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Employing smart systems in integrated management of infrastructure for housing projects

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KEYWORDS

smart infrastructure, smart housing projects, smart systems, integrated management.

ABSTRACT

resources, economic statuses, and rapid growth, have enabled to introduce technologies of sensor networks, computation and communications systems to the cities' infrastructure and contemporary housing projects with a goal to fulfill the integrated and accomplished management. The research's goal has been to clarify the role of smart systems in fulfilling the integrated management, and the research problem was identified "The need to employ smart system processors in integrated management of housing infrastructure." Goal achieved adopting a descriptive analytical approach that included a number of stages, the first of which is the analysis of multiple studies and the extraction of the key vocabulary represented in (the basic elements of infrastructure smarting, planning for smarting infrastructures, design for smarting infrastructures, Monitoring and Observatory for Infrastructure smart). Secondly, applying these vocabularies to a number of global projects, to determine the most important vocabulary approved therein, and then analyzing and discussing the results of the practical study, and put the final conclusions, to be a knowledge base that can be used and applied to future projects.

الكلمات المفتاحية

البنية التحتية الذكية، مشاريع الإسكان الذكية، الأنظمة الذكية، الإدارة المتكاملة.

الملخص

قد مكنت وفرة الموارد والأوضاع الاقتصادية الجيدة والنمو السريع من إدخال تقنيات شبكات الاستشعار وأنظمة الحاسوب والاتصالات الذكية إلى البنية التحتية للمدن ومشاريع الإسكان المعاصرة بهدف تحقيق الإدارة المتكاملة فيها. لذلك كان هدف البحث توضيح دور الأنظمة الذكية في تحقيق هذه الإدارة المتكاملة، وقد تم تحديد مشكلة البحث ب "الحاجة إلى توظيف معالجات الأنظمة الذكية في الإدارة المتكاملة للبنية التحتية للإسكان". وتم تحقق الهدف بتبني منهج تحليلي وصفي اشتمل على عدة مراحل، أولها: تحليل دراسات متعددة واستخراج المفردات الأساسية المتمثلة في (مقومات اذكاء البنية التحتية، التخطيط لإذكاء البنية التحتية الذكية، التصميم لإذكاء البنية التحتية. والمراقبة والرصد لإذكاء البنية التحتية). ثانياً: تطبيق هذه المفردات على عدد من المشاريع العالمية، لتحديد أهم المفردات المعتمدة فيها، ثم تحليل ومناقشة نتائج الدراسة العملية، ووضع الاستنتاجات النهائية، لتكون قاعدة معرفية يمكن استخدامها وتطبيقها لإذكاء مشاريع الاسكان المستقبلية.

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Introduction:

Infrastructure represents the backbone and lifeline of all economic, social and political activities in civilized societies, which have not recently met the requirements in comparison with the population expansion and rapid technological development taking place in all fields of life, hence the concept of smart housing projects is emerged for being considered as entities with high technology capacity connected with the information systems, and with it a concept has emerged called smart infrastructure: which is described as the backbone of smart housing projects, led by a wireless sensor network . These smart structures are managed by the smart systems technology solutions, which achieve the vision of smart management represented in the transition from "system to systems" with benefits greater than its parts through the concept (integrated management of infrastructure) and its operations and its transactions, which will be considered as one of the specific features of any smart housing project. So, the need is emerged to clarify the role of smart systems in achieving this integrated management. A research steps was adopted:

- Building a theoretical framework with a variety of concepts about the topic.
- Reviewing a set of architectural studies related to smart systems in order to extract their variables and possible values that contribute to building the theoretical framework.
- Studying and analyzing the applied, contemporary, and architectural samples, whose infrastructure has been partially or completely smarted, in order to carry out the application of the theoretical framework vocabulary.
- Presenting findings, conclusions and recommendations.

And the research hypothesis:

Smart systems fulfill the integrated management of infrastructures for housing projects through a set of infrastructures' basic elements and by adopting planning and design thought, and monitoring and control operations for smart infrastructures.

