ROLE OF INFRASTRUCTURE IN THE SUCCESS OF A RESIDENTIAL DEVELOPMENT

Summary

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Abstract

Residential developments are results of economic and social activities. The significance of infrastructure in a residential development cannot be overemphasized as it is critical for its success. This report uses literature review and case studies to define supporting infrastructure for residential developments. The study then prioritizes the infrastructure systems required for the success of a residential development including their preferred distances with the help of structured interviews with six developers and four municipal officials in Michigan. The results reflect that the top five priorities for developers are Employment, Digital, Education, Utilities, and Community infrastructure whereas the Municipal Officials' priority list includes Education, Utilities, Waste Management, Transportation and Digital Infrastructure. By combining the responses of the developers and the municipal officials, the top five infrastructure categories come out to be: Education, Utilities, Employment, Digital and Transportation Infrastructure. Infrastructures such as Renewable Energy and Green Infrastructure are yet to gain widespread popularity in the real estate industry. All infrastructures are preferred within a range of 2 to 7 miles distance with special preference of Transportation Infrastructure, Education Institutes and Community Infrastructures to be within 3 miles. The authors believe that this analysis will be valuable in guiding the developers and the municipal officials in selecting the infrastructure required for a successful residential development.

1. Introduction

Infrastructure is an essential component of a residential development. Infrastructure can be explained as the facilities, structures, equipment and similar physical assets; that are important for people to thrive as individuals and participate in the economic, political, civic, household, and other roles in ways critical to their own well-being and that of their society. (Beeferman & Wain, 2016). Developing a residential neighborhood is a long-term investment for any community. "For most developers, this involves taking a step back and reassessing the objective of the finished product. Presence of the infrastructure necessary to serve the proposed development is essential for the growth of a new community." (Beauregard Small Area Plan, 2012)

Housing demand triggers the need for new residential developments. The demand for housing is experiencing a growth in both urban and suburban areas. Suburbs refer to primarily low-density residential areas, located within metropolitan areas (not rural), but outside the central cities (not core). The key features distinguishing a suburb are presence of substantial open space and scattered employment (Forsyth, 2013).
The decentralization of job centers to the suburbs, the availability of automobiles combined with expressways, and the quest for single-family homes have attracted individuals to outlying areas for housing. These forces have resulted in the development of what previously used to be classified as agricultural and rural areas. This points to the need for more infrastructure to support the residential developments in suburban areas (Suen 2005).

In addition, urban neighborhoods in America are presently encountering a dramatic transition, with condominiums, townhouses and apartments supplanting parking lots, industrial sites, and underutilized commercial areas. As indicated by US Census, residential building permit data for 209 metropolitan areas analyzed over a 5-year period (2005 to 2009) shows a noteworthy increment in the share of new residential construction built in focal urban areas and older suburbs. Infill residential construction

exceeded 50% of the total construction only in four metropolitan regions, whereas 205 of the total 209 regions studied had more residential developments on greenfield sites. Even with current strong economic fundamentals, several large-scale development projects require optimization in infrastructure investments to move forward (U.S. Environmental Protection Agency, 2010).

This report begins with a brief overview of the literature studied and several case studies investigated, outlining the categories and sub-categories of infrastructure required in a residential development. It emphasizes the importance of infrastructure, points out the benefits and discusses the factors of success in a residential development.

2. Defining Infrastructure for Residential Developments based on Literature and Case Studies

Infrastructure can impact human lives tremendously. Adequate infrastructure and services serve as a backbone for growth and are essential for community health, safety, and quality of life (Humboldt County General Plan, 2007). Research has demonstrated that the availability of goods and services (diverse land uses, for instance) within neighborhoods enable residents to better participate in the society. This contributes to economic and social sustainability locally (Yigitcanlar, Kamruzzman, & Teriman, 2015). The benefits of infrastructure can be summarized as: enhanced quality of life, improved safety of residents, improved health and aesthetics, reduced household expenditures, creation of new employment opportunities and enhanced neighborhood vitality.

A review of single-family, multi-family and mixed-use type of residential developments across the United States assisted this study in defining key infrastructure for successful residential developments. The availability and absence of infrastructure categories in the case studies were documented. Table 1 lists the name, location, and type of the development. The determination of the success of these case studies is based on the analysis conducted by the Urban Land Institute between 2006 and 2010 (ULI 2006, ULI 2007, ULI 2008, ULI 2010).

