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A CRITERION FOR MEASURING URBAN INTELLIGENCE

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Keywords: Sustainable Development; Urban Forms Sustainability; Urban Development; Urban Intelligence; Urban environment

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INTRODUCTION

During the last three decades, technological development taking place had its revolutionary effects on contemporary life, starting with founding a dramatically sophisticated system of information networks, and ending with scientific postulates which visualize and verify the surroundings from a perspective contradicting previous prevailing thoughts. Accompanying alterations have emerged in the characteristics of urban fabric, that caused it to function in a more complicated and interfering way.

Conforming to this thrust of alterations, architecture and urban forms had to comply with this technological context as well, and to advance solutions that resemble the echo of knowledge and scientific accumulation, and to make its effect appear in the professional practice, on the designing level and on the final product itself.

Many theoreticians have tackled the design process performance as a superior activity, aiming its development to maintain the optimum design product, and assisting to achieve the maximum amount of community needs, (El-Sewefy, 2000).

Development is significantly taking place in the tools and means dealing with measuring almost all aspects of life and enumerating these measures with fixed values. This is besides the capability of science to put certain evaluation for various fields of human activities.

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This imposes a deep effect on altering the characteristics of the human product together with its development potential, and leading to the practical need to formulate a measuring device for the incommensurable variables, not able to be directly measured or evaluated.

Intelligence of urban conglomerations, and generally all works related to urbanism would be aggregated in this difficult group of parameters. They include a wide range of items and variables to be surveyed and assessed, and still difficult to evaluate with distinctive ranks, to indicate their compliance to a certain group of standards, and thus called intelligent.

Intelligence: Resemblance and Properties

It is of a considerable difficulty to present a comprehensive definition for intelligence, or to reach its intrinsic nature, (El-Sewefy: 2000).

Intelligence is one of the mind's capabilities for knowledge processing, and it's a criterion of mixing knowledge, emotional, psychological properties, forming a sophisticated structure of comprehension. It is conducted through performance and different actions performed by a person in his life, on condition to be oriented towards success and excel in any field.

Various researches have dealt with many references which covered various aspects of intelligence, including human and animals' intelligence, which led to its utilization in modern technology for human remediation, and also for deriving and producing artificial intelligence, theoretically and practically, (El-Sewefy: 2000).

Intelligence can be defined as, the human capability to imagine things and to analyze their properties and out-coming deductions and results, depending on three main factors (Stet: 2005):

- A strong and intact biological means: physical
- An environment of identifiable features: evidential
- A learning possibility within time and place: experiences

Intelligence can be sensed in various points. Among them is the learning capability, or the extent for a human to appropriately be adapted with his environment. Specialists go on their attempts to disentangle clashes and debates between different ideologies, (Kamel: 2006).

Urban Intelligence

Urbanism is a human physical product that resembles and symbolizes organized human existence and influence, and it is the product with which man forms the medium he lives in (Hefny: 2006). It is a creation and formation method for solutions concerning various facilities and services that serve man and facilitate secure shelter, protection, comfort and settlement against overall surrounding environmental factors.

The population increase has led to an increase in consumption and depletion of large amounts of energy, difficult mobility, scarcity of parking parcels, and an increase of pollution indices, causing the increase in the degree of awareness of these conflicts and negative impacts for conserving the balance within the urban environment. This issue has augmented the development of what is known by the concept of intelligent cities which are knowledge-dependant and based on economy that aims to maintain high value products/services, and future sustainable conditions, as shown in Figure 1, (Hefny: 2006).

In another view, they are cities in which governmental and private sectors evaluate knowledge and generously fund them with capabilities, possibilities, and resources.

Various principles have been put and discussed determining intelligence of urbanism. Mainly including: institutional integrity, availability of opportunity matrix, efficiency, respect of tradition and existing cultural assets, utilization of appropriate technology, social interaction through public domains, suitability of human scale, regional integration, integrated transport systems, and balance with nature, all are main principles and determinants of intelligent urbanism, (Benninger, 2001; Hefny, 2006; Horita et al.: 2009).

As compiled in table 1, and as aggregated from the previous ten determinants, the main contributing aspects of intelligent urbanism would be the factors of human, environmental, energetic, materials, and financial aspects, (Benninger, 2001; Hefny: 2006).