The concept of smart systems:

A group of interconnected elements that can be linked to the network dealing with data in real time and aiming to achieve a specific goal (Buckman AH et al., 2014, p:92), which is based on remote sensing, operation, system control to describe and analyze the situation, making decisions based on available data in a predictive or adaptive way (to take better decisions in quick time).

Hence the implementation of smart procedures can be attributed to an independent operation system based on network capabilities (Anna swamy AM et al., 2016, p: 261,262). The smart systems aim to: employ technology to meet human needs and requirements in the best and fastest way, conserve the environment, energy, provide safety, and achieve sustainability values while minimizing the human role in decision-making and action (Bakro Khalid, 2017). Smart systems operate on two levels: on the lower level "building systems", and on the larger level "city" and "housing projects" (Oracle Corporation**,** 2014). The infrastructure associated with smart systems is called as " the smart infrastructure", which aims to achieve the smart services principles and its role in reducing design costs and increasing the possibility of future expansion of its size based on its new functions and its components relationships (Houlin Zhao et al., 2016). It has indicated that the rapid spread of technical solutions for housing projects ' infrastructure management has resulted into inconsistencies in the application of these solutions. The error lies not into the solutions themselves; each solution has the potentiality to contribute to improving urban management of the housing projects assets, but the uncoordinated application of these solutions has led to the complexity of asset management. Hence, the importance of ensuring the organization and efficient management of these solutions gets high level of elevation by achieving the vision of smart management represented in the concept of integrated management of Infrastructure that being considered as one of the most important features of contemporary housing projects (Prasad R and Ruggieri M, 2014, p: 121,122). Note Table (1): -

Table (1) definition of the smart systems, the source (the two researchers)

Smart Systems Sources	Its applications	
The intellectual Basis	Simulating the human intelligence qualities	
Information Technological Techniques	Artificial Intelligence	expert systems
Smart Devices	Multi- functions devices Minimized Industrial Devices Sensor Devices	

The concept and applications of integrated management:

The Integrated management is described as: (an infrastructure based on participatory intelligence between modern technology and individuals, or what is known to be called as human and social capital, this participation in decision-making lead to smart governance and better rationalization of resource consumption and sustainable development, in order to improve the quality of life in the urban areas (OECD, 2015, p. 2-8).

Integrated management allows smart housing project managers to understand their roles and responsibilities in operating their smart infrastructure, accessing information resources very quickly, determining the exact location of events and taking appropriate action on them (Enrique Alba**,** 2015, p3).
As every smart housing project needs an infrastructure based on participatory smart between modern technology and individuals, the participation of the city's residents by sending their observations, needs and suggestions is a vital part of the smart city system. This participation in decision-making leads to smart governance and better rationalization of resource consumption and sustainable development, in order to improve the quality of life in urban areas (Tara Alshahadeh & Akin Marsap, 2018). Hence, the importance of integrated management description and its applications came, as the most important applications of technology to achieve integrated management are: (smart governance, open data, Internet of things, smart networks) (Kaoru Ota et al., 2017). Through a set of global studies to achieve the concept of integrated management, a theoretical knowledge framework will be built on ways and solutions to achieve it.

The set of technological studies for achieving integrated management of smart infrastructure assets in housing projects:

This paragraph includes a set of studies on solving the research problem and arriving at a set of solutions that have a direct impact on managing the structure of contemporary smart housing projects by achieving integrated management and by extracting the main major and minor vocabulary from these studies:

1- study of Oracle Corporation ,2014 comes under the title (The Challenges of Managing Public Infrastructure Projects): (Oracle Corporation**,** 2014) The current study has discussed methods to face the challenges of managing the contemporary public infrastructure sector and factors of success; the study has indicated that the successful project management requires insight into all the risks that may affect service delivery or system performance, that is encountered through predictability and inevitable modeling of risks, with the need to plan and monitor project progress at a high level to achieve better performance.