The construction of effective infrastructure has long been an impetus for advancing and supporting economic development. Developers, business and inhabitants are attracted by adequate “on the ground” infrastructure. This implies ample water, sanitary sewer, electricity, transportation, communication resources and other supporting civil infrastructure. Another broad category of infrastructure is “inbuilt infrastructure”, that is a part of housing development, such as waste management, utility lines etc. (Colorado, 2016)

Another important aspect of the background work was the review of market analysis literature. When developers initially consider a site for development, they usually do not begin without gaining a sense of general market conditions. As entrepreneurs, they keep themselves updated with the current trends, observing other developers and searching for new niches to fill in the market. They would generally seek the following information from the market analysis (Novak, 1996):

- Employment trends in the market area.
- Population growth rate in the market area.
- Best configuration and size of units for the proposed development.
- Number of units that the market can absorb, the price for those units and the length of time required for development.
- Percent of market demand expected by the project to capture.
- Strategy for the units be marketed to the target customers.

- Operating revenue or income expected to be generated by the project over a certain time.
- Regulatory controls placed on type of development.
- Position of communities on the potential development in the proposed location.

Table 1: List of Case Studies of Successful and Unsuccessful Developments
(Based on the availability and quality of infrastructure)

S. No.	Name of the Development	Location	Type of the Development
SUCCESSFUL DEVELOPMENTS			
1	Maple Grove at College Fields	Okemos, Michigan	Single-family
2	Wild Sage Cohousing	Boulder, Colorado	Single-family
3	Wild Meadows	Medina, Minnesota	Single-family
4	Prairie Trail	Ankeny, Iowa	Single-family
5	Bailey's Grove	Kentwood, Michigan	Single-family
6	Aurora Square	Anchorage, Alaska	Multi-family
7	Burbank Senior Artists' Colony	Burbank, California	Multi-family
8	Chestnut Commons	Austin, Texas	Single/Multi-family
9	Eco Village	Loudoun County, Virginia	Single/Multi-family
10	The Benton	Alameda County, California	Mixed-use
11	Mill Creek	Kane County, Illinois	Mixed-use
12	Prairie Crossing	Grayslake, Illinois	Mixed-use
13	Stonebridge	St. Helena, California	Mixed-use
14	Curran House	San Francisco, California	Mixed-use
15	Cotati Cohousing	California	Mixed-use
UNSUCCESSFUL DEVELOPMENTS			
16	Garden Green	Boise, Idaho	Single-family
17	Oak view	Marine County, California	Single-family
18	Philippi Park Condominiums	Boise, Idaho	Multi-family
19	Oak Park Village/Brampton Square	Boise, Idaho	Single/Multi-family
20	Fountain Grove	Santa Rosa, California	Single/Multi-family

Based on the case studies and the literature review, the infrastructure required to support a residential development can be split into thirteen broad categories and then can be further divided into forty sub-categories, as shown in Table 2 (Bracknell Forest Council, 2012).

Table 2: Infrastructure Needed to Support a Residential Development

1	**Transportation Infrastructure**	Local Road Network
		Footpaths & Cycle ways
		Public Transport
		Parking
2	**Waste Management**	Waste Collection
		Recycling
3	**Utilities**	Water Supply
		Wastewater Management
		Electricity Network
		Gas Network
		Telecommunications
4	**Renewable Energy:** **a) Unit level** **b) Community level**	Solar Energy
		Wind Energy
		Other
5	**Education**	Early Years Education
		Primary Education
		Secondary Education
		Further education (Colleges)
6	**Community Infrastructure**	Community Centers
		Libraries
		Built Sports
		Pools
7	**Social Infrastructure**	Children's Day Care
		Religious spaces
8	**Emergency Services/ Safety**	Police Service
		Ambulance Service
		Fire & Rescue Service
		Street lighting
9	**Health**	Primary Health Care
		Hospitals
		Senior Citizens' Care
10	**Green Infrastructure**	Open Space
		Arboretum/Biodiversity
11	**Digital Infrastructure**	Internet Access
		Cable Access
12	**Retail**	Restaurants
		Banks
		Grocery stores
13	**Employment Infrastructure**	Employment Potential
		Office Spaces

1. Stakeholders and Associated Parameters of Success

There are numerous stakeholders involved in the process of development, in addition to the end- users of the product or residents. Each stakeholder will consider a development successful based on varied parameters, depending on their perspectives (Buckman et al., 2017). For example, predevelopment owners will be driven by monetary goals and personal intent to sell; developers motivated by profits; potential occupants impelled by their housing preferences, etc. (Robinson & Robinson, 1985).