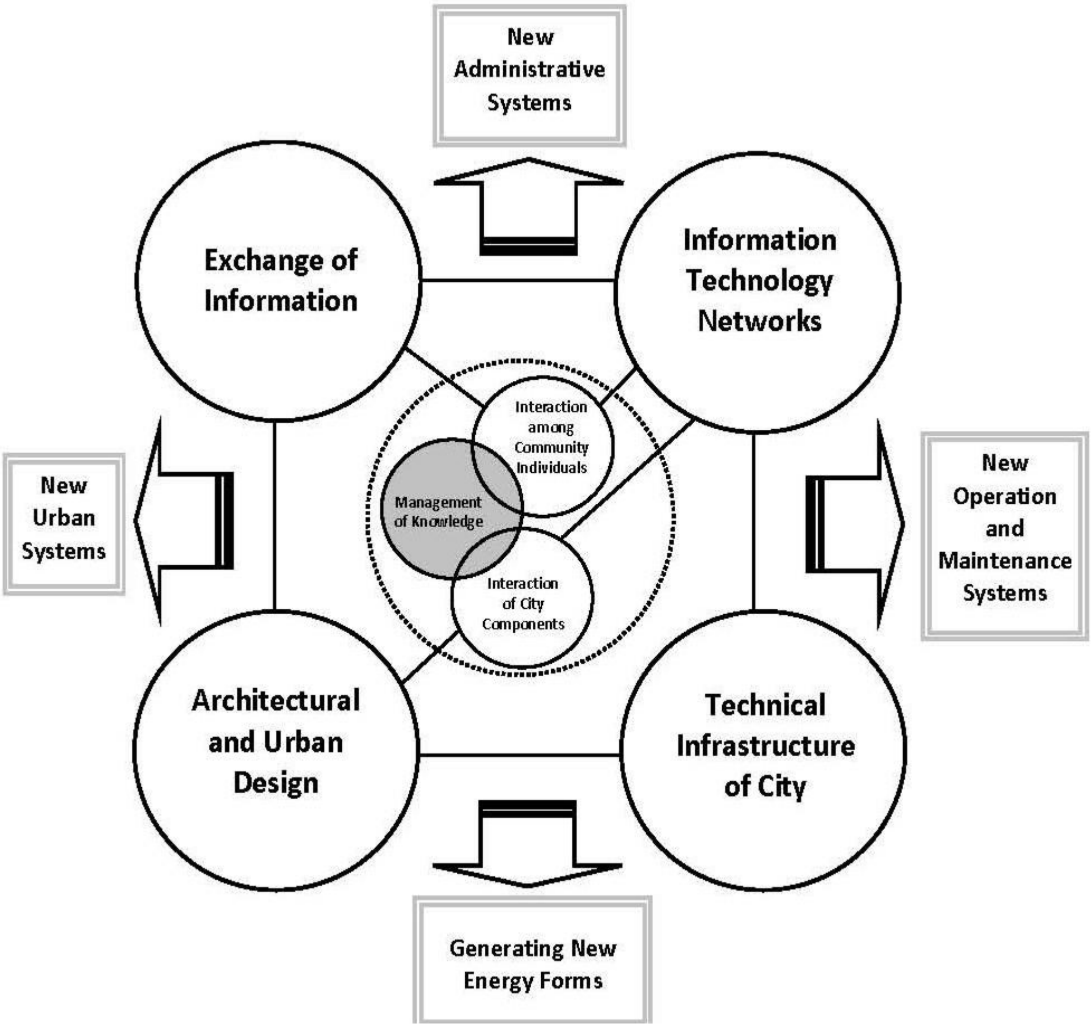

Figure 1: A diagram showing the concept of intelligent urbanism, and its interfering components mainly based on networks, information, and technology, (Hefny: 2006).

Intelligence in urban configurations

Different visions have debated the understanding of "Intelligent or Smart Cities" with respect to their settlement into three groups, (Rigg, 2000; Hefny: 2006):

- First: As they use modern technology in internal and external communications, and information technology facilities, in grouped or separated services, and have advanced controlling systems through which all city facilities could be controlled with.
- Second: As they use energy alternatives, which efficiently save operational expenses and resist pollution dispersion while performing their vital tasks.
- Third: As they facilitate various sources of services considering their locations, types, magnitudes, and efficiency.

While other visions tended to advance different definitions and understanding according to the urban scale treated.

Smart Cities

A city with a developable fully controllable infrastructure and components, that succeeds in fulfilling the community needs in a sustainable manner, (Horita and Koizumi: 2009).

Smart Landscape

Not only concerned with the achievement of beauty, but also with minimization of energy consumption, and with an additive value granted to the whole site, besides the suppression of pollution indices resulting from neighbouring urban clusters, (Pickett et al.: 2012).

Human	Environment	Energy	Materials	Finance
Through supporting communal participation, and attempting the formation of an urban environment of a sensible security and safety for its residents with coherent administrative capabilities	Usage of parks landscaping, availability of leafy plants for minimizing pollution, maintaining the biological equilibrium with the environment, predicting design impacts on thermal rising, acid rain, pollution indices, also usage of computer simulation for the mimic of shades and shadows in different seasons and the identification of thermal loads	By usage of new energy models that give the ultimate performance efficiency rate, and by coping between design and future needs, considerably highly depending on renewable energy usage, photovoltaic systems, and biogas	Thrusting marketing forces to direct investments flow towards primary local materials and using nearby locations for material extraction, and overcoming using toxics-containing materials, and expanding methods for waste recycling and reusing	Availability of financial resources and expansion in Return-on-Investment system application, also in long-term investment, working on inventing new financial models for the redistribution of financial benefits

Table 1: The main contributing aspects of intelligent urbanism, (Benninger: 2001); (Hefny: 2006).

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Smart Buildings

Considering accompanied smart constructional and operational systems, (Leeuwen and Timmermans: 2006), they would be characterised by:

- adaptable built environments that support human activities under varying condition, and harmonize with natural environment, (Vale B. and Vale R., 1991; Sim and Cowan: 1996)
- with innovation, technology, skilful management, to maximize investment revenue
- provide a productive and cost-effective environment through optimizing its four basic elements: structure, systems, services, and management, together with their interrelationships
- help business owners, manager and occupants to realize their goals in the aspects of cost, comfort, convenience, safety, long-term flexibility and marketing

It is possible that urban intelligence would catalyse the buildings intelligence as well, and vice versa, the intelligence deterioration of urbanism would result intelligence deterioration of that of the buildings (Bakri and Mokhtar: 1997). Also, the urban intelligence would be generated from the buildings intelligence, as if a group of buildings in a certain urban area could be described as intelligent this would consequently catalyses the urban area itself and raise its intelligence level.

AIM, TARGET, AND IMPORTANCE

The study aims to formulate a methodology for the measurement of urban intelligence, through the sequenced phases of an urban project, and in parallel and in harmony with the planner/designer’s personal thinking. Currently, measuring norms or gauges are used for some definite measurable parameters like energy consumption levels, thermal alterations, monitoring wind blooming, solar radiation, and others physical parameters, (Wazeery: 2007).

Also, the measuring gauge aims to investigate whether the planner/architect has succeeded to reach the optimum solution or not. This is besides the ability to investigate if the design has already accomplished the optimum distribution of spaces, and capability of the urban cluster to bear harsh emergent conditions like fires, earthquakes or any other emergent incidents, besides measuring the users' activity inside the urban cluster.

Mainly put for urban clusters and urban landscapes, the urban intelligence measurement gauge was primarily proposed. It is essential to confirm that by measuring the urban intelligence the urban conglomeration under study is not pointed at as intelligent or not. Instead, there are different levels of intelligence that can be assigned to it, and which start with the brain storming planning phase, proposed design tools, passing by the implementation phase, and until the phase of project operation, and coroneted with users' opinions.

