Pixelated Cities: Simcity in Urban Planning - A Case of Sector 55, Gurugram

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***Abstract*—Urbanization poses significant challenges for modern cities in India, such as Gurugram, where rapid growth demands innovative solutions for sustainable development. This study delves into the potential of virtual cities as a transformative tool in contemporary urban planning especially when it comes to India.**

Drawing inspiration from Singapore's visionary approach, which harnesses advanced virtual city simulations to help emulate proposed changes beforehand and optimize urban development, this research endeavours to assess the applicability and impact of such simulations in the unique context of Gurugram.

The study is analytical in nature and explores urban planning of Gurugram (Gurgaon) at a microlevel. Finally, the study investigates the notion of urban convenience, addressing residents' and commuters' quality of life concerns.

Methodologically, this research employs a comprehensive approach, combining surveys, interviews, data analysis, and direct observation to gauge the status quo of Gurugram's urban fabric. The chosen sectors within Gurugram become the focal points of our survey, providing insightful data and enabling comparative analyses with virtual city simulations.

The research's findings aim to contribute to the ongoing discourse on urban planning by revealing the potential of virtual cities to alleviate traffic bottlenecks, optimize space, and enhance the overall convenience of city living. The implications of this research extend to urban planners, lawmakers, students, and stakeholders invested in shaping Gurugram's future.

As Gurugram stands at a crossroads, grappling with the complexities of urbanization, the insights derived from this study seek to illuminate a path forward that harnesses the power of technology and innovation to create more liveable, efficient, and sustainable urban environments.

***Index Terms*—Urban Planning, Traffic, Spatial efficiency, virtual cities, simulation**

I INTRODUCTION

Urbanization is an irreversible global phenomenon, and its rapid pace presents both opportunities and challenges for modern cities. As urban areas expand and evolve, the need for innovative and sustainable urban planning solutions becomes increasingly imperative. Simulation software, a powerful tool in various domains, has emerged as a key instrument in envisioning, analyzing, and optimizing urban environments. It aids in predicting the behavior of complex urban systems, offering invaluable insights for urban planners and policymakers.

The simulation software for city simulation software's began with City Sim, made by Will Wright. He liked playing games which involved bombing cities when he had an epiphany; he wanted to create a game which involved creating cities. It began as a fun game but it would soon become a fast-catching trend and begin the trend of simulation in urban planning.

Players would tackle complex issues like traffic, crime and land use optimization while calling it a game. The trend caught on so much it soon became the simulation software Brazil would use for their 2016 Summer Olympics to make the urban planning of the city as efficient as possible for traffic efficiency. Soon many urban planners would credit their interest in urban planning due to urban planning games and many cities would begin making their own prototypes each tailor made for the cities and their specific complex issues. Some would manually update the various aspects of the city while others would use it automatically via use of lidar and other measures.

While these software's would work spectacularly in tangible issues like road planning and urban planning, they cannot seem to understand the intangible aspects of the city. For example, these softwares would assume people would drive properly, stay under the

speed limit, people would not build in areas meant for green areas, complex multifaceted social and cultural issues. Regardless, the softwares would prove to be very helpful, both in understanding issues which would not spring to mind of an urban planner immediately, as well as help students of urban planning to see how various parameters work. These 'citysim' softwares would also with time take into account tangible factors such as proximity with living essentials and safety factors and convert them into intangible factors such as happiness and splitting a percentage of the populace into various professions and begin theater and music communities among themselves. They would also understand the complexities of traffic planning and simulate accidents and people driving rashly causing congestions. Taking into account all these factors, CitySim softwares caught on rapidly in urban planning as urban planners began using these as an 'urban calculator'.

1.1 : Aim

To compare virtual cities with real life context to find the accuracy of CitySim simulations in enhancing spatial optimization, particularly in terms of land use optimization, traffic efficiency and infrastructure planning, within the Gurugram context.

1.2 : Objectives

- To dissect the issues in Gurugram at an urban level using a micro site as a base
- To compare data sets generated from simulation softwares and actual real-life on- site data collection for various factors including traffic and spatial efficiency
- To identify the various parameters of the simulation softwares and their feasibility in the Indian context.

1.3 : Research Problems

- How accurately can SimCity softwares emulate real world cities and on how much of a vast scale?
- Can intangibles be incorporated into the list of factors which goes into the algorithm the software follows? Eg. politics, squatters etc.
- How financially viable are these softwares considering mapping of entire cities, their keeping up to date either manually or using cameras and or manually by officials

1.4 : Scope

The primary research area is Sector 55 in Gurugram, India. This sector has been chosen as the focal point for in-depth analysis and sector-specific surveys. The research examines the utilization of virtual city simulations as a tool for urban planning, specifically exploring how this technology can be applied within the context of Sector 55 in Gurugram. The study delves into various aspects of urban planning, including traffic efficiency, spatial optimization, and urban convenience, with a focus on their relevance and applicability within Sector 55. A central component of the research involves a comparative analysis. It compares the current urban situation in Sector 55 with the projected outcomes generated by virtual city simulations. The research intends to offer practical recommendations and insights that are tailored to Sector 55 in Gurugram. These recommendations are intended for urban planners, policymakers, and stakeholders actively involved in the urban development of this specific sector.

1.5 : Limitations

- The City: Skylines exists as a game and thus trades off realism for fun partially
- The sector although completely mapped would have functioned better had macro context could also have been added which the software doesn't allow due to the sheer scale
- The CitySim software cannot predict natural disasters, only how the city would react to it
- The CitySim software cannot account for intangibles

II. LITERATURE REVIEW

2.1 : HISTORY

Simulation softwares has been around for nearly eight decades and they simulate a real-world activity. Players control an aspect of the game in a virtual controlled environment and the game then moves forward based on the player's choice. The first ever simulation game widely considered is the Sumerian Game, which was released in 1964. The game tasked the player to help manage a Mesopotamian city. It wasn't until the 1980s however that the genre rose to popularity. They started using a hydraulic motion simulator sparked by Sega's 'taikan' games with