Residential developers are key personnel responsible for issuing approval to purchase land for a residential subdivision. It is essential for developers to understand what draws in people to locate and remain in a new development. Broadly, their interest lies in providing infrastructure and amenities that attract consumer households (Robinson & Robinson, 1985; Buckman et al., 2017).

Developers display entrepreneurial characteristics, reflecting a behavior of profit-seeking, risk-taking and innovativeness. For a private organization, development involves heavy investments of time and money without a guaranteed return. The entire process requires the developer to consider availability of land, zoning and policy regulations; occupant demands, land characteristics and pecuniary risks. No developer will want to lose money after going through this tedious process. Also, those who constantly fail to gain profits on developments have a difficult time staying in the business. Private developers will aim to ensure that organizational benefits exceed the cost of development (Novak, 1996; Shaw, 2003, Maruani and Amit-Cohen, 2011). The basic indicators of project success for a developer are time, cost, and quality. Based on a research conducted by Wai et al. (2012) and supported by literature review and case studies, the criteria of measuring success from a developer's perspective can be classified into five categories, as shown in Figure 1.

Municipalities/Governments generally do not have profit as their primary objective. They mostly aim to increase public benefits by providing needed services at reasonable rates. Often, government agencies will concentrate on social costs such as increased tax returns for neighboring business or necessary infrastructure enhancements. At times, they may be propelled by supplementary motives such as organizational objectives, professional context, institutional structure or reputation (Novak, 1996; Maruani & Amit-Cohen, 2011). Similar to developers' success criteria, municipal officials' success criteria is proposed in Figure 2 (Wei et. al., 2012).

In order to complete the understanding of the development success criteria residents' input is also important. Developers gain that input directly and indirectly by conducting market analysis, focus groups, surveys, etc. From the residents' view, 'success' would depend on the level of their satisfaction, arising from the quality of life offered by that development. Factors affecting resident satisfaction include traffic noise, the presence of green space and services, the proximity of social relations and waste management facilities. Understanding occupant perspectives and the variables affecting their satisfaction can assist developers to provide resident-focused services and improve their quality of life, ultimately adding to the success of the neighborhood. Also, the inputs obtained by measuring occupant satisfaction may help housing associations, as well as other stakeholders that are developing urban, housing and neighborhood revitalization, find the right strategy to improve the overall quality of life, and deliver successful developments meeting the expectations of occupants (Chou et al., 2003; Adriannnse, 2007).

Company Success: Company Growth, Personnel Training, Experience and Knowledge Gain, Improvement of Management, Developer-Contractor Relation
Profitability Success: Sales, Project Profitability
Primary Project Success: Quality, On-time Completion, Within Budget Completion
Secondary Success: Sustainability, Environmental Impact, Project Safety, Life-Cycle Cost
Branding Success: Occupant Confidence in the Product, Developer's Reputation, Customer Satisfaction

Figure 1: Project Success Criteria from Developer's Perspective

Success of the Local Government: Attracting Population, Employment Growth, Community Development (Health, Education, etc.)
Profitability Success: Revenue / Taxes
Project Success: Sustainability, Environmental Impact
Branding Success: Residents' Satisfaction

Figure 2: Project Success Criteria from a Municipal Official's Perspective

One of the major factors affecting the value of a residential development is its physical location. The terms proximity and accessibility are often used to describe the physical location of a site. Proximity of the

infrastructure contributes to the quality of life. Literature suggests that residents select a property based on its access to different amenities such as restaurants, retail spaces, print centers, gym facilities, etc. Residents also care about the proximity to interstate highways, distance to employment sources and availability of schools in the neighborhood. Therefore, it can be concluded that not only availability, but also an appropriate distance is required for the infrastructure to contribute positively to a residential development (Smersh et. al, 2003; Romkaew, 2011; Allen, 2015).