The Practical Need

In spite of the elevated level of design performance of planners and architects, reflected through thousands of successful urban projects and buildings proposals, a great and persisting need has emerged for a practical scientific evaluation means for evaluating plans, designs, and application methodologies in all of their technical stages.

Traditional design procedures that totally depend on individuality, intuition, and creativity, and that consider being a group of sequential procedures of trial-and-error works, are what characterize contemporary architects and planners' working trends (Stet, 2005). The case here is by following certain logic, methodology, or simply an algorithm that guarantees an acceptable level for design quality, standardized through all of its procedures, on a group of competing views, (Sayed: 2005). Here we are discussing means and tools that may enable us to measure and distinctively describe how high the quality of these urban products is, and to identify their levels of "intelligence" according to its described comprehension.

These methods, which are currently able to measure the human capabilities (physical and mental), would they fail to measure the capabilities of urban clusters and buildings' performances?, (Rigg: 2000).

Importance of the Technique

The research importance emerges from the absence of its proposed methodology within the current practice of the specialization. Lacking the evaluation means is a major defect that may result in the elaboration and iteration of negative impacts and faults within the implementation of new projects.

By retrieving cumulative results of positive and negative experiences of many designed projects, and after extracting and analyzing and testing them, it is possible to acquire a tested comprehensive upgradable extract of database. The data would aggregate new, precise and tested ideas and applications, which would lead to the formulation of assisting determinants and guides that would help planners/architects to maintain their objectives and primarily to overcome the involvement of any previously encountered negative factors in any future projects. This would confidently lead to the improvement of the urban environment quality, and acquire its continuous upgradeability, (Alberti: 2008; Marzluff et al.: 2008; Endlicher: 2011), regardless to its scale, ranging from a limited urban compound to a city-wide.

It is obvious that the urban intelligence is linked, to a considerable extent, to a convenient management for its systems operations, construction, and the activity algorithm inside the project elements. This concept is tangible through the design, identification and usage of resources, and taking advantage of them in the best environmentally and hygienically fitting manner (Jenks and Jones: 2010; Van Bueren et al.: 2012). Besides that, this management works on achieving the project objectives, and dissemination of its benefits to the circumscribing medium.

URBAN INTELLIGENCE MEASUREMENT

Disciplines Involved

As discussed in previous studies and researches (ElWakeel: 1997); (C.A. and Ding: 2001); (Leed Pilot Version: 2007), and as displayed in Table 2, there are certain tangible aspects of the built environment which can be measured in one way or another like: energy efficiency, water consumption efficiency, minimization of waste, optimum cost, hygiene, contribution to economy, cleanliness, and social equity. It is the list of disciplines involved in maintaining a successful urban conglomeration that fulfils the needs of its residents, and ensures the achievement of sustainability along its future, (Leed Pilot Version: 2007).

Measurement Discipline	Importance	Method	Expected Results
Acquiring Energy Efficiency	Capability of decreasing energy consumption by 60% in heating and cooling, and by 50% in illumination	Design considers meteorological and climatic conditions, and studying modern applications of energetic technologies	Urban areas with energy efficiency are capable of minimizing their needs, emphasizing the importance of revenue from energy investments
Assurance of Proper Water Utilization	Minimizes the amount of consumed water, and resists wasting water	Utilization of water devices and equipment of high efficiency, and improving user's behavior towards water consumption	Possibility to decrease water consumption more than 40%
Minimization of Waste	Construction waste forms 30:40% of total solid waste, forming a problem in its storage, transporting, … etc.	Through reformation, recycling, and reuse, with the minimization of residues	Revitalization of present economic activities, and the creation of new ones, and minimization of its related negative environmental impacts.
Minimization of Implementation/ Operational Costs	Increment of design efficiency, and addition of new possibilities for the designer	Reoperation of old buildings and utilizing them in new purposes, or appropriately merging them with the surrounding urban areas	Minimizing constructional costs of new infrastructure, and consequently decreasing construction primary costs, and elevating the project economic revenue
Maintaining Human Hygiene	Improvement of living indoor and outdoor environment	Usage of materials of no impacts on human health or comfort	Could increase human productivity by 16%
Supporting National Economy	Minimization of needs to imported materials	Concentrating the demand on buildings that depend on locally manufactured materials and local industries and craftsmanship	Achievement of self reliance, and minimizing materials imported from outside the region
Cleanliness of the Environment	Resisting pollution and the "Global Warming" phenomenon	Utilizing Environmental friendly materials, with no/minimum pollution emission	Minimizing the negative impact on the Ozone layer, acid rain, and soil, water, and atmospheric pollution
Maintaining Social Equity	Spotlighting the neglected and developmentally abandoned communities	Minding the circumstances of community clusters, their human characteristics, and design needs	Merging these human communities to the overall community as one part and common interest

Table 2: A list of disciplines involved in urban intelligence measurement and their importance, implementation means, and expected results.

Characteristics of an "Intelligence Measuring" System

For evaluating the effectiveness of any measuring algorithm, there are elements bounding the functionality of the measuring gauge to gain its functional success.

Gauge Comprehensiveness

The gauge should contain all main elements and even the details that influence the urban conglomeration under study. This would assist in the development of the gauge, and would facilitate its inclusion of additive new aspects of the study case. The gauge proposed in this study aims to measure the intelligence of urban designing without being involved in the social or political aspects.

Types of Applied Queries

It is meant to display the forms of the applied questions in the gauge, which mainly depend on specific types of replies, which in turn would make it easier to assign them to numeric values, as distinct scientific ranking, far from any miss-interpreted descriptive language.

Assignment of Values

The no-how of putting specific values for each reply formed in the gauge, and the assumption of general values for the main elements of the gauge, are extremely difficult processes, due to the presence of differences in the influence scope of every element in the gauge, and that the estimated values are put depending on the evaluator's vision. Depending of the feeder/replier's background and experience, the reliability of the fed data would increase.