The study has specified three strategic motives for project success, such as financial management, risk mitigation, and operational excellence (innovation).The study has stressed the need for a central management platform to create a shared vision through automating and unifying information, data, procedures and decisions and modeling them with BIM programs and the presence of a unified place to manage the projects of PMO, and the study has clarified the critical role of informational data in achieving (planning, scheduling, implementation and monitoring of large-scale capital programs / better allocation of Resources and track progress / monitor and visualize project performance against the prepared plan / implement governance for change management / integration with financial and human management).

2- Rahla & Jasim Study, 2014 entitled (GIS and Integrated Infrastructural Design and Management using BIM and GIS): (Rahla Rabia M. P, Jasim Farooq, 2014) The study has examined information management to improve infrastructure and its maintenance and the optimal alternative to old traditional

approaches to creating new structures through simulation (preparing a real 3D model), Supported by a Geocoding information system using digital modeling with BIM technologies, gathering non-spatial data and geographic information systems (GIS) spatial data with storing time-related data in the fourth dimension and cost-related data stored in the fifth dimension. With the help of specific programs where the coding system associated with database to manage activities efficiently and thus reduce the cost of reconfiguration as well as work. The interoperability with an integrated approach through applications such as planning and visualization, data collection, location-based services (LBS), and virtual and augmented reality (VR & AR) reduces costs associated with interoperability and automates examination and analysis.

3- David & Stephen, 2016 study (A Systems Approach to Smart City Infrastructure: A Small City Perspective): (Paradice & Dawe, 2016) The study has dealt with the actual vision of the concept of smart cities and what is the system approach used to create a smart infrastructure for cities, as the study aimed to identify applications that enable any a housing project (with a population less than 100,000 people) to become smart by following the design science methodology, taking into account the resources possessed by the project in terms of budgets and limited technology. The study has indicated that the strategic vision of the concept of smart residential complexes requires building a set of infrastructure solutions for information and communication technology, which is an integrated data center , integrated applications , advanced communications network capable of collecting data from internet sensors (IOT) that allows data to be sent back to the city data center for processing, and by developing an operational framework that ensures the work of information and communication technology systems in an integrated way that detect errors and malfunctions proactively, allowing the system Self-healing, within an operational framework that guarantees the work of a group of efficient management systems ERP, events management system, spatial analysis.

4- David Faulkner Study, 2016 (Infrastructure for new, smart and sustainable cities) :(David Faulkner, 2016, pp. 3-6) The study has explored ways to plan new housing projects characterized by being (future smart sustainable projects) by integrating information and communications technology in the existing urban infrastructure. The study has suggested two approaches to achieve Infrastructure standards: First: existing housing complexes, as the study has proposed the idea of sharing infrastructure to reduce the cost of building and maintaining wire and wireless communication networks. This partnership is carried out with three levels are: 1- Sharing the infrastructure at the level of service centers by choosing a central location such as the main railway station, or the center of the project where high-power services are being distributed towards the terminals of the city 2- Sharing the infrastructure at the street level: It includes sharing wireless towers, as an installation of small base stations on street's lighting poles and layout with underground channels. 3- Sharing the software infrastructure: a common application platform. Second: When building a new smart city from zero point , a service is selected that deals with the total required software functions on a single platform, such as the “open data” approach, collecting all information and converting it into a common platform, such as an integrated management system at the city level.

5-International Telecommunication Union (ITU) study, 2016, entitled (Building smart and sustainable future cities): (ITU,2017) The study has established a curriculum for integrated management of infrastructure services through which an integrated management framework and procedures for any smart sustainable housing project can be represented in the form of events detected by sensors and recorded by monitoring operations through higher modeling, processing integration , and unified service of these information resources. The has stressed the necessity of managing the owners and preserving the environment by controlling pollution, water quality and monitoring in order to be protected from distracters and discovering them with the importance of economic and financial management and smart distribution of resources. The study has suggested a comprehensive design that achieves an integrated management of the smart city. Its elements are as follows:

- Technology components: 1- Urban automation 3- Sensor-based smart infrastructure
- Smart City Elements: 1- Protocols and Standards 2- Low Cost, Efficient, Safe and Flexible Information and Communications Technology 3- Smart use of Land.