4. Determining Infrastructure Priorities for Developers and Municipal Officials

A structured interview was employed at this phase of the study to find the overall and relative importance of infrastructure categories in the success of a residential development for key stakeholders. The project scope focused on the developers and the municipal officials while both groups were asked to also keep in mind the future residents' perspective when answering the interview questions.

Residential developers can be either part of a private or non-profit organization. Municipal officials can include city councils, county commissioners, planning board members and other elected officials (Novak, 1996). They are involved in the development approval process and can provide a detailed idea about what they expect from the developers. Due to the type of questions, it was determined that in-person interviews were needed to explain the questions to the experts in order to obtain better results. Ten local developers and nine city officials from Michigan were contacted to collect data. Out of those contacted, the authors were able to successfully communicate with six developers and four municipal officials. Five of the six developers interviewed had extensive experience in single-family, multi-family and mixed-use residential developments in Michigan. One of the developers has done multiple projects in North Carolina, South Carolina, Texas, Ohio and Florida. All city officials interviewed have more than 10 years of experience each. Two sets of questionnaires were developed for interviewing the developers and the municipal officials. Each questionnaire was divided into four sections:

Section1: Background of the Developer/ Municipal Official

Section 2: a. Prioritization of sub-categories

b. Acceptable Infrastructure Distance (miles)

c. Prioritization of broad categories

Section 3: Market Analysis/ Infrastructure-specific questions

Section 4: Other comments / Input

The overall structure of the questionnaires was very similar, except the variation in the criteria of success for a developer and a municipal official, as shown in Figures 1 and 2. The open-ended questions in the final sections of each questionnaire were also slightly different to account for the difference in perspectives of developers and municipal officials. A reference scale of 0-10 was used, with 0 being extremely unimportant, 5 being neutral and 10 being extremely important.

5. Data Analysis

The data collected by interviewing developers and municipal officials is qualitative in nature and its analysis require a method that can incorporate the preference of one infrastructure category in relation to other infrastructure alternatives. An analysis method known as the ELECTRE III method (Velasquez & Hester, 2013) was found to fit the bill.

ELECTRE III is a multi-criteria decision making-model that effectively helps in prioritization or optimized ranking of alternatives. The underlying principle for outranking an option over an alternative in ELECTRE III is the preference of a decision-maker for a given set of alternatives. An alternative "a" is said to outrank an alternative "b," if the decision-maker's preference supports the conclusion that "a" is at least as good as "b." The authors created a decision matrix to determine the ranking of various infrastructure categories in ELECTRE III. The matrix is meant to establish a relation between the alternatives (i.e., 13 categories in Table 2) and the criteria (i.e., five categories of success in Figures 1 and 2). Once a matrix is developed with these variables, participants' evaluations were inserted in the model. Additionally, the suitable distance for each infrastructure category was determined by calculating the mean of values provided by the participants.

6. Results

Three different sets of results were obtained for the ranking of the broad categories, the sub-categories and the acceptable infrastructure distance. Results were compiled separately from the perspective of the developers, the municipal officials, followed by combined results. These results are presented in the sections below.

A.1 Ranking of Broad Categories

The ranking of the broad categories of infrastructure obtained through data analysis in ELECTRE III considering the opinions of the developers and the municipal officials respectively are shown in Tables 3a and 3b. Table 3c shows the combined rankings.

A.2 Observations

The overall ranking of broad categories, as provided in Table 3c, shows Education Infrastructure with the highest ranking, followed by Utilities at Rank 2 and Employment at rank 3. Positions 4, 5 and 6 were attained by Digital Infrastructure, Transportation Infrastructure and Waste Management, respectively. These ranks indicate the preference of the developers and the municipal officials regarding infrastructure provisions in a development. Since these results are based on expert opinions who know their market well, these ranks can be considered a reflection of the infrastructure needs currently prominent in a residential development. Education Infrastructure at rank 1 implies that the presence of high-rated school districts is a major contributor to the success of the development. The availability of education infrastructure attracts potential residents, and the developers give prime importance to a site located within a good school district. Second, Employment infrastructure, ranked 3, has gained popularity and this can be interpreted in several ways. Residents prefer a house located close to or well connected with the industrial hubs and office sectors in a city. Alternatively, a mixed-use set up attracts people who prefer to have an office set-up/ workplace and residence to be in the same community. Also, a housing development provides direct and passive employment to many small and large scale industries. Since the