At the end, the evaluation process may result different readings from one evaluator to another, with expected divergence according to the personal and professional characteristics of the evaluator. This emerges the need for further studies to enable a standardisation process of the assignment of data fed in to the measurement gauge to be applied to any urban project.

Classification of the "Urban Intelligence" Gauge

According to the Temporal Phase of the Project

The urban intelligence gauge can be categorized with respect to the project timing phase as shown in table 3.

With this classification, it is possible to acquire different records and figures, categorized according to the active phase of the project; either it is design, implementation, or operation. Besides, it is possible to acquire new results which facilitate the development of the gauge itself, together with physical planning work environment.

Project's Phases		
Design Phase	**Implementation Phase**	**Operation Phase**
The adopted gauge data are prepared to measure what is expected. So the measurement is performed according to the designer's vision. The expected result does not reflect the project intelligence rather than depending on previous experiences and visions based on expectations and studies resulted from a prototype or digital modeling, or even a realistic mimic to reality, in either the post-execution phase or the post-operation phase for similar previously implemented projects.	The gauge data here are real data, reflecting a living reality for what could be measured of physical quantities or tangible parameters. However, results here reflect predictive values within exemplary or digital modeling or even a realistic emulation for how the project would be operated, giving the gauge (in this case) a moderate degree of accuracy.	The gauge data are distinctive and accurate, reflecting a live reality for what could be measured of different physical values, and different operational quantities. The gauge in this case is distinctively accurate. This knowledge-based information could be used later in similar projects as experimented references.
Indistinct Expected Results	**Moderate Expected Results**	**Distinct Expected Results**

Table 3: Measurement gauge data depending on operational phases of the project.

According to the Type of Data

Urban intelligence gauge input data is operationally divided in to two main classes. The first is the experimental data, which involves measuring data concerned with the project emulation model, resembling the theoretical type of data, until its practical operational phases carried out afterwards.

While the second class of data is all measurable data acquired from the project, and involved in the working team describing its perception capabilities towards implementing/developing ideas for intelligent physical planning.

FORMULATING THE GAUGE

Identification of the Gauge Elements

The study has selected the temporal phases of the project as a categorising means for the selection of the gauge elements. This method for selection would be the most appropriate prototype for the gauge elements, as it included the comprehensive timeline of the urban project under study. Still, other methods could be used for the identification of the most appropriate elements that would realistically resemble the project and to measure its intelligence level.

Elements of Measurement	**Planning and Designing Phase**	1- Management of Urban Project
		2- Site Location Validity
		3- Urban Design of Project
		4- Project Planning Patterns
	Implementation Phase	1- Management of Urban Project
		5- Efficiency of Resources & Energy Usage
		6- Construction Materials and Ores
	Operation Phase	1- Management of Urban Project
		5- Efficiency of Resources & Energy Usage
		7- Inter-Urban Buildings
		8- Waste Disposal
		9- Development Possibility

Table 4: Elements of measurement according to the project phase.

This method selected the elements of the intelligence gauge within the planning/designing phase, the implementation phase, and the operation phase, as shown in table 4, and depending on this distinct methods, it is possible to assign reliable scores which can be fed into the gauge, enabling it to perform the project evaluation reliably.

Primarily the gauge elements and components are selectively identified to cover the main phases and procedures an urban project would encounter, with their ability to be altered for further development and upgrading. Shown in table 5, nine main elements are proposed to cover the main attributes of the urban project under study. These elements are liable to alteration according to the case in hand. For each element a "points" weight is specified according to its importance and role played in the project success towards an issue that would contribute to the intelligence belonging.

Internally, these elements are divided into different components; each of them surveys a certain parameter and also to be covered with an estimated weight. The summation of these components weights forms the total weight of their circumscribing gauge element. While the summation of the nine elements' points (weights) forms the overall estimated rank (out of 124 points) that describes the project under study for the intelligence property, or in other words; would express the overall project intelligence total weight.

Serial	Item	Overall Proposed Weight
1	**Management of Urban Project**	(15)
1-1	Specialization Diversity of the Project Team	2
1-2	Dependence on the methodology of project objectives interaction	2
1-3	Steadfastness of project management by successful solution to project problems	1
1-4	Control and Automation techniques with network of smart urban electronic linking	1
1-5	Management of Transportation Means	1
1-6	Energy Management	3
1-7	Upgrading Possibility	3
1-8	Putting emergency plan for the project	2
2	**Site Location Validity**	(24)
2-1	Location importance to the country developmental plan	2
2-2	Achieving the project time plan objectives	1
2-3	Availability of a direct link with regional roads network	2
2-4	Connection to the Network	1
2-5	Prevailing Wind	2
2-6	Solar Energy in the site	2
2-7	Site content of fresh water	2
2-8	Urban-Resultant Pollution Percentage	2
2-9	Noise index in site	2
2-10	Infra structure preparations	1
2-11	Providing electrical power	1
2-12	Site green content	1
2-13	Cultivable areas	2
2-14	Preservation of natural life in site	2
2-15	Site changing extent	1
3	**Urban Design of Project**	(8)
3-1	Design Team (Specialty diversity of design team)	1
3-2	Dependence on Methodology (Interaction of project objectives)	1
3-3	Usage of simulation tools	1
3-4	Usage of digital modelling	1
3-5	Availability of design alternatives	1
3-6	Examining the synthesis and tuning of the design elements (Theoretical examinations)	1
3-7	Examining the synthesis and tuning of the design elements (Experimental examinations)	1
3-8	Matching examination results to site sample measurements	1
4	**Project Planning Patterns**	(26)
4-1	Site planning orientation to climatic aspects	1
4-2	Compaction of plan	1
4-3	Ratio of building area to land area	3
4-4	Services diversity in project	7
4-5	Streets networks	1
4-6	Integrity of sewage network	1
4-7	Parking area ratio according to code	3
4-8	Ratio of pedestrian paths length to vehicles paths length	2
4-9	Coherence of urban spaces	1
4-10	Linking between the residence and business areas	1
4-11	Hierarchical street networks	1
4-12	Secured pedestrian paths	1
4-13	Secured students pedestrian paths	1

Table 5: Main proposed elements and components that cover all vital aspects of a certain urban project.