6- ICE Study, 2017 titled (Smart infrastructure: an emerging frontier for multidisciplinary research): (ICE ,2017) The study has endeavored to reach a comprehensive concept to describe smart

infrastructure: as the backbone of the city, led by a wireless sensor network and defining values for smart infrastructure are: (a) Self-monitoring and accuracy in decision-making: the ability to monitor internal self-structures, preserve environmental conditions, employment to improve the accuracy and timing of decision-making (b) efficiency and cost savings, (c) reliability, (D) Security, safety and resilience, (e) user interaction and empowerment, (f) sustainability, improving decision-making, ensuring sustainable use of resources, (g) reducing redundancy by minimizing system components (h) early detection and response to critical events such as failure and external threats, (I) Low carbon dioxide emissions (j) quality of service, improved the type and the extent of services provided by the infrastructure in order to achieve the best quality of life and social productivity and economic results. The study has identified basic principles that fuel the design and smart infrastructure construction, namely: (a) data acquisition, (b) data analysis, (c) maintaining the feedback loop, (d) design for adaptability.

7- Hanan, Darwishe & Fadi, Chaaban study , 2018 entitled (Semi-Automatic Methodology for 3D Modeling and Visualization of Utility Networks in the GIS Environment): (Hanan, Darwishe& Fadi, Chaaban**,** 2018) The importance of the study lies in providing assistive tools that save time and effort in building and modeling housing projects according to a flexible and adjustable work methodology pursuant to the status and type of public services networks. It can benefit from the results in the future planning process and modeling of new cities. The study has reached to a proposal for a semi-automatic methodology for modeling and representing infrastructure networks in a three-dimensional way in the geographic information systems environment (GIS) as an aid tool in analysis, understanding, planning, management and decision-making. This methodology includes the following steps:

• Building a spatial and descriptive base for the infrastructure networks of residential complexes or small cities.

• Developing two automation tools for building 3D networks in a model environment within the program ArcGIS.

*Send the form and all its elements to a Web Scene to make it available to users and easily obtain the data associated with it.

The General Application Framework

Building the theoretical framework: Through a set of studies related to integrated management solutions for smart infrastructure, an integrated knowledge framework has been built that explains the main and minor vocabularies and its possible values and within four main vocabularies, which are shown in Table 2:

Table (2): Vocabularies of the theoretical framework for the research, the source (the two researchers)

Main vocabularies	Minor vocabularies	Methods of vocabularies fulfillment
1.Essential elements of smart buildings		
Intelligent infrastructure values	Self-monitoring and accuracy in decision-making	
	Safety, security and reliability, early detection and response to critical events	
	User interaction and empowerment, sustainability and carbon footprint	
	Minimize redundancy of system components	
	Improving the quality of infrastructure services (quality of service)	
Smart infrastructure principles	Sensors and sensors (data acquisition) smart meters	
	(Data analysis and processing) Adaptive capacity building of physical and digital system components	
Infrastructure requirements	Get inspired by global experiences and international engagement	
	Legislating laws and government facilities and providing the security aspect	
	Diversity in human and economic resources and their smart distribution	
2. Planning to raise the infrastructure		
Human Resources Management	Participation and empowerment style for the smart community	
The	Effective cooperation between stakeholders and coordination across government levels	
	Control monitoring system with planning system of institutions resources (ERP)	