Table 3a: Ranking of Broad Categories of Infrastructure from a developer's perspective

RANK	INFRASTRUCTURE CATEGORY
1	Employment Infrastructure
2	Digital Infrastructure
3	Education
4	Utilities
5	Community Infrastructure
6	Transportation
7(tie)	Social Infrastructure
7(tie)	Emergency Services
9	Health
10	Green Infrastructure
11	Waste Management
12	Retail
13	Renewable Energy

Table 3b: Ranking of Broad Categories of Infrastructure from a Municipal Official's perspective

RANK	INFRASTRUCTURE CATEGORY
1(tie)	Education
1(tie)	Utilities
3	Waste Management
4	Transportation
5	Digital Infrastructure
6	Employment Infrastructure
7	Health
8	Retail
9(tie)	Green Infrastructure
9(tie)	Emergency Services
9(tie)	Renewable Energy
9(tie)	Community Infrastructure
13	Social Infrastructure

Table 3c: Combined Ranking of Broad Categories of Infrastructure

RANK	INFRASTRUCTURE CATEGORY
1	Education
2	Utilities
3	Employment Infrastructure
4	Digital Infrastructure
5	Transportation
6	Waste Management
7	Community Infrastructure
8	Health
9	Emergency Services
10	Social Infrastructure
11	Green Infrastructure
12	Retail
13	Renewable Energy

people today heavily rely on internet access and cable access for working and staying connected, Digital Infrastructure(ranked 4) has become as basic a requirement as Utility Infrastructure(ranked 2), i.e., gas and electric lines.
The last three positions 11, 12 and 13 were obtained by Green Infrastructure, Retail, and Renewable Energy respectively, meaning that this type of infrastructure comparatively holds less importance in a development. It can be inferred that the availability of green space, banks, restaurants, grocery stores and social/religious spaces is not of prime importance but can be an added advantage to a development. According to the results, Renewable Energy Infrastructure is yet to become a desirable feature in residential developments.

The categories occupying ranks 1-5 for both the developers and the municipal officials are almost similar. When these results are viewed individually to consider the perspectives of the developers and the municipal officials separately, some differences are observed. For developers, the topmost rank is filled by Employment Infrastructure as compared to rank 6 for the municipal officials. This indicates that the most important infrastructure that the developers will aim to provide is Employment Infrastructure. According to the developers, the presence of jobs and the potential to attract new employers are primary driver of success in a residential development. The developers are also found to value Community Infrastructure more (Rank 5) as compared to the municipal officials (Rank 9).

B.1 Ranking of Sub-categories

The ranking of the sub-categories shows a similar trend as observed from the ranking of broad categories. Tables 4a and 4b show the results from a developer's and municipal official's perspective respectively. Finally, Table 4c shows the combined ranking of sub-categories.

B.2 Observations

The final rankings of the sub-categories are shown in Table 4c. The sub-categories at the top 10 ranks all belong to the broad categories of Utilities, Education Infrastructure and Digital Infrastructure. Internet Access, which is a part of Digital Infrastructure, obtained Rank 2 vs Cable Access at Rank 12, which suggests that Internet Access is given more value than cable access in recent times. Some of the higher ranked amenities are Education infrastructure except colleges, Water Supply, Electricity and Gas network, Wastewater Management and Telecommunications. Local Road Network at Rank 7 indicates that the availability of well-connected roads is valued in a development. The ranks at the bottom are achieved by Primary Health Care, Hospitals, Libraries and Pools and renewable energies. This infrastructure can be given less importance if the development project has time or budget constraints.

A prominent difference in the views of the developers and the municipal officials shows the inclination of the municipal officials towards Transportation Infrastructure. Two of the top ten ranks of sub-categories in municipal officials' list in Table 4b are occupied by Local Road Network (no. 3) and Footpaths and Cycle ways (no. 9). These sub-categories are at ranks 12 and 22 in the developers' list in Table 4a. With the combined score, these two subcategories are at 7 and 13 as shown in Table 4c.