4-14	Security surveillance network	1
4-15	Commitment to traffic plan	1
5	**Efficiency of Resources Energy Usage**	(19)
5-1	Minimization of clean water usage	3
5-2	Stored water	2
5-3	Possibility of recycling sewage water and reusing it	2
5-4	Communal Productivity	2
5-5	Type of power technology available in the urban conglomeration	2
5-6	Energy consumed in construction	3
5-7	Energy consumed in operation	2
5-8	Energy generated from renewable resources	3
6	**Construction Materials and Ores**	(7)
6-1	Sources of construction materials and ores	3
6-2	Energy content of construction materials and ores	2
6-3	Hazardous materials ratio of construction materials	2
7	**Inter-Urban Buildings**	(11)
7-1	Ratio of buildings floors areas to site area	3
7-2	Ratio of old buildings to project buildings	2
7-3	Ratio of smart buildings to project buildings	3
7-4	Rate of building productivity of energy	3
8	**Waste Disposal**	(10)
8-1	Environmental waste disposal methodology	2
8-2	Possibility of damping all waste	3
8-3	Possibility of waste recycling	2
8-4	Possibility of construction materials recycling	3
9	**Development Possibility**	(4)
9-1	Is there a possibility of developing the project management systems?	1
9-2	Have the design tools and methodologies been developed?	1
9-3	Have the technical systems been developed?	1
9-4	Have new building materials been developed?	1
	Total	**124**

Continue Table 5: Main proposed elements and components that cover all vital aspects of a certain urban project.

Utilised Scale of Urban Intelligence

Urban intelligence scale was quoted from human intelligence levels as proposed by psychiatrists in assigning a certain intelligence level to a person after performing the appropriate tests, (Stet: 2005). Mimicking the levels wordings, and the used number of levels, they would form an appropriate scale for describing the intelligence level of an urban conglomeration.

The proposed urban intelligence scale is divided into 7 levels: eminent, superior, over-moderate, moderate, below-moderate, on the edge, and retarded, put on the scale line, where intelligence levels are gradually aligned so as levels differences are minimized with the scale incrimination similar to the logarithmic scale, to facilitate more distinctive details and an accurate description of the project according to the phase evaluated, as shown in figure 2.

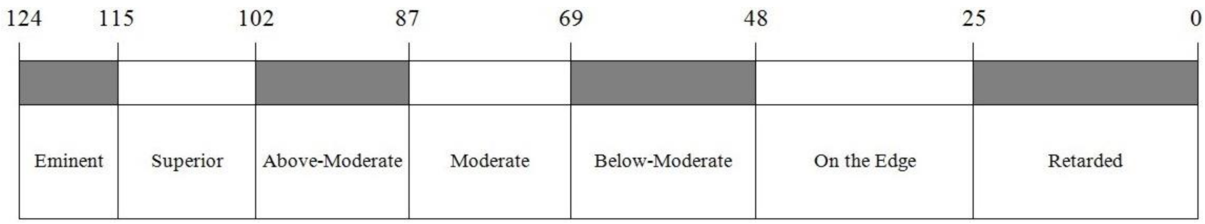

Figure 2: The seven different levels scaling the urban intelligence measure.

Table 6 lists the seven proposed levels with their naming, definition and reasoning of assignment to each level according to fulfilling certain conditions for each level, and the points range assigned for each level.

Urban Intelligence Levels			
Level	**Definition**	**From**	**To**
Eminent	Projects: - which achieved the majority of the intelligence gauge elements - efficiently took advantage of design success, technological capabilities - were able to add an urban value	124	115
Superior	Projects: - which achieved the majority of the intelligence gauge elements - efficiently took advantage of design success, technological capabilities	114	102
Above-Moderate	Projects: - which were highly efficient to take advantage of design success, and technological capabilities	101	87
Moderate	Projects: - which were acceptably efficient to take advantage of design success, and technological capabilities	86	69
Below-Moderate	Projects: - which took advantage of the technological capabilities, without design success	68	48
On the Edge	Projects: - which achieved the minimal level of the intelligence requirements	47	25
Retarded	Projects: - which did not achieve the minimal level of the intelligence requirements	24	0

Table 6: Ranges of levels used in the urban intelligence gauge.

APPLICATION OF THE PROPOSED GAUGE ON A STUDY CASE

Considered as one of the massive urban projects in Egypt, it was selected for the assurance of the gauge proper operation and efficiency. The "Smart Village" - Cairo, Egypt, aggregates many of the leading firms’ head quarters, office buildings, computer services firms, private Universities, communication services firms, and the Ministry of Communication. It is located at the entrance of Cairo city on the Cairo-Alexandria desert road, in Abu-Rawash area.

This vital site was selected as a study case on which the urban intelligence gauge is to be applied. Aiming to investigate and verify how this urban area is conforming to the standards and determinants of intelligent urbanism, and in other words to investigate the validity of its name.

Description of Study Case: "Smart Village" - Cairo, Egypt

One of the worldwide leader design bureaus has designed the project on a land of approximate area of 3 square kilometers (shown in Figure 3), at the west of Greater Cairo, aggregating the most important and huge firms of communications and information technology, of local and international identity. Currently developed, the village has become one of the widest and most important business conglomerates in Egypt.

The smart village is exclusively characterized by a significant merge of various services considering the gigantic infrastructure and the specialized management of all facilities. Also the village enjoys a luxurious and beautiful business atmosphere considering expanded green areas, waterfalls, artificial lakes, besides spacious zones for buildings characterized by their unique architectural style (Rigg: 2000; Ibrahim: 2005).

For maintaining exclusivity and distinction, the smart village planning was keen to provide various services to firms and authorities, like providing the gigantic optic fibres network connecting all facilities and buildings inside the village and ensuring good and fast data exchange in audio and video formats. This is besides facilitating systems of video conferencing, cable TV, and voice over IP, and also all firms are wirelessly connected, and provided with multi-voltage power generation that guarantees 24 hours of power fluency along the week. The village facilitates a giant central cold/hot air conditioning network for all buildings, utilizing environmentally friendly natural gas.