Management of stockholders	Mutual independence (shared geographical location of services, approval of a service network function over another, sharing use of equipment and resources) and recycling of materials and equipment.			
Spatial organization	Spatial organization of housing services and transportation components			
	Spatial organization of support structures services	Underground space exploitation		
Risks Management	Prediction	Planning, scheduling, monitoring and visualizing the project performance		
	Innovations systems	Modeling BIM, unification and automation		
	Integration	Human and financial management	Managing the capital and Centralization of management	
3.Monitoring and control of the infrastructure				
The actual monitoring of the information centers and communications technologies ((ICTs)				
Protocols for integrating wire and wireless information technologies and common technical standards				
Upgrading the infrastructure with Information management	Content and data management tools (software)	GIS with Global Positioning System (GPS) CAD		
	Predicting THE data collection techniques (equipment)	Techniques (RFID), Electronic fingerprint technology		
		Satellites connecting: Surveillance cameras, electronic screens, human intensity monitoring devices		
	Wide-range Networks	Technologies and sensors	Optical tissues and sensors devices	
			Wireless networks (internet IOT and opened data)	
			Wire networks	
	Artificial intelligence systems	Innovative algorithms for machine learning		
4. Design for smarting infrastructure				
Infrastructure sharing (centralized services)	Services	On the level of services centers	Central site and joint passage for services	
		On level of streets: Planning with underground channels		
	Information	Sharing the infrastructure with software	Joint applications platform	
Comprehensive design for infrastructure	Technological components for infrastructure design (urban automation)		Sensor-based smart infrastructure	
	Designed elements to smart housing projects	Safe design and smart design	Principles improvement and guidelines standards of structure	
			Clever use of lands	
Design	Imitation	(Preparing a Real 3D Model) Buildings Information Modeling (BIM)		
Information With BIM and GIS technologies	Semi-automatic modeling to represent and manage the infrastructure	Geo data base & geo-processing		
		Automated networks (3D modeling)	Visual programming language, program ArcGIS	

Practical application:

The application includes the use of descriptive analytical measurement, as four research samples have been selected for international and local projects, (Dukso District Dousing Project Yongsan District Housing Project, Bismayah New City, Basra New City), whose infrastructure has been partially or totally smarted , described and analyzed according to the vocabularies of the extracted framework, and then the mathematical application has been carried out on it according to the verification of the possible values of

the theoretical framework vocabulary or not, depending on the symbol (1) for verification and the symbol (0) for non-verification:

1- Yongsan District Housing Project, Location: Seoul, South Korea, Design By: Adamson Associates Architects, 2014-2020

The project is located in Seoul City Center in South Korea with an area of 3,155,787㎡, the project buildings are of mixed use, and the project area has been proposed as it needs a new development according to the requirements of the age (HAEAHN, 2014**,** P45,46), as the project towers were fully smarted and the realization and automatic control of operations enabled self-monitoring for infrastructure, and self-monitoring of internal structural. To obtain data, an internal smart network has been created for each residential complex, connected with sensors that are installed in all aspects of the complex (junglum org., 2015, P430-438, 2016), and to achieve mutual dependence in the presence of a common geographical location for technical services, the center of the administration's operations in the central tower in the middle of the project and that being connected with a common underground services corridor, a comprehensive management approach to simulate the methods with real data through modeling and software tools for the control center. The monitoring process are carried out with radars via electromagnetic waves and following the broadcast protocols and guidance in the administration center (HAEAHN, 2014**,** P45). (Fig.1).

Figure (1): Yongsan International Project Site Plan, Source: (HAEAHN, 2014**,** P45)

2. Dukso district housing project, Location: Gyeonggi, Dukso, South Korea, Design By: Le Sang Uon, 2015

The smart housing project, which is located in the smart city of Gyeonggi near Seoul in South Korea, with an area of (91,333 m2), the project has been chosen despite its relatively small area compared to the rest of the research sample projects because it has been designed as part of the Dukso area development project to be converted into a smart province through inspiration from global experiences (Fig.2). The strategy has been identified with three main goals: to create a cognitive space for the digital economy, to provide digital content, broadband communications and digital services, to promote the search and innovation in the field of information and communication technologies, and to enhance the quality of life for individuals (junglum org., 2015, P430-438). It includes the implementation of the standards (smart cities) in the construction of public roads, areas and residential complexes. An internal smart network has been formed for the residential complex, which is linked to the main network of the smart city in which the project is located, this network connects with sensors installed in all aspects of the complex, to collect information and data on internal roads , and the rates of energy consumption and natural resources, to determine the appropriate consumption and use mechanisms. The movement of internal consumption for each housing unit has been also linked, to show its residents the volume of consumption and savings rates that can be achieved (HAEAHN, 2014**,** p230).

Figure (2) shows the site plan and project interface, source: (HAEAHN, 2014**,** p230).

3- Basra New City Project, Location: shatt al-arab district, Basra, Design by: Al Rajhi Trac, 2013-2020

The project includes the development of 100 thousand housing units, extending over an area of 23,273,000 m2, off-site infrastructure includes: access road, power station, wires and wireless communications, sewage drainage, and solid waste treatment facility as for the infrastructure inside the site are landscaping, electrical, mechanical engineering work and plumbing (Al Rajhi Trac, 2013). The use of smart energy meters and smart distribution devices that are installed in all aspects of the complex determines the rates of energy consumption. With the start of implementing the standards for smarting housing projects which are: firstly, setting priorities and secondly starting providing the area that includes the project with a smart grid, with the need for legislation and government facilities, and the use of supervisory control and access to SCADA Energy Data Integration System for project resource planning (Junglum org., 2015, P430-438). The deployment of information technology infrastructure in the city through the establishment of an access network, IP backbone based on the latest technology FTTH, OFC and U-city experience for Europe with the sharing of infrastructure in the field of software with the presence of Internet network stuff IOT (Al Rajhi Trac, 2013) (Fig.3).

Figure (3) shows an aerial view and a plan for the new Basra city project, source: (Al Rajhi Trac, 2013)

4- Bismayah New City Project, Location: 10 km southeast of Baghdad, Iraq, Design By: Hanwha E & C, 2011-2019

The city of Bismayah is located to the southeast of the city of Baghdad, on an area of 1,830 hectares and it is hoped that it will accommodate about 600,000 people and the total number of housing units is 100,000 units (Hanwha E&A, 2013,P36,37). The project is endowed with the public facilities to be developed by the Government of Iraq, including educational, religious, recreational and commercial facilities, welfare and management. The project provides biodiversity, commercial facilities, and a green belt within the city and green circular park (Fig.4). A network of integrated infrastructures will be constructed of electricity, water, main streets, traffic system, water stations, sanitation, and the electrical network, as well as social infrastructures such as schools and clinics (junglum org., 2015, p438). The project achieves smart distribution of resources and the development and preparation of human frameworks by training professionals and creating skilled workers. Resource management: cooperation in iterative design, integration of all different specialties, cooperation in construction, cooperation with owners and users, and a safe and flexible environment user by increasing the quality of services and achieving the requirements of residents (Hanwha E&A, 2013,P36).

Figure (4) an aerial view showing the administrative center of the Bismayah project, source (http://www.bismayah.org/)

Practical application to research samples:

Multiple indicators from the theoretical framework will be applied here to the selected applied samples to obtain verification results for them and discuss and analyze them later and as follows, Table (2-a, b):

Table (2-a): Practical application to research samples, the source (the two researchers)

