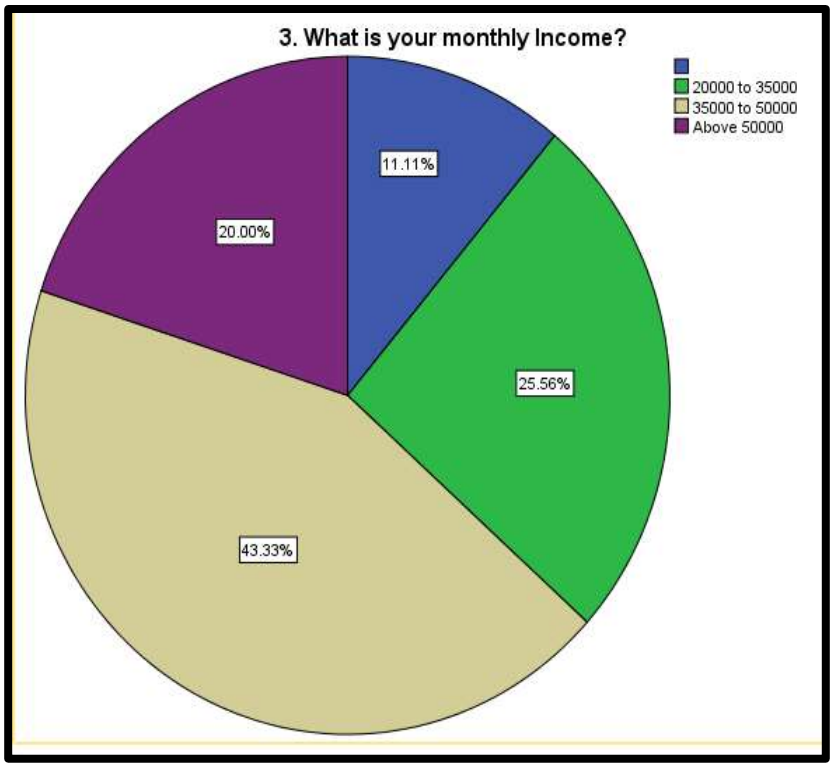

Figure 7: Analysis of monthly income

(Source: SPSS)

Figure 7 deals with the division of monthly income of all the respondents who participated in the response survey. This figure shows the sections of the monthly income of the respondents into 4 different parts. A maximum of 43.33% of people belong to the group with a monthly income of 35000 to 50000. 25.26% of the whole participants have a monthly income of 20000 to 35000. The significant group of people who have rs.50000 and above as their monthly income are 20% of the overall participants of this research survey. As commented by Miao (2019) monthly income depicts the class division in the current society as people with different earnings cannot have the same opinion on a single topic as their mental thinking capacity and social awareness.

Descriptive analysis

Hypothesis 1

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.547[a]	.299	.290	1.54581	.299	33.235	1	78	.000	2.707

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	79.416	1	79.416	33.235	.000[b]
	Residual	186.384	78	2.390		
	Total	265.800	79			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.389	.827		2.889	.005
	IV1	.450	.078	.547	5.765	.000

Table 5: Hypothesis 1 (Source: SPSS)

Table 5 discusses the results of the first hypothesis analysis with the regression values. This hypothesis contains 3 different processes and expresses the data values in a model summary, ANOVA, and coefficients. The significant value of the first hypothesis analysis is 0.00 which means the variables of this hypothesis are correlated and share a strong bond among them.

Hypothesis 2

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.158[a]	.025	.013	1.82277	.025	2.000	1	78	.161	2.839

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.646	1	6.646	2.000	.161[b]
	Residual	259.154	78	3.322		
	Total	265.800	79			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.630	1.025		5.495	.000
	IV2	.127	.090	.158	1.414	.161

Table 6: Hypothesis 2

(Source: SPSS)

Table 6 states the successful results of the second hypothesis. The regression value of this result is 0.161 which is higher than the general parameter 0.05 in the hypothesis. It means the variables do not share a strong bond among themselves. As stated by Merschman (2020) the relationship of these variables could connect to a relationship if it is a relational analysis of the hypothesis.

Hypothesis 3

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.373[a]	.139	.128	1.71272	.139	12.611	1	78	.001	2.651

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.994	1	36.994	12.611	.001[b]
	Residual	228.806	78	2.933		
	Total	265.800	79			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.325	.791		5.468	.000
	IV3	.383	.108	.373	3.551	.001

Table 7: Hypothesis 3

(Source: SPSS)

Table 7 analyzes the results of the third hypothesis. The significant value of regression is 0.01 which means the variables share a strong connection among themselves. As stated by Zhang, Cheng & Ren (2019) the statistical value of any hypothesis test goes through several mathematical calculations that have to be programmed manually and with accuracy to expect the proper results.

Discussion

The discussion part of this research work consists of the overview evaluation of the relational impact of distance with graph theory. As commented by Virmani (2021) the mathematical educational process linked with the topological network system helps to create a practical networking system. The practical application of Distance segment in graph theory has gone far beyond than its traditional implication of limited usage. The proposition of graph theory can be accessed by lining the concepts and ideas of different activities in different fields rather

than engineering and demographics. This research study not only discusses the propaganda of the relevance of distance in graphical points but it also suggests the expansion of the usage of this particular .The significance of the Graph theory concept is used in almost every area of interest and for many reasons in daily life. As stated by Majeed & Rauf (2020) in the real world the theory is implied in connection with maps, social media, roads, and city planning. Apart from the road network, technological advancement helps to deliver real-time features with color classification maps with the congestion of roads. Graph theory can be additionally used to predict how diseases move across borders or across cities. In medicine and biology, graph theory is used to distinguish between pharmacological targets and to determine the quality of ambiguous capacity.

Conclusion

In the concluding part it can be stated that graph theory concepts are fundamental in SN analysis and modeling. In algorithmic execution, for example, graphs may be utilized to explain statements and their relationships, the execution order of the algorithm's statements, the control flow, the information flow, and the algorithm testing. The scope of graphs in many real-world issues can be exceedingly big, frequently encompassing over and services, happenings and operations, and trifles. It has been employed to organize the web according to interest instead of indexing only web pages with an infinite number of edges and nodes.

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Appendices

Survey Link:

https://docs.google.com/forms/d/e/1FAIpQLSflmi0TCtX2EI3hTzjCzz_Td7GJJ94InZuTcbLSQ9A1zgu6xA/viewform?usp=sf_link

Survey questions

1. What is your Gender?

2. What is your age?

3. What is your monthly Income?

DV. Importance distance in graph theory

4. Graph theory can help to detect natural motions of particles

5. Distance in graph theory can locate the positional movements of elements

IV1. Topological aspects of graph theory

6. Image segmentation process can be cut through graph theory

7. Metric dimensional factors help to represent the road network in graph theory

8. Graphical presentation can enhance the topological theory more accessible

IV2. Attributes in road networking

9. The nodes in a graphical representation help to create virtual conception

10. The nodes in crossing creates the junction points for better road linking process

11. The attributes of graph can help to measure the practical networking design

IV3. Key functions of road networking in graph theory

12. Graphical theory helps to prioritize the on going project

13. Graphical theoretical designs can analyze the strategically necessity of road mapping