It was inevitable to facilitate a high quality security service and surveillance system, using the most recent methods and techniques to protect and secure this important strategic site.

Also, providing a system for management of buildings with high level of professionalism for periodic cleanliness works of buildings and facades, emergency mending, with all requirements of maintenance and care for entrances and landscape.

For increasing the luxury and integrated services, and to conform to the ecological design principles, (Sim and Cowan: 1996), the smart village was keen to acquire the sport and sanitary club including tennis, squash playgrounds, swimming pools, gymnasium, integrated spa, a jogging track, football field, and other multiuser playgrounds for village workers and their families. This is besides a nursery school, international school, and a 5-stars hotel for hosting businessmen visiting the smart village.

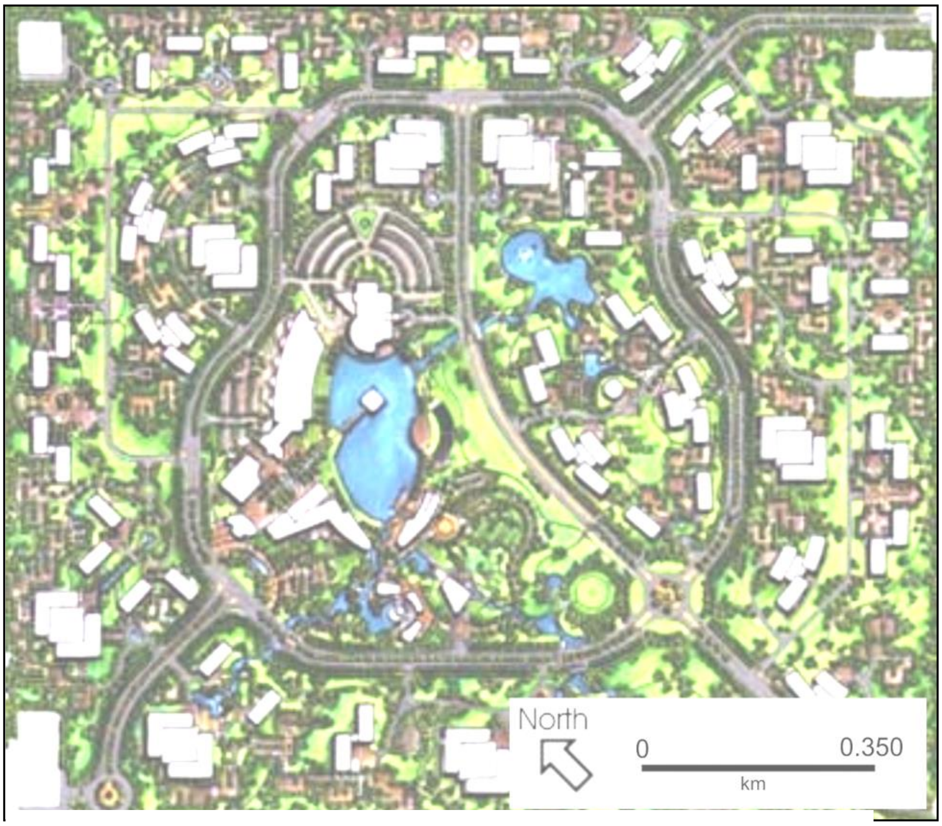

Figure 3: "Smart Village" site plan in Cairo, Egypt.

Calibration of the Urban Intelligence Gauge

Through practical visits to the site, and questioning a wide range of facilities users, and collecting suitable answers to questions previously prepared and listed, the urban area of the smart village was put under study for measuring its urban intelligence and specifying its intelligence index.

The gauge elements previously described in section 11 are to be verified within the practical direct contact with the urban area, and the practical acquisition of data. As shown in table 7, weights, reasons, and verification (with their details and method of execution) were assigned to each of the gauge elements applied to the "Smart Village" study case.

Smart Village Urban Intelligence Gauge

Serial	Item	Weight	Reason / Method Verification
1	**Management of Urban Project**	(15)	
1-1	Specialization Diversity of the Project Team	2	Project Management Team relied on a variety of design and management capabilities
1-2	Dependence on the methodology of project objectives interaction	1	Project Design Team adopted a special environmental and cultural methodology
1-3	Steadfastness of project management by successful solution to project problems	1	Emergence of a number of problems during design, implementation, and project management
1-4	Control and Automation techniques with network of smart urban electronic linking	1	Availability of project urban electronic linking network
1-5	Management of Transportation Means	1	Unavailability of direct management of Transportation Means
1-6	Energy Management	2	Energy Management is implemented through separated controllers, not electronically linked
1-7	Upgrading Possibility	3	Future upgrading plans were put
1-8	Putting emergency plan for the project	2	This methodology was adopted on during project design
	Total Score	**13**	
2	**Site Location Validity**	(24)	
2-1	Location importance to the country developmental plan	1	This studying was performed by the village management council
2-2	Achieving the project time plan objectives	1	The project was implemented according to the view put for it
2-3	Availability of a direct link with regional roads network	1	This methodology was adopted in project design

Table 7: A table illustrating the measurement criterion of urban intelligence of the "Smart Village", Cairo, Egypt.