Main vocabularies	Minor vocabularies		1-0 Verification values					
1-Essential elements of smart buildings			**Code**	**A**	**B**	**C**	**D**	**Values**
Intelligent infrastructure values	Self-monitoring and accuracy in decision-making		X1	1	1	0	0	2
	Security reliability.		X2	1	1	1	1	4
	User interaction and empowerment		X3	1	1	1	0	3
	Minimize redundancy of system components		X4	1	1	0	1	3
	Improving the quality of infrastructure services		X5	1	1	1	1	4
Smart infrastructure principles	(Data acquisition)		X6	1	1	1	0	3
	(Data analysis and processing)		X7	1	1	1	0	3
Infrastructure requirements	Get inspired by global experiences		X8	1	1	1	0	3
	Legislating laws and government facilities		X9	1	1	0	0	2
	Diversity in human and economic resources		X10	1	1	1	1	4
2-Planning to raise the infrastructure								
Human Resources Management	Participation and empowerment style for the smart community		X11	1	1	0	0	2
The Management of stockholders	Effective cooperation between stakeholders		X12	1	1	1	1	4
	Control monitoring system and resource (ERP)		X13	1	1	1	0	3
	Mutual independence		X14	0	1	0	1	2
Spatial organization	Spatial organization of housing services		X15	1	0	1	1	3
	Spatial organization of support structures services		X16	1	1	0	0	2
Risks Management	Prediction		X17	1	1	1	1	4
	Innovations systems		X18	1	0	0	0	1
	Integration		X19	1	1	1	1	4
3.Monitoring and control of the infrastructure								
Upgrading the infrastructure	Actual monitoring at (ICTs) centers		X20	1	1	1	0	3
	Protocols for integrating wired and wireless information technologies		X21	1	1	0	0	2
	Management tools data	(GIS) &) GPS)	X22	1	1	0	0	2
		(CAD)	X23	1	1	1	0	3
	Prediction of data techniques)	(RFID)	X24	0	1	1	0	2
		satellite	X25	1	0	0	0	1
	Wide-range Networks	Sensors and fibers	X26	1	0	0	0	1
		Wireless networks	X27	1	1	0	0	2
		Wired networks	X28	1	1	1	1	4
	Artificial intelligence systems		X29	1	0	0	0	1

4. Design for smarting infrastructure								
Infrastructure sharing	On the level of services centers		X30	1	1	1	0	3
	On level of streets		X31	1	1	1	0	3
	Sharing the infrastructure with software		X32	1	1	1	0	3
Comprehensive design for infrastructure	Technology elements of architecture design		X33	1	1	0	0	2
	Design elements to fuel housing projects		X34	1	1	1	0	3
	Clever use of lands		X35	1	0	1	0	2
Design Information With BIM and GIS technologies	Imitation (Preparing a Real 3D Model)		X36	0	1	0	0	1
	Semi-automatic modeling to represent	Geo data base& Geo processing	X37	0	1	0	0	1
		Automated networks (3D modeling)	X38	1	1	0	0	2
			Sum 38	34 %89	32 %84	21 %55	10 %26	

Table (2-b): Reason for giving verification value (1) to the above variables

X1: The project towers were fully fueled, automated and automated processes were enabled, enabling self-monitoring of infrastructures and internal structural self-monitoring.
X2: Reducing failure and downtime from work and work through efficient management of resources, capital, and stakeholder management
X3: The computer environment enables residents and visitors to access various services anywhere and anytime, and these services cover various areas of life, and develop the quality of life for individuals.
X4: Reducing the frequency of system components to a minimum, which achieves infrastructure economy.
X5: Adapt to the changing needs of consumers through periodic improvement and monitoring and control operations managed by the project management center
X6: Data acquisition - An internal smart grid has been created for each housing complex, connected with sensors that are installed in all areas of the complex.
X7 :Data analysis, processing and decision-making are done in the central data center.
X8: Drawing inspiration from global experiences that included: creating a knowledge space for the digital economy, providing digital content, broadband connections and digital services, promoting research and innovation in the field of information and communication technologies, and enhancing the quality of life for individuals.
X9: Adoption of principles: smart growth: developing an economy based on knowledge and creativity, sustainable growth: increasing resource efficiency and creating a sustainable and more competitive economy. Inclusive Growth: Providing job opportunities which enhances social cohesion.
X10: Diversity in human and economic resources - participatory between the public and private sectors
X11: Enabling the smart community to provide the city's residents and others with information-providing machines, including what is placed in public places, and consists of a three-dimensional screen, providing information about the complex, institutions, weather. Or in the form of a mobile phone with limited functions, this information can be accessed and developed using smart applications.
X12: Effective cooperation among stakeholders through coordination between the public and private sectors, defining a management strategy and a national plan for infrastructural stimulation and creating broadcast and direction protocols.
X13: ERP implementation is the basis for creating the smart system for the project, through which the old systems and interfaces available in the application of one rich functional system for the project.
X14: Achieving interdependence in the presence of a joint geographical location for technical services, the center of the department's operations in the central tower, in the middle of the project and connected with a joint underground corridor of services.
X15: Spatial organization of transportation components through the integration of metro stations in the project with public bus stations and providing them with the latest communication technology and the

use of open data in controlling information on transport and transferring new developments to the management center.
X16: Spatial organization of infrastructure services through the presence of a central area for service management located in the center of the project and the presence of a corridor for underground services.
X17: Managing risk by forecasting through information control that includes project planning, scheduling, implementation and monitoring.
X18: Innovation systems through the use of advanced digital systems and the BIM modeling process for building information.
X19: Centralization of the administration with the presence of the central tower of the project, which includes an integrated management and operations center for infrastructure control related to satellites, the smart electric network, the Internet of things and open data to complete information and information management and governance processes.
X20: Information technology and communication technology centers (ICTs) in the Central Administration Tower.
X21: Protocols for integrating information and communication technologies that include coordinated regulatory and business frameworks These include protecting intellectual rights, and providing competitive rates for telecommunications .The application of the concept of electronic government in the administrative centers.
X22: Content and data management tools (software) using GIS with information governance.
X23: CAD-assisted design throughout the project design and implementation phases, which ensures information and communication management.
X24: The techniques of data collection include computer networks and data transmission, multifunction phone system, audio-visual equipment, security systems and surveillance cameras, remote control devices, and radio wave recognition systems.
X25: Advanced digital cameras within a modern network and a tactical security system will be used in transportation tunnels, and fixed cameras will be used at checkpoints.
X26: Broadband Networks - Advanced fixed and wireless communication networks, GIS, GPS and RFID services, providing information in an integrated and easy way.
X27: Satellite, wireless communications and optical fiber cables provide access to all buildings and provide flexibility Providing an ISDN digital service network that enables data communication.
X28: Using artificial intelligence systems by following advanced algorithms for the automated leadership of the management center to control the operations of integrated services management.
X29: The use of artificial intelligence systems and smart self-controlled systems that can make decisions to tackle problems simultaneously.
X30: Underground space was used in the form of tunnels to extend joint technical services, which are equipped with sensors, sensors and smart meters connected to the management center.
X31: The road services infrastructure was shared in the form of energy-saving power stations as a small base on streetlights.
X32: Share infrastructure with software through a unified platform for exchanging information such as open data and internet.
X33: Achieve safe design by improving the principles and guidelines of the structure.
X34: Intelligent design, modular buildings, interconnected with the city's infrastructure, via broadband technology.
X35: Building information modeling was used to design information for the integrated infrastructure of the project with BIM and GIS technologies for simulation (preparing a real 3D model) which is spatial data.
X36: Networking automates building 3D models and using ArcGIS Environmental impact analysis, mapping levels of pollution Integrated graphics data management, created and delivered by local city infrastructure contractors. This data reflects changes to city infrastructure networks that occur across the country or project area, on a daily basis.
X37: Semi-automatic modeling to represent and manage infrastructure through the “spatial information system” environment in which the geographic information systems (GIS) operate (machines, people,

networks) and are designed and created to respond to the strategic spatial information needs of people or organizations in the form of a 3d model of a residential complex including two networks of exchange Sanitary and rainy.
X38: Automated networks (3D modeling) using BIM modeling software.

Presenting, analyzing and discussing the results:

1-Detailed analysis

1-