Table 4a: Ranking of Sub-categories from a developer's perspective

RANK	SUBCATEGORY
1(tie)	Primary Education **
1(tie)	Internet Access
3	Employment potential
4	Secondary Education **
5	Water Supply
6	Early Years Education
7	Wastewater Management
8	Cable Access
9	Electricity Network
10	Telecommunications
11	Gas Network
12	Local Road Network
13	Office space
14	Parking
15	Police Service
16	Fire & Rescue Service
17	Ambulance Service
18	Children's Day Care
19	Public Transport
20	Further Education(colleges)
21	Grocery stores
22	Footpaths & Cycle ways
23	Street lighting
24	Open Space
25	Restaurants
26	Built Sports
27	Libraries
28	Waste Collection
29	Banks
30	Pool
31	Religious spaces
32	Community Centers
33	Hospitals
34	Primary Health Care
35	Recycling
36	Arboretum/Biodiversity
37	Senior Citizens' Care
38	Solar Energy
39	Wind Energy
40	Other (Renewable energy)

Table 4b: Ranking of Sub-categories from a municipal official's perspective

RANK	SUBCATEGORY
1(tie)	Water Supply
1(tie)	Electricity Network
3	Local Road Network
4	Waste Collection
5	Gas Network
6	Wastewater Management
7	Internet Access
8	Telecommunications
9	Footpaths & Cycle ways
10	Primary Education **
11	Secondary Education **
12	Early Years Education
13	Recycling
14	Public Transport
15	Restaurants
16	Cable Access
17	Police Service
18	Fire & Rescue Service
19	Street lighting
20	Ambulance Service
21	Parking
22	Open Space
23	Primary Health Care
24	Employment potential
25	Grocery stores
26	Banks
27	Further Education(colleges)
28	Built Sports
29	Hospitals
30	Children's Day Care
31	Office space
32	Senior Citizens' Care
33	Libraries
34	Arboretum/Biodiversity
35	Pool
36	Religious spaces
37	Community Centers
38	Solar Energy
39	Wind Energy
40	Other (Renewable energy)

Table 4c: Combined Ranking of Sub-categories of Infrastructure

RANK	SUBCATEGORY
1	Water Supply
2	Internet Access
3	Primary Education **
4	Electricity Network
5	Secondary Education **
6	Wastewater Management
7	Local Road Network
8	Early Years Education
9	Gas Network
10	Telecommunications
11	Employment potential
12	Cable Access
13	Footpaths & Cycle ways
14	Waste Collection
15	Police Service
16	Parking
17	Public Transport
18	Fire & Rescue Service
19	Office space
20	Ambulance Service
21	Restaurants
22	Street lighting
23	Children's Day Care
24	Grocery stores
25	Further Education(colleges)
26	Open Space
27	Built Sports
27	Recycling
29	Banks
30	Primary Health Care
31	Hospitals
31	Libraries
33	Pool
34	Religious spaces
35	Community Centers
36	Senior Citizens' Care
37	Arboretum/Biodiversity
38	Solar Energy
39	Wind Energy
40	Other (Renewable energy)

** Note: The two education sub-categories rank in top 5in the Developers' list and in the combined rank list. But the same are ranked 10 and 11 in the Municipal Officials' list due to low ranking by one municipal respondent.

C.1 Acceptable Infrastructure Distance (in miles)

The questionnaire for finding the acceptable distance consisted of only seven of the thirteen broad categories of infrastructure in which distance can be measured. These categories include: Transportation, Education, Community, Social, Emergency Services, Health and Retail. The other six categories not included in this list are: Utilities, Digital Infrastructure, Waste Management, Green Infrastructure, Renewable Energy and Employment Infrastructure. The data collected through the interviews resulted in the distance for available infrastructure acceptable to the developers, the municipal officials and a combined preferred distance. These values are shown in the Tables 5a, 5b and 5c respectively.