2-4	Connection to the Network	1	This methodology was adopted in project design
2-5	Prevailing Wind	1	Prevailing favourable wind from the North and the North West, while, hot seasonal wind from the South West of the site
2-6	Solar Energy in the site	2	Photo-voltaic cells to be used for generating energy from the solar energy, but not wide spreading
2-7	Site content of fresh water	1	No water available till depth of 120 meters below ground surface, and water source facilitated by the governorate through municipal water lines
2-8	Urban-Resultant Pollution Percentage	2	As a services project, outer pollution sources aspects were taken by design team
2-9	Noise index in site	2	Considered by design team
2-10	Infra structure preparations	1	Available
2-11	Providing electrical power	1	High (sufficient) amount of electrical energy supply is serving the project
2-12	Site green content	1	Project land is within desert land
2-13	Cultivable areas	2	A wide area was cultivated for shading
2-14	Preservation of natural life in site	1	This methodology was adopted in project design
2-15	Site changing extent	0	This methodology was adopted in project design (future extensions)
	Total Score	**18**	
3	**Urban Design of Project**	(8)	
3-1	Design Team (Specialty diversity of design team)	1	This methodology was adopted in selection of project design team members
3-2	Dependence on Methodology (Interaction of project objectives)	1	A methodology was formulated for project design
3-3	Usage of simulation tools	0	No skeletal simulation tools were used in the project urbanism studies
3-4	Usage of digital modelling	0	No digital simulation tools were used in the project urbanism studies
3-5	Availability of design alternatives	1	This methodology was adopted in project design
3-6	Examining the synthesis and tuning of the design elements (Theoretical examinations)	1	This methodology was adopted in project design
3-7	Examining the synthesis and tuning of the design elements (Experimental examinations)	0	The project urban parameters were not examined experimentally
3-8	Matching examination results to site sample measurements	0	The project urban parameters were not examined in the form of site samples
	Total Score	**4**	
4	**Project Planning Patterns**	(26)	
4-1	Site planning orientation to climatic aspects	0	This methodology was adopted in project design
4-2	Compaction of plan	0	This methodology was adopted in project design
4-3	Ratio of building area to land area	3	This ratio was adopted according to active building law
4-4	Services diversity in project	7	Project services are of significant diversity
4-5	Streets networks	1	Street networks are gradually linked according to their importance and what they serve
4-6	Integrity of sewage network	1	Sewage network integrates, with sewage water purification station, and water reuse
4-7	Parking area ratio according to code	2	Parking areas are available with possibility of addition of additional parking areas
4-8	Ratio of pedestrian paths length to vehicles paths length	2	During design, it was specified that the maximum walking distance duration between buildings and parking areas is from 05 to 10 minutes only
4-9	Coherence of urban spaces	1	This methodology was adopted in project design
4-10	Linking between the residence and business areas	0	This methodology was adopted in project design
4-11	Hierarchical street networks	1	This methodology was adopted in project design
4-12	Secured pedestrian paths	1	This methodology was adopted in project design
4-13	Secured students pedestrian paths	1	This methodology was adopted in project design
4-14	Security surveillance network	1	This methodology was adopted in project design
4-15	Commitment to traffic plan	1	This methodology was adopted in project design
	Total Score	**22**	
5	**Efficiency of Resources Energy Usage**	(19)	
5-1	Minimization of clean water usage	2	This methodology was adopted in project design
5-2	Stored water	1	Mainly depending on saving the public water source
5-3	Possibility of recycling sewage water and reusing it	1	Availability of sewage water recycling station and reusing it in plantations and irrigating
5-4	Communal Productivity	0	No clear plans in this field
5-5	Type of power technology available in the urban conglomeration	2	Photovoltaic cells are used but not in a wide range
5-6	Energy consumed in construction	1	According to project distance from other urban areas
5-7	Energy consumed in operation	1	According to high-level services advanced by the project

Continue Table 7: A table illustrating the measurement criterion of urban intelligence of the "Smart Village", Cairo, Egypt.

5-8	Energy generated from renewable resources	2	Indirect dependence on solar energy
	Total Score	**10**	
6	**Construction Materials and Ores**	(7)	
6-1	Sources of construction materials and ores	1	No dependence on specific manufactured materials
6-2	Energy content of construction materials and ores	0	According to their usage and synthesis
6-3	Hazardous materials ratio of construction materials	2	This methodology was adopted in project design
	Total Score	**3**	
7	**Inter-Urban Buildings**	(11)	
7-1	Ratio of buildings floors areas to site area	1	This methodology was adopted in project design
7-2	Ratio of old buildings to project buildings	0	Te site is new and devoid of any old buildings
7-3	Ratio of smart buildings to project buildings	3	Smart buildings exist in high ratio
7-4	Rate of building productivity of energy	2	Compared to energy consumption ratio
	Total Score	**6**	
8	**Waste Disposal**	(10)	
8-1	Environmental waste disposal methodology	1	This methodology was adopted in project design
8-2	Possibility of damping all waste	2	Plans exist
8-3	Possibility of waste recycling	1	No clear vision
8-4	Possibility of construction materials recycling	1	No clear vision
	Total Score	**5**	
9	**Development Possibility**	(4)	
9-1	Is there a possibility of developing the project management systems?	1	There are plans for this purpose
9-2	Have the design tools and methodologies been developed?	0	No new views and methodologies have been put for the project original designs
9-3	Have the technical systems been developed?	0	They have not been developed but the same usual system has been used
9-4	Have new building materials been developed?	0	They have not been developed but the same usual materials have been used
	Total Score	**1**	
	Grand Total Scored:	**(124)** **82**	**Intelligence Ratio: Moderate**

Continue Table 7: A table illustrating the measurement criterion of urban intelligence of the "Smart Village", Cairo, Egypt.

The "points" grand total was 82 points; consequently, and by referring to table 5 for urban intelligence scale ranges, the urban intelligence level of the "Smart Village" is consequently assigned to "moderate".

Considered as a dependable scientific and professional reference in the urban development specialization and aware of the urban project under study, opinions of a number of experts and planners have been gathered, organised, and used for the comparison between their opinions/estimations and the results of the gauge, taking into account mentioning all of the referees' points to objectively clarify the differentiation ability of the measuring gauge.

The experts/referees were three in the specialization and with the following posts and work fields:

- First referee:a freelance urban planning consultant
- Second referee:an urban planning expert in the Ministry of Housing
- Third referee:a university staff professor of environmental planning

dTheir opinions towards what have been viewed and judged of the various elements of the measuring gauge were confined within the "moderate" category of intelligence (middle to high within the category), as shown in table 8. An overall average of 79 points has compiled their overall estimate of urban intelligence for the site under study, and by referring to table 6, the average would be pointing to the "moderate" category.