Taikan meaning body simulation. Arcades started introducing simulators to provide players with a simple complete and engaging experience.
Space Tactics (1981), a space battle simulator with a cockpit cabinet where the screen moved in time with the on-screen action, was Sega's first game to use a motion simulator cabinet. Later, the "taikan" trend started when Yu Suzuki's team at Sega (later renamed as Sega AM2) created the racing video game Hang-On (1985), in which the player controls the actions of the game by sitting on and moving a replica motorbike. Following it, Suzuki's team at Sega produced racing games like Out Run (1986), combat flight simulators like After Burner (1987) and G- LOC: Air Battle (1990), and hydraulic motion simulator cockpit cabinets for rail shooters like Space Harrier (1985). Sega's R360 (1990) motion simulator cabinet, which replicated an aircraft's complete 360- degree rotation, was among the most advanced motion simulator cabinets found in arcades. From then until the 2010s, Sega kept making motion simulator cabinets for arcade games. Arcade games like Space Tactics and Hang-On led the way, meanwhile games outside of arcades such as Flight Simulator, Fortune Builder, and SimCity came into existence. (Clarke, 2021)

Although in its very initial stages, the first game to implement city building was Doug Dyment's The Sumer Game, a game in which the player could buy land, sell seeds and farm to feed the populace and maintain their economy. While making a game about bombing a city by flying a helicopter over it, Will Wright have discovered that designing the city above which he would fly the helicopter over was more fun than actually bombing it. This concept gave birth to CitySim. This game did not have a set of rules as such. It just gave the players a set of tools and their imagination was the limit. If the player wanted to make the road five times bigger to improve traffic they could. If they thought a railway line increased crime in the vicinity, they could remove it and check. After explaining mechanisms like traffic management and municipal finance, the guide casually directs players to read city planning heavyweights like Kevin Lynch and Le Corbusier, an obtuse book on population projection, and the American Planning Association's monthly magazine.

2.2 : PRECEDENCE STUDIES

2.2.1. CityMoS - City Mobility Simulator (TUMCREATE, Singapore)

At TUMCREATE in Singapore, researchers have developed the City Mobility Simulator (CityMoS), a pioneering tool designed to facilitate the electrification of transportation. This simulator not only aids in the transition to electric mobility but also assesses the consequential impact on urban heat dynamics. Currently in deployment in both Germany and Singapore, CityMoS has found practical application in supporting the transformation of logistics terminals, exemplified by its role in the electrification efforts at a DHL Freight logistics terminal in Germany. The software was made in Singapore. It was developed as both cities wanted to start making their vehicles electric powered instead of relying on fossil fuels like petrol, diesel etc. They wanted to understand the impact and analyze how this change would affect the city in terms of various factors including traffic. It also did heat analysis and energy calculation and analysis for the same. This proprietary technology has since been used worldwide in many urban cities such as in Munich, under the leadership of global corporation Siemens in planning, dimensioning and city-level placement of charging stations. Another important use was in an initiative by the Singaporean government to try and cool the city, this began by trying to understand the impact of human and infrastructure in the heating of the city. (Andelfinger,2022) (www.tum.de, n.d.)

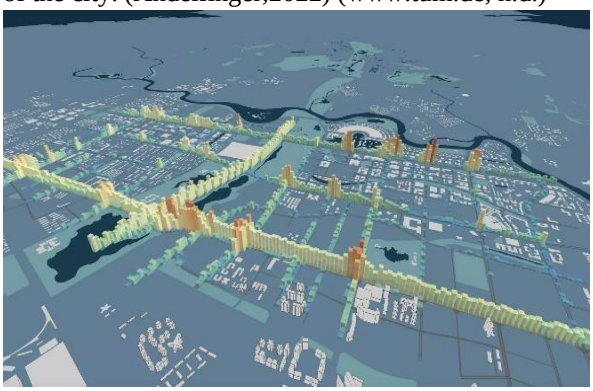


Figure 1 Andelfinger, Philipp. A simulation modelling an entire city state. News Article. City: Technical university of Munich, 10/10/2022

2.2.2. Future Scenario Modeling for Curitiba

An in-depth study aimed at modeling future scenarios for Curitiba delves into the intricacies of urban planning. The research meticulously selected static

variables to portray changes in the cityscape over time. To ensure the accuracy and reliability of these variables, the study employed two distinct indicators — the Cramer Index and Uncertainty of Joint Information — assessing their independence. Data was fed into the softwares over the span of multiple years to get a baseline and then it was simulated to get the ideal placement and arrangement for the vegetation planning to maximize economic growth via farming to develop the urban fabric of the city in the future on the back of this vegetation growth.

Although the software was used for urban planning purposes, the precedence study shows the reliability and versatile nature of the softwares. (Araki,2021) (Freitas, 2021)

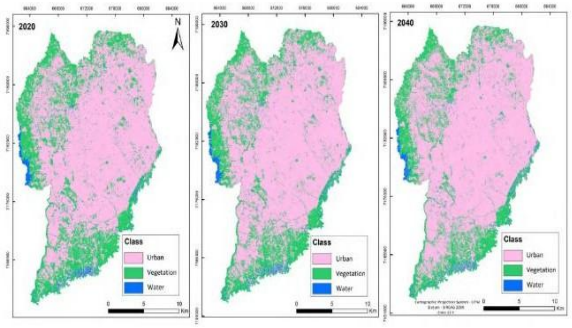


Figure 2 Araki, Hideo.: Validation by fuzzy similarity. Research paper. Simulation of urban growth: a case study for curitiba city, brazil, 01/04/2021

2.2.3.: AMARAVATI CITY - Real-Time Construction Monitoring

In the ambitious Amaravati City project, a cutting-edge approach to construction monitoring has been adopted. Leveraging the capabilities of IoT sensors, the project aims to monitor construction progress in real time. The sophistication of the system goes beyond mere monitoring — a dedicated platform integrates designs from a multitude of consultants, creating a unified simulation of the proposed buildings. Remarkably, this simulation is not static; it dynamically adjusts to real-time changes, providing a comprehensive and adaptive view of the construction progress. As Amaravati City, envisioned to be home to 3.5 million people, grapples with a hot and humid climate, the simulations play a crucial role in assessing how buildings will cope with these challenging environmental conditions. The plan was to make a digital twin of the city and to connect it with the citizens of the city completely in a seamless way. The citizens would have a digital twin user ID scheme that will serve as a single portal for all government information, notifications, forms and applications. This would give reliable information about the demographics, populace etc. This would also help the simulation software try numerous simulations based on many factors such as natural disasters etc, and see how the populace would react, the chokepoints and problems and plan accordingly. [3] (Indian Express,2023)

2.2.4.: Virtual Singapore (Digital Twin)

Singapore stands as a beacon of technological innovation with its development of a comprehensive digital twin, aptly named Virtual Singapore. This 3D digital replica, built upon topographical and real-time dynamic data, serves as the authoritative platform for urban planners. Developed by French firm Dassault Systems, Virtual Singapore enables the simulation and testing of innovative solutions in a virtual environment. With a population of six million, this island state has embraced this digital twin as a tool to test and refine ideas in a risk-free digital space, showcasing the synergy between technological advancements and urban planning. [4] (Soebandrija,2020)

Figure 3 Soebandrija,Khristian EN. system simulation and modeling: virtual cities toward designing the metropolises of the future

Figure 4 Soebandrija Khristian EN. system simulation and modeling: virtual cities toward designing the metropolises of the future

III. DATA COLLECTION

3.1 : Mapping of Sector 55 Gurgaon Choke Points

Figure 5 Points mapped for traffic congestion, Sector 55, Source-Author

Figure 6 Traffic Junctions, Source- Author

CitySim softwares can be used to help analyze traffic in the city. To test the accuracy of the softwares they need to be compared with a real-life traffic analysis. For this an onsite traffic analysis must be done and compared with a digital traffic analysis of the city. Traffic mapping of various points across sector 55 were done. Traffic was analyzed for a day for ten minutes at regular intervals and cars, two-wheelers, three wheelers and trucks were counted. This was then used to analyze various choke points and do a general traffic analysis of the sector. This was then finally compared to a digital simulation of the city and these will be compared to see the traffic analysis accuracy of the virtual software.

3.1.1 : Sector 55 Unicosmos School T Point

Table 1: Unicosmos Road T point, Source- Author

TIME	CARS	TWO WHEELERS	THREE WHEELERS	TRUCKS
11AM	45	66	8	2
2PM	40	53	8	2
5PM	65	49	6	2
8PM	48	39	14	0

3.1.2 : Sector 55-56, Entry into the Sector

Table 2: Sector 55-56, Entry into the Sector, Source-Author

TIME	CARS	TWO-WHEELERS	THREE-WHEELERS	TRUCKS
11AM	40	52	9	1
2PM	43	47	12	3
5PM	46	43	8	1
8PM	49	63	19	0

3.1.3 : Sector 55 Sushant University Entry T Section

Table 3: Sector 55, Sushant University T point, Source- Author

TIME	CARS	TWO WHEELERS	THREE WHEELERS	TRUCKS
11AM	52	43	7	0
2PM	45	50	10	2
5PM	45	46	9	1
8PM	48	53	13	0

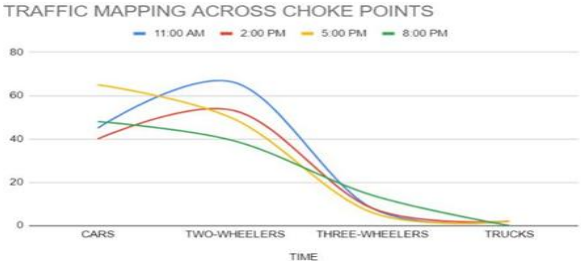


Figure 7: Traffic mapping across sector, Source-Author

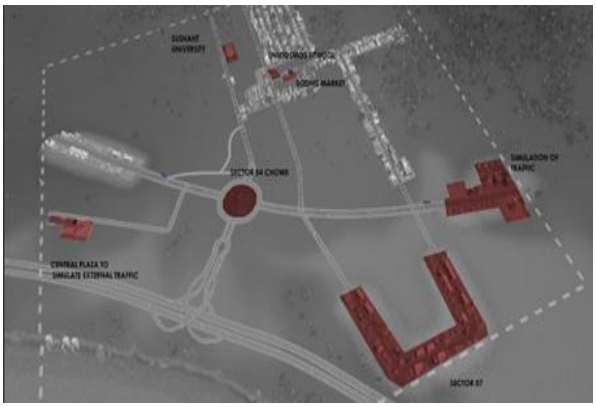


Figure 8: Sector 55 Simulation, Source-Author

SELECTION OF THE SOFTWARE FOR CITYSIM PURPOSES

The software chosen needs to be based on various parameters. No software contains all the parameters perfectly so the software chosen needs to be one which is very popular, has a high sense of accuracy when it comes to city simulation, the simulation needs to be able to be viewed properly ideally in the form of tabulated, compiled data. It also needs to be modded with ease and have a strong community engagement. The following softwares were considered-

- Minecraft
- Cities in Motion 2
- Cities: Skylines
- SimCity 2013

Table 4: Comparison between software's to choose the one for the assessment, Source- Author

GAMES	MINECR AFT	CiM	C:S	Simcity
Copies sold	180	1	6	2
Community	2500	1.2	273	25.9
Urban simulations	No	Yes, but only traffic and transportation simulations	Yes	Yes
Previous uses	Yes	No	Yes	Yes, but only for imaginary cities
3D space	Yes	Yes	Yes	Yes
Modding environment	Yes	Yes	Yes	Yes
Modding support	Yes	No	Yes	No
Geodata processing	Yes, using a combination of inbuilt and 3rd party tools	No	Yes, using a combination of inbuilt and 3rd party tools	No

Going by the stats, Minecraft comes off as the most appealing game in our assessment. It's not just for fun; it's been used before in spatial planning for creating visualizations. However, its versatility takes a hit because Minecraft doesn't traditionally cater to city-related simulations. Thus, modding might help but the game is not overall worth it.

The potential of SimCity 2013 for its application in spatial planning is heavily limited by an insufficient modding environment. Particularly, the lack of modding documentation and support makes the development of geodata processing tools very difficult.

Cities in Motion 2 didn't fare too well in the rankings. Still, given its niche focus on transport and traffic management, there might be some value in exploring to model a real-world location.

Now, here's the standout – Cities: Skylines. It clinched the top spot in the evaluation. Sure, it might not boast the mind-blowing player numbers and copies sold like Minecraft, but it reigns supreme as the best-selling game in the city-building genre. What sets it apart is that Cities: Skylines offers excellent modding support, making the development of geodata processing tools a breeze. This game is a versatile player, fitting into all the nooks and crannies of spatial planning. Therefore, the game Cities: Skylines was selected as the game with highest potential for application in spatial planning.

But there still arises a major problem. Cities Skylines is a game. It, despite being extremely well known and having a ton of untapped potential, is not tailor made for predicting simulated cities. It still has game-like features. Thus, it is crucial to use scripting to fix these issues using mods.

In general, the use of commercial video games in their base version for non-entertainment/informative purposes is quite restricted. However, these limitations can be overcome or at least mitigated by incorporating changes to the game's behavior. The process of changing the game using custom scripting is known in the gaming community as "modding" (Scacchi, 2010). This process can modify the original version of a video game to solve a given problem. Modding represents a way of accessing and changing the game's "black box" behavior.

Table 5: Scripting for the software, Source- Author

MODS	LIMITATION IN VANILLA SOFTWARE	MITIGATION BY MOD
81 Tiles	The original version of the software has too little of a workable area to be used effectively for simulation purposes. The game aims that the player works in a smaller area and then purchases new workable areas as they unlock it. Even then 81 tiles aren't available in the site even when they reach near end game unlocked features. (E a c h tile -1.9km x 1.9km)	Immediately all 81 tiles allowed by the game's code are unlocked allowing for a far greater area workable for simulation purposes.
Lifecycle Rebalance	The game, when started, invites people of the same age group to come live in the city. Due to this reason, a 'death wave' happens which is a strong drop in the population which is unrealistic in real life.	Mod adds randomness to the aging of the citizens. Additionally, it modifies the transport preferences of the citizens based on their age group.
Realistic population	The game puts approximately 1/7th the realistic number in a simulated area for computational purposes and to make it less realistic for a tradeoff between realism for fun to invite players.	Makes the population realistic.
Remove Need for Power Lines and Realistic city services	The game requires a functional power line system needing power lines to connect all over the city. Additionally, the game upes the ante like creating far additional fires than real life to keep the game happening and fun.	Removes needs for additional power lines and sets the cities services like fire to realistic standards.

A digital version of the sector has been recreated in a city simulation software (Cities: Skylines) which was available as most softwares of this kind are proprietary. The major landmarks and chokepoints of the sector have been marked. Pgs. and hostels have been added along with schools to simulate the major parts of the sector as closely as possible. Landmarks nearby have been added along with small chunks of other sectors to have the mapping for the traffic and spatial analysis as close as possible. Cab stands have been used in places of most autos stands.

Figure 9: Figure of partial sector 55 with major landmarks, Source- Author

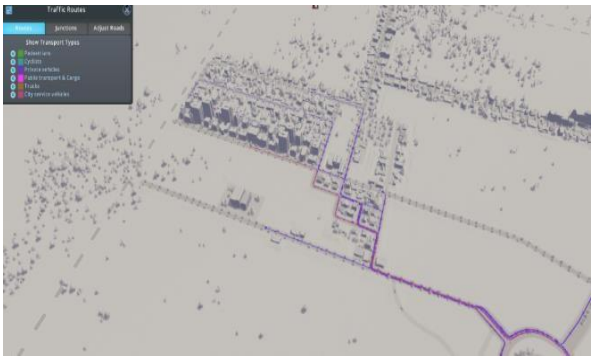


Figure 10: Analysis done by the software showing pedestrian movement, flow of traffic for private vehicles, public vehicles, city service vehicles and trucks, Source-Author

3.2 : Primary Survey

For a higher accuracy of the real-life traffic analysis, a sample survey needed to be conducted in which the stakeholders, i.e., the residents of the sector needed to be questioned to get an in-depth survey about the sector. A survey is prepared and about fifty people will be asked about fifty people as representatives of the residents of sector 55. The survey was done both in person and via google forms. The in-person data collected was manually entered into the google form by the author to get a compiled list of data. The following QR code when scanned leads to the google form.

The total population of sector 55 being 6,456 (3476 males and 2980 female) (as per geoiq)

The following questions are asked-

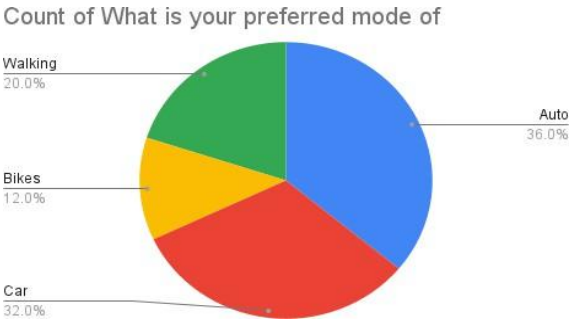
1. Detailed information about residents' specific residence locations within Sector 55 was sought, aiming to comprehend the diverse spatial distribution across the sector.
2. Inquiries were made regarding participants' typical daily routines, including their regular work commute timings and return schedules, with the intention of shedding light on the temporal dynamics of their engagement with Sector 55.
3. Insights into participants' preferred modes of transportation for commuting within and around Sector 55 were sought, aiming to discern patterns and preferences in the sector's diverse mobility landscape.
4. Participants were prompted to elaborate on the locations they most frequently visited within Sector 55 for professional and recreational purposes, providing a comprehensive understanding of the sector's focal points.
5. Information about residents' engagement in activities outside of Sector 55, which the sector did not readily offer, was sought to uncover the extent to which residents ventured beyond the sector for various pursuits.
6. Perspectives on points of congestion within Sector 55 were gathered, with residents encouraged to identify specific locations or intersections they perceived as problematic, providing valuable qualitative data on traffic bottlenecks.
7. Opinions on the optimization of land use within Sector 55 were sought, with participants asked to express their views on the efficiency and appropriateness of the current land use, offering insights into the sector's spatial planning from a resident's perspective.
8. Participants were engaged in discussions regarding their perceptions of congestion as a prevalent issue in Sector 55. Residents were encouraged to share their observations and opinions on the existence and severity of

congestion challenges within the sector.

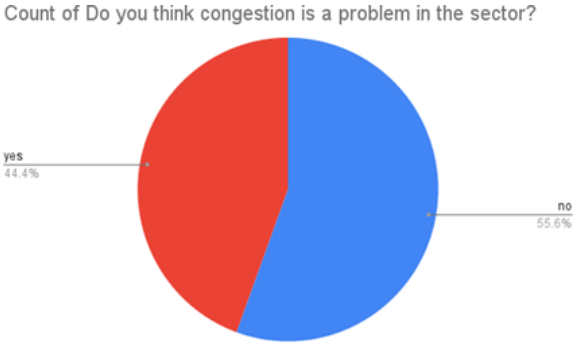
9. Views on the walkability of Sector 55 were elicited, aiming to gauge the perceived pedestrian-friendliness of the sector and to uncover potential areas of improvement in enhancing walkability.
10. Perspectives on the efficiency of vehicular movement within Sector 55 were sought, aiming to understand residents' insights into the effectiveness of the current transportation infrastructure in facilitating smooth and efficient traffic flow.
11. Residents' beliefs regarding the sufficiency of public transportation options in Sector 55 were explored, with participants encouraged to share their opinions on the accessibility and adequacy of public transport services within the sector.
12. The study investigated residents' observations regarding specific times of the day when traffic congestion became particularly problematic in Sector 55.
13. Residents were asked to express their opinions on whether improving traffic flow in Sector 55 could contribute to a reduction in air pollution.
14. Openness to the introduction of smart traffic management systems in Sector 55, such as traffic lights synchronized for optimal flow, was assessed.
15. Residents' perspectives on whether promoting alternative modes of transportation, such as walking or cycling, could help alleviate traffic congestion were gathered.

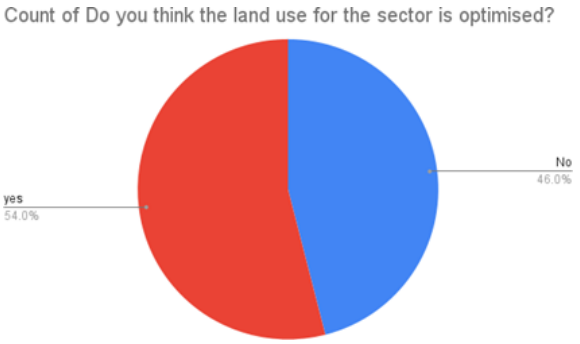
RESULTS-

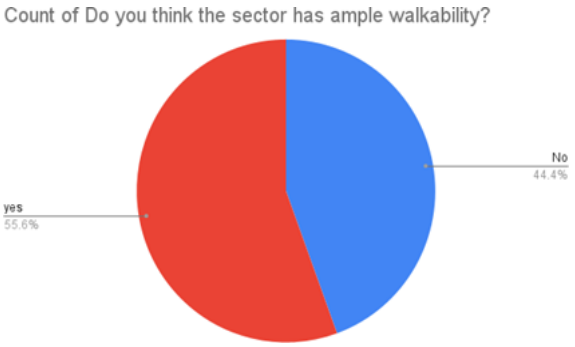
1. This question was asked to establish a location analysis of the sector to understand the points in the sector the people answering were answering and the points being properly represented.
2. Although the time people went to work flickered a lot due to them being in many different occupations and ages, Maximum people went to work between 7-10 with maximum leaving by 8:30. Maximum people came back between 5-9 with maximum reaching by 7:15pm.
3. Most people travel via autos and cars. Some go by bikes and some travel via cycle or walking to work.

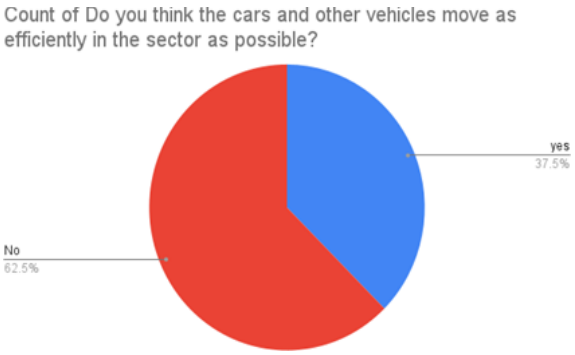


4. Most people go to the Sodhis complex in sector 55 for recreational activities, and to each other's residences.
5. Most people responded that they very often go outside sector 55 with half leaving almost daily while most people leaving more than twice or thrice a week.
6. The various points of congestion identified were the the Sector 55-56 metro station entrance into sector 55 road, the road to Ghata gaon, the unicosmos T-point, the entrance to Unicsomos road which was under construction during the majority of the surveying phase for the experiment, finally the Sushant University Road was the final congestion point in the sector.
7. People in the sector are torn if the land use is optimised in the sector or not.
8.









9. Most people in the sector believe that the sector has ample public transportation systems, being connected to the entire Delhi-NCR via metro and autos and bikes and other transportation systems connecting everything with auto stands near the 54 chowk and 55-56 metro stations.
10. 8:30-9:30, 5-6 primarily.
11. Most people answered yes
12. Most people answered yes
13. Most people weren't sure but were optimistic

This data helps in making a more accurate traffic analysis of the sector which is then compared with the digital compiled traffic analysis of the virtual Sector 55. The data is collected and used to fill in the gaps between the information collected by the manual traffic data collection. It is of vital importance to know the needs and views of the residents of the sector as they are the primary stakeholders in the urban context.

3.3. CitySim Softwares and Urban Planning

"I do not think CitySim Softwares are advanced enough yet to tackle urban planning issues effectively yet, they need to be updated on a daily basis, and they cannot simulate intangible factors. For example, if I wanted to make a flyover over an area, a simulation software would not foresee that EWS would begin sitting in the area forcefully or informal or illegal areas would start happening in the area if it's isolated but an urban planner might. I support city simulation softwares as a tool to help out because it might simulate and think of things an urban planner might miss. But I would definitely not like it if its AI becomes too advanced and becomes our competition."- Ar. Naman Golcha, Urban Planner, Professor at Cept University, Ahmedabad.

One of the most significant ways that SimCity has been used in urban planning is for public engagement. The game offers a platform for communities to come together and envision their ideal city, allowing them to experiment with different layouts, zoning plans, and infrastructure. By engaging citizens in the planning process, urban planners can get a better sense of what residents are looking for in their community and can design cities that are more responsive to their needs.

City Simulation Softwares, especially CitySim was a revolution for city planning and urban planners as a whole, many urban planners credit City simulation softwares as the thing which introduced them to the concept of urban planning and also taught them a lot initially before they pursued formal education in the matter.

IV. ANALYSIS

Figure 11: Complete Sector 55 virtual simulation done in CIty:Skylines, Source-Author

Sector 55 virtual simulation complete with macro-context. The sector 55 was made and tweaked based on real life analysis of the sector and using help from google maps. For an accurate analysis major landmarks of the sector needed to be added, commercial zoning to be done as well as macro context needed to be added. Based on surveys, people who went out of the sector for recreational purposes, went to a specific set of places which were also added

to simulate the traffic as accurately as possible.

Figure 12: Macro Context- Central Plaza Mall, done in Cities:Skylines, Source-Author.

Macro context- central plaza mall. Macro level site inviting various people in sector 55. It has a strong commercial character and it being open 24/7 invites a lot of people. This was a major landmark and thus needed to be added to get an accurate result.

Figure 13: Sushant University, done in Cities:Skylines, Source-Author

Sushant University- A major landmark of sector 55. Arguably a defining factor in sector 55, it has invited major cultural events, concerts and infused a student character in the sector. The university invited people from all over the country and made a huge real estate business boom using builder apartments, flats and pgs.

Figure 14: Marco Context-Sector 57, done in Cities:Skylines, Source-Author

Macro-context- Huda market sector 56. Macro level site inviting various people in sector 55. It has a strong commercial character and it being open late at night and having a vivid streetlife invites a lot of people. This was a major landmark and thus needed to be added to get an accurate result.

Figure 15: Unicosmos School, done in Cities:Skylines, Source-Author

Unicosmos School- a landmark of sector 55. Placed in the center of the sector and being a landmark inviting people for various activities like swimming, tennis etc.

Figure 16: Bird Eye view of sector 55, done in Cities:Skylines, Source-Author

Figure 17: Taxi Stands to simulate informal auto stands, done in Cities:Skylines, Source-Author

Taxi Stands to simulate informal auto stands. Sector 55 has a strong public transport system, being run by autos. These taxi stands are placed near the areas to simulate the heavy influx of people in the area travelling by autos.

Figure 18: Traffic analysis done by the CitySim software showcasing the traffic in the simulated sector, done in Cities:Skylines, Source-Author

Traffic analysis of the sector done by the software. When this analysis is done and compared with the real-life version of the software, many similarities are seen, choking near the sector 54 chowk, choking near the unicosmos school entrance near the sector, congestion near the University. various paying guests and apartment complexes were added, various public transport systems were connected along with various private vehicles. Of course, the simulation will be restricted in its analysis as it is an isolated preview of sector 55 itself and the simulation must be taken with a grain of salt then. Despite the same, the traffic analysis is pretty accurate to real life and can be used to study analysis. Various experiments were carried out in the software like replacing roundabouts with traffic lights and connecting dead ends. The comparative analysis unveils a granular understanding of traffic dynamics, dissecting the accuracy with which the digital model replicates the ebb and flow of vehicular movement in the physical sector. By scrutinizing data on peak hours, congestion hotspots, and average traffic speeds, the analysis demonstrates a substantial correlation between the two domains. This suggests that the digital model effectively mirrors the real-world traffic patterns within Sector 55. The synchronization between the digital and physical sectors extends beyond traffic patterns to provide insights into user behaviour. Leveraging data from various digital platforms and physical sensors, the digital twin offers a comprehensive view of commuter habits. The comparative analysis indicates a congruence between the digital model's depiction of user behavior and the observed habits in the physical sector. This insight is pivotal for urban planners, offering a blueprint for tailored interventions aligned with residents' needs and preferences. The efficiency of digital simulations emerges as a focal point in the analysis, evaluating how well simulated scenarios align with the ground reality. The results demonstrate that the digital twin not only accurately reflects current traffic conditions but also offers a reliable platform for testing proposed urban interventions. This suggests that the digital model can transcend being a passive reflector to become an active contributor to urban planning strategies. The implications for urban planning are profound. The accuracy and reliability of the digital twin in reflecting traffic patterns and user behavior position it as a powerful anticipatory planning tool.

Urban planners can leverage the digital model to simulate the impact of proposed changes, transforming the planning process into a more informed and proactive endeavour. Additionally, the participatory approach enabled by the digital twin fosters a collaborative and inclusive urban planning process. The simulation was done with a roughly near the same amount of populace as real life. The question of accuracy however can always be questioned. The software no matter how advanced cannot predict the future, we can test how the city could react in a perfect world if a disaster occurs, but not when it could occur. It can randomise events and people to simulate people’s behaviour on an urban level, but people are unpredictable. A simulation software can never

account for intangibles. What if people illegally start living in a random place, what if people don't follow priority rules of the roads, what if they don't follow the speed limit. Things like corrupt cops randomly stopping traffic for bribes creating congestion, or politicians stopping chunks of traffic for their parade of lights going out causing manual traffic management on the ground leading to inefficient management can always hamper the process of the perfection of the software. Real life spends eternity achieving perfection but fails to. But virtual worlds are already perfect. The people follow rules, the infrastructure doesn't crumple. But we live in the real world. It is ugly, it is imperfect and it is beautiful in its own way. Thus, the virtual world hasn't been able to and never will be able to achieve perfect imperfection.

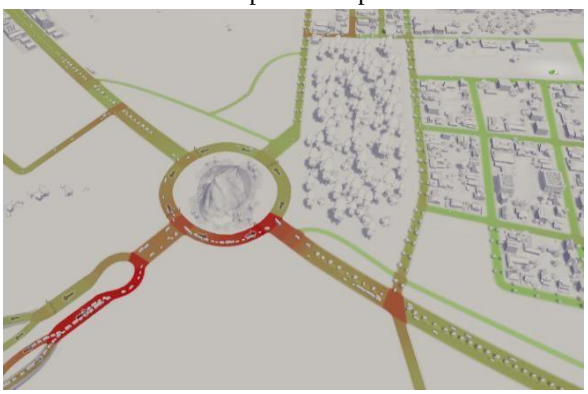


Figure 19: Existing Traffic of sector 54 Chowk, Gurugram, done by Cities:Skylines Source-Author

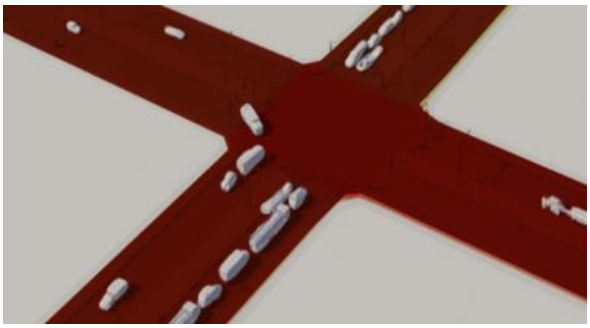


Figure 20: Traffic of sector 54 Chowk after changes, Gurugram, done by Cities:Skylines Source-Author

We can see as an example where sector 54 chowk a major landmark and a traffic choke point near the sector has a traffic problem. So if an urban planner choses that the chowk is unnecessary and creates additional traffic, he may want to plant a simple cross section in the place of the roundabout, we could emulate that in the software first and then determine the outcome.In this particular instance, we can see that the change makes the traffic much worse and overall considering the additional costs for the infrastructure change, it is not worth the change.

A notable opportunity that surfaced involved the revitalization of the slip lanes on Golf Course Road, leading to blockages at the entry points of the sector.

This incident coincided with the manual traffic analysis conducted in the sector, resulting in heightened congestion at various entry points. The burden on these entrances increased due to the obstacles posed by the ongoing construction of the slip roads on Golf Course Road.

For the sake of simplicity, let's focus on one specific entry point, namely the Unicosmos road entry into the sector. The construction of GCR slip roads not only impeded the roads directly connected to it but also affected secondary traffic for destinations unrelated to the road itself. This includes individuals seeking convenience or aiming to avoid the traffic near the sector 54 chowk chokepoint. The impacted area encompasses various establishments such as paying guest accommodations, real estate offices, and serves as a direct link to Sodhi's market complex, the largest commercial area in sector 55.

As indicated by a sample survey and secondary research, Sodhi's complex attracts a substantial number of people in the sector. The peak traffic on this road occurs between 9 am and 9 pm, with the highest influx observed between 7 pm and 7:30 pm.

Consequently, the sudden disruption of the road's access to Golf Course Road resulted in a significant increase in additional traffic at other entry points in the sector, deviating from the sector's usual state of 'normalcy.'

Utilizing Cities: Skylines, the software employed for mapping sector 55, has demonstrated a reasonable accuracy in depicting the sector's day-to-day activities. To assess the deviation from this norm, the sector was initially mapped at its 'normal' base level, allowing for subsequent modifications and testing.

The simulation involved breaking and testing the road connecting Unicosmos Road to Golf Course Road over several in-game days. The resultant traffic congestion at the base level was observed, and comparisons were drawn between the simulated city and the real city.

While acknowledging that the exact values may not be

entirely precise, it is crucial to recognize that Cities: Skylines is a city-simulation video game and does not offer a wholly accurate representation of real-life scenarios. Furthermore, the game has limitations in its macro-context, and the accuracy of results improves with further development of the macro context, albeit with diminishing returns.

Beyond traffic simulation, gaming software like Cities: Skylines serves as an educational tool, sparking interest among students and aspiring urban planners. Despite the trade-off between realism and fun in these mass-produced playable games, they act as a bridge connecting individuals unfamiliar with urban planning to experienced professionals who understand how to effectively 'design and fix' cities.

These games provide players with an opportunity to grasp the basics of urban planning, offering insights into the consequences of certain decisions, even if the quantitative precision may elude them.

Table 6: Matrix showcasing comparison between real life and virtual citysim software's city, Source- Author

ASPECT	REAL LIFE DATA	SIMULATED DATA
Congestion Points	• Sector 55-56 metro station entrance • Road to Ghata gaon • Unicosmos T point • Sushant UniversityRoad	• Sector 55-56 metro station entrance • Road to Ghata gaon • Unicosmo s T point
Land Use optimisatio n	• Based on samplesurvey- No but the issue is not severe	• No- needs more housing and office spaces
Commuter behaviour	• Travel by autos andpublic transit. • Walkability is sufficient but in noway effective enough to be considered ideal	• People travel by public vehicles and walk comparabl e to real life data
Changes	• Unicosmos road entry in sector closed dueto constructio n creating additional	• Unicosmo s road entry in sector closed for simulation purposes creating

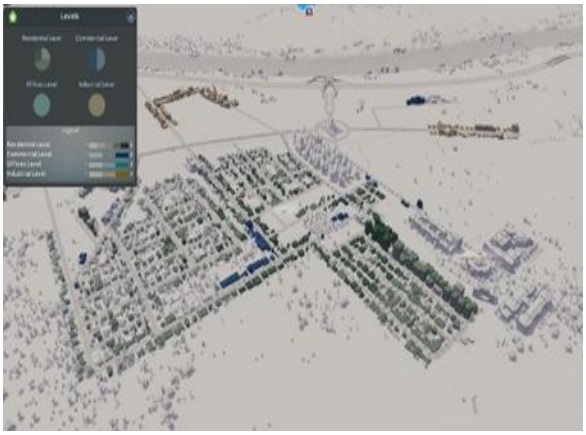


Figure 21: Landuse representation of sector 55, done by Cities:Skylines Source-Author

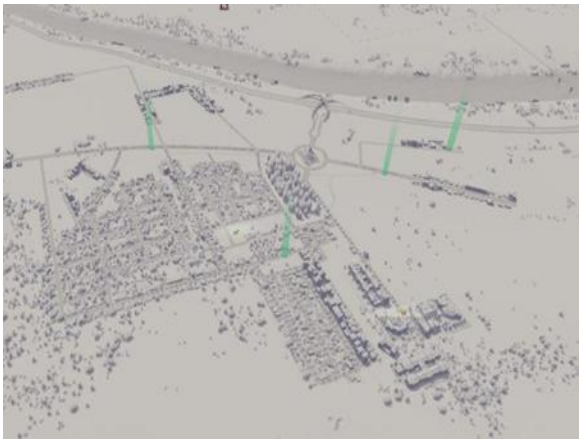


Figure 22: Sector 55 public transit, done by Cities:Skylines Source-Author

Figure 23: Walking around in the sector, done by Cities: Skylines Source-Author

Urban planners also get a chance to walk in the cities they make, to feel an essence of the city planning and see their results first hand. It could also let them make decisions and then see firsthand how various factors like how cars interact with each other via traffic. It is also a factor which urban planners never get to experience if it's not for simulation. They can go for site visits and see how their decisions make changes firsthand. But unlike in the case of simulations, if they make a mistake, they cannot undo it like in simulation softwares. This is eminent and a monopolous point of simulation softwares as a whole. The chance to redo. We can make as many good, bad and outrageous decisions and sometimes brute force our way out of intense head scratching urban level issues.

The significance of having the opportunity to redo decisions, especially within the realm of city simulation software, is paramount. In the context of urban planning, where precision is crucial, the ability to make decisions, assess their impact, and, if necessary, undo and refine is a game-changer. This concept aligns with the core functionality of software, as seen in the simulations carried out in Sector 55.

As observed in the analysis conducted using Cities: Skylines, the software allows for meticulous experimentation and adjustment. The ability to replace roundabouts with traffic lights or connect dead ends provides urban planners with a dynamic platform to gauge the consequences of their decisions. This iterative process mirrors real-world urban planning challenges, where the consequences of infrastructure changes are complex and multifaceted.

The comparative analysis between the digital model and the physical sector in Sector 55 unveils the granular understanding of traffic dynamics. This understanding is a direct result of the software's capacity to simulate, undo, and refine decisions. By breaking down the accuracy with which the digital model replicates the ebb and flow of vehicular movement, urban planners gain insights that are invaluable for effective decision-making.

The flexibility to undo decisions in a city simulation software transcends mere convenience; it is an essential tool for anticipating and addressing challenges. As evident in the simulation of replacing roundabouts with traffic lights, these software platforms serve as dynamic laboratories where planners can observe, measure, and adjust variables to optimize outcomes.

Furthermore, the iterative process facilitated by the undo feature contributes to the development of an accurate digital twin. This digital twin, as seen in the simulations, not only reflects current traffic conditions but serves as a reliable arena for testing proposed interventions. The software, by allowing planners to undo and revise decisions, becomes an active contributor to the urban planning process.

The importance of this redo capability becomes even more pronounced when considering the uncertainties of real-world scenarios. While the software cannot predict the future, it empowers planners to simulate various potential outcomes. The ability to randomize events and people, albeit within the confines of the software's limitations, enables planners to assess a spectrum of potential challenges and responses.

In the imperfect and unpredictable real world, the chance to redo decisions in a simulated environment is a luxury that urban planners do not possess. The software, despite its limitations, offers a controlled space for exploration and learning. It becomes a bridge between the idealized, predictable world of

simulations and the complex, unpredictable nature of actual urban environments.

In conclusion, the ability to undo decisions in city simulation software is not merely a technological feature; it is a strategic asset for urban planners. It transforms these software platforms into powerful tools for experimentation, learning, and decision refinement. The redo capability is a testament to the dynamic nature of urban planning, where adaptability and iterative processes are key to creating resilient and efficient cities.

4.1: Future exploration

Table 7: Comparisons between widely used simulation software ArcGIS and Cities: Skylines, Source- Author

ASPECT	CITIES: SKYLINES	ARCGIS
USER INTERFACE	Easy UI, everything is easily findable, doesn't depend system to system	For further UI, usually tutorials and certification courses are needed to get a basic understanding of the software
3D VISUALISATION	Passable 3-d visualization. Mods can be used to enhance the 3d experience.	Far superior 3d visualization
DATA INTEGRATION	Selected areas have to be made in the game. Data cannot be added any other way.	Various ways to add data in the software which are far easier and quicker depending on the person working on the software
SIMULATION FEATURES	Accurate in the sense it can simulate what happens, quantitative data isn't too reliable	Reliable quantitative data
COMMUNITY ENGAGEMENT	Strong community of players, making mods, helping tutorials and overall ready to help with issues.	Since the software is so hard to get, very few people in the country know how to accurately use it causing a poor community for the software
COMPATIBILITY	Easy to download, available on popular gaming websites like steam. Although cheap, it is also easy to crack. *	Hard to get, expensive and takes approximately 2 hours to crack by professionals. *
CUSTOMIZATION	Highly customisable, plenty of mods due to the strong community.	Low customization options.
COST	₹1300 one-time cost	₹8300 per year
GIS INTEGRATION	Limited GIS Integration	Enhanced GIS Integration
REAL TIME DATA UPDATES	Real time data updates impossible to achieve unless a player manually updates everything instantaneously	Live real time updates possible via Lidar or other ways of integration
PLANNING ACCURACY	Decent accuracy for simulation purposes	Highly effective for GIS Integration
FLOOR	Low Floor level**	High floor level due to steep learning curve
CEILING	Medium Ceiling level**	Very high ceiling level

The paper does not discuss the potential of the software Cities:Skylines as a whole. It discusses the potential of gaming softwares to further commercialise the urban planning industry and slingshot their use to a whole new level. But there are various issues with this hope. Urban planning is not easy to start with. This is an age where the general public has too little of an attention span and it's not possible for urban planning softwares like ArcGis and QGis to pique the interest of regular people. This is why the gaming industry has to step in and further peddle the urban planning concept to the regular

people. The gaming industry in itself is not self-sufficient for this but due to the extremely huge community of gamers, it has a strong community support and thus scripting can help combat the issue.

A new version of Cities: Skylines is under development as of right now called GeoSkylines. A scripted version of the software, capable of importing assets, roads, buildings, rivers, city services etc being made will be a huge step into propelling urban planning to the new commercialised level and can even be used by the government to offer incentivised proposals by sharing asset files and providing an objective to complete. Every person could have their own aims and techniques to complete their project and the government could cherry pick their choice and proceed with it for a fraction of the cost to hire a whole team of urban planners and use heavy duty softwares like ArcGis and QGis. A half complete version of Geo:Skylines was used to farm out a design competition required to build a military complex, a jury of volunteer urban planners was used and self-proclaimed public experts in urban planning took part in the competition. Various entries were taken in out of which eight stood out in the further round and the most cost-efficient one was considered for the basis of actual plans for the complex. These types of techniques may be repeated in a complete version of Geo:Skylines as well as much better modded softwares and be used to bring the public touch in urban planning as well as simulation of the city effectively leading to far reaching results which will trickle down can affect urban planning for the better.

V. CONCLUSION

In conclusion, the exploration of city simulation software within the context of Sector 55, Gurgaon, reveals a compelling narrative about the viability and transformative potential of these tools in contemporary urban planning. The comprehensive analysis of traffic patterns, land use optimization, and the intricate interplay between the digital and physical realms presents a nuanced perspective on the role of city simulation software in shaping the urban landscape. It was shown in the study that the virtual city shows promise in matching the real world in various factors but especially in traffic analysis. It can be used by urban planners to test their theories, opening the doors to many creative and innovative possibilities in urban planning. It can also be used to teach students of urban planning about existing strategies and they can understand in detail the intricacies of each and how they affect their surroundings. It is imperative however that they be used as only a tool and not to replace urban planning as urban planning is as much an art as it's a science.

Thus, CitySim softwares is nothing more than 'urban calculators'; you feed it raw information and it can give you an estimated result. But the human mind is so complex and random and chaotic that only a human can determine correctly how it should work.

But CitySim softwares can be used as a powerful tool in the urban planner's arsenal. It is recommended that they be used more extensively by urban planners as 'urban calculators' and so that it gets promoted and invites more students into the urban planning field.

APPENDIX

Terminologies-

- Scripting- Modifications made in the vanilla or stock version of the software based on additional add ones usually not made by the developers of the software
- Roof- minimum skill required to get by a software to accomplish the required set of goals
- Ceiling- Highest level of skill upon which on polishing further, the efficiency of the use in software does not increase

*The author does not support or condone cracking or piracy of software. The above-mentioned points only exist to speak about the availability of the software.

** In gaming, floor level means the minimum amount of skill required to pass-by whereas ceiling means the maximum amount of skill and understanding of the software above which significant increase in efficiency in use of the software diminishes.

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