Table 5a: Acceptable Infrastructure Distance from a developer's perspective

INFRASTRUCTURE	ACCEPTABLE DISTANCE (miles)
Transportation hub	2
Education	2.5
Community Infrastructure	2.5
Social Infrastructure	4.5
Emergency Services	4
Health	6
Retail	5

Table 5b: Acceptable Infrastructure Distance from a municipal official's perspective

INFRASTRUCTURE	ACCEPTABLE DISTANCE (miles)
Transportation hub	4
Education	2
Community Infrastructure	3.4
Social Infrastructure	4.5
Emergency Services	4.75
Health	7
Retail	4

Table 5c: Combined Acceptable Infrastructure Distance

INFRASTRUCTURE	ACCEPTABLE DISTANCE (miles)
Transportation hub	2.9
Education	2.3
Community Infrastructure	2.9
Social Infrastructure	4.5
Emergency Services	4.3
Health	7
Retail	4.5

C.2 Observations

Table 5c shows the results for the acceptable infrastructure distance (in miles) for seven categories of infrastructure. According to the results, Primary Education Infrastructure is preferred to be at the least distance of 2.3 miles. This is followed by Transportation hub and Community Infrastructure at 2.9 miles. Health Infrastructure achieved the largest acceptable distance of 7 miles, which means that distance of the development from a hospital is not a deciding factor in the success of the development. Emergency Services and Social Infrastructure received an acceptable distance value of 4.3 and 4.5 miles respectively. It can be concluded that it is convenient for residents to drive up to 4.5 miles to a social infrastructure element, such as religious spaces. This also implies that Emergency Services are acceptable if located within a radius of 4.3 miles.

Considering the results separately to account for the distinct opinions of the developers and the municipal officials, the preferred distances are not very different. Variation is seen in the preference of Transportation Hub for developers at an acceptable distance of 2 miles, in contrast to a distance of 4 miles preferred by municipal officials.

Based on the above-discussed results, it can be inferred that the interview sample and responses were best suited for a development targeting young families or newly married couples about to start a family. These families would prefer to live in a neighborhood in close proximity to a school. In addition to basic utilities, they would expect digital infrastructure to ensure they stay well-connected and are able to work-from-home, if need be. Their next concern while selecting a development would be commute times to work. This is where employment infrastructure close to the development will be advantageous. Therefore, the presence of highly ranked infrastructure clearly plays a major role in the success of the development.

8. Discussion and Conclusions

The results achieved from the data analysis in this research can be valuable for a wide variety of individuals; such as residential developers, municipal officials, financial institutions, and even private and public infrastructure providers and operators. This analysis holds the advantage of incorporating the opinions of municipal officials, resulting in combined rankings based on both the developers and the municipal officials.

The model developed in this research can serve as a decision-making tool for the developers. If the development project has budget restrictions, the developer can only choose to provide the infrastructure category or subcategory with high ranks and give less importance to the categories with lower ranks. This model can also be used to make decisions when the time for delivering a project is limited. The acceptable distance of different infrastructure can help the developer in site selection. The site with the existing infrastructure within a suitable distance can be given higher priority. In addition, the results can guide the developers in determining a reasonable distance for providing the missing infrastructure.

Municipal officials can use these rankings to gauge the success of the new development, aligning with the best interests of the city. This can help the municipal officials in the approvals process. For instance, a proposed development with the availability of the high ranked infrastructure categories, within the

acceptable distance can be trusted to have a positive impact on the community. Consequently, the time and deliberation involved in the entire process of approving the development can be reduced.

Other entities in the development process, such as public or private lenders can also use this decision-making model to choose to finance a project. The lenders can ask the developer to submit the list of planned infrastructures and check its conformance with the highly ranked infrastructure in the priority list.

However, there are certain limitations to this research. As the number of data samples for analysis are low, the results have scope for further refinement. These will get more refined as the sample size increases. Also, the numbers used for obtaining the results are only gathered from the experts located in Michigan. Different locations with a considerable change in weather and price conditions may require inputs from the experts located in that area.

There are various aspects of infrastructure in residential construction that hold the potential of further research. The decision-making model developed in this research considers the perspectives of the residential developers and the municipal officials. Occupant satisfaction is a major component in the success of the development. Significant research can be conducted for understanding the infrastructure provisions required for meeting occupant expectations and improving their comfort. This will help understand the needs of the end-users of the development process. In addition, this research focused on the importance of infrastructure in the success of new residential developments. Currently, redevelopment projects are gaining popularity in urban areas due to the problems associated with population growth, lack of buildable land area and urban sprawl. The impact of infrastructure on residential revitalization projects in urban areas should also be studied.

This research provides a multi-criteria decision-making analysis for determining the priorities of different categories of infrastructure. The authors believe that this analysis will be valuable in guiding the developers and the municipal officials in selecting the infrastructure required for a successful residential development.

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