Measurement of the Urban Intelligence of the "Smart Village", Egypt								
#	Item	Virtual *Item Weight*	Referees' Estimation				Gauge Readings
			First Referee	Second Referee	Third Referee	Average	
1	Management of Urban Project	15	12	11	10	11	13
2	Urban Conglomeration Site Location Validity	24	16	16	16	16	18
3	Urban Design of Project	8	3	4	2	3	4
4	Project Planning Patterns	26	21	21	19	20	22
5	Efficiency of Resources Usage	19	9	10	7	9	10
6	Construction Materials and Ores	7	2	2	2	2	3
7	Inter-Urban Buildings	11	10	9	8	9	6
8	Waste Disposal	10	7	8	7	7	5
9	Development Possibility	4	2	2	1	2	1
	T o t a l	**124**	**82**	**83**	**72**	**79**	**82**

Table 8: "Smart Village" urban intelligence weights according to the vision of experts and planners, compared to the resulting readings of the gauge.

By comparing the referees' average reading (79) to the gauge result (82), a difference of only 3 points separates the two figures, giving an acceptable tolerance between the readings. The two readings were sufficiently close to confirm to an acceptable extent the reliability of the gauge results in using such a systematic means of measurement for evaluating an urban project conforming to intelligence calibres.

RESULTS AND CONCLUSIONS

Not only by describing an urban conglomeration with smart or non-smart, but by measuring its intelligence level, it is possible to assign the case under study to one of the various intelligence levels, throughout its different phases, starting from the thinking phase, the construction phase, and ending with the operation phase, according to its compliance to the various elements of verification.

The gauge magnitude and limitations can be identified as follows:

- The acquired benefit resulting from such measurement gauges and norms would from a high magnitude in urban projects evaluation, similar to algorithms currently adopted in the architectural scale for building in ranking as Green, Leed, or environmentally conforming building.
- The intelligence measurement gauge with its comprehensive elements and components is developable, and able to accept more detailed items, and to increase its evaluative resolution, capacity, and capabilities.
- Putting values and assuming them may differ from one planner/assessor to another, as each may hold a different value according to the personal view and professional background.
- Applying the intelligence measurement gauge on all available project phases gives a clear view, and resembles a detailed evaluative process for this project. This may lead to an upgradable view for construction materials and administrative systems by drawing a special historical sequence for the project. Through this historical sequence of experiences and accumulation of knowledge extracted from various projects, a practical view would be generated for any experience of a similar nature that may be introduced in the future.
- Upgrading and build-up possibilities are still the most important elements of an intelligence gauge. The utilised gauge can be developed, and its weights can be updated to express in higher precision the intelligence of certain urban projects, and to be widely applied to buildings and urban landscape projects as well, after performing the necessary modifications of its modules and structuring elements to be customised for the case under study.

An integrated methodology should be available for all project aspects: urban, environmental, economic, and scientific. Also, it is necessary to acquire certain diversity in the designing team, so that it includes environmentalists, planners, social researchers, and others from a variety of disciplines that serve the urban planning/development issue. This diversity would ensure the complete coverage of all multi-disciplinary issues and aspects of an urban project inside the gauge elements groups.

Urban proposals should be thoroughly tested and evaluated by all available means to settle on the most appropriate proposal. In such procedures, the intelligence gauge can play a major role selecting the most appropriate urban proposal which records the highest points scored, covering a set of important issues that should be aggregated in the gauge elements, like:

- Energy and transportation management
- Compactness of the urban fabric is still the most suitable alternative to maintain energy conservation, and to integrally take advantage of resources included in the elements of urban intelligence
- Site validity and suitability with all of their urban and architectural aspects are major elements of the intelligence gauge, and can be identified by direct scientific standards
- Waste disposal and recycling
- Proper and useful ways of waste disposal in a positive environmental and economic manner accomplishes higher rank of intelligence

The deduced advantages of the proposed gauge for measuring urban intelligence can be listed as follows:

- Adaptation of urban and architectural design procedures to comply and conform to available financial and technologies resources
- Through utilisation of the gauge, it would be possible to maximize the advantage of heritage and cultural ingredients, and use them as elements of attraction within the urban fabric that emphases the local or the national identity
- Adopting excel and organised creative thinking as a main support in urban development
- taking advantages of techniques of the digital revolution together with the advantages of information banks and technologies, as the operation mode and upgrading of the gauge depend on the readiness and fluency of the acquired information
- involvement of the people's participation in preserving and improving their living environment through self convincing and practical advancement of information, and inserting this factor as a measurable element in the gauge

RECOMMENDED MEASURES

The intelligence gauge - as a measuring/monitoring algorithm - should be adopted through all phases of urban/architectural/construction works, and a database should be prepared for a certain project, concerning different applied urban/architectural experiences.

Further studies could be carried out to investigate the possibility of applying the intelligence gauge to new urban conglomerations, especially in its starting phases, as this is expected to save a huge amount of financial bulks on the governmental expenses, and thus helping the instalment of new and advanced activities without further financial of resources burdens.

The gauge within its technical development can be used as a means for evaluation of projects in its early status and phases, specifically in the designing phase. Upon the success in fulfilling certain conditions and standards, expressed by the scored points in the gauge, it would be permitted to proceed to the following practical step, or otherwise granted a group of recommendations and instructions for amendments and curing the implementation steps from technical of administrative obstacles and defects.

It is necessary to reframe the design process to get advantage of the technological capabilities of computer systems, especially those linked to measurement norms and gauges.

It is wisely thinking to alter the designing work environment, as to be activated among groups of designers rather than a single designer, with a collaborative work within different specializations, bound with a universal works-organizer and orchestrator. All proposals can be introduced to a selectivity algorithm by the utilisation of the gauge to be acknowledged with the most appropriate solution which scored the highest grade resembling its fulfilment to the widest range of determinants that serve the multi-aspect view of the urban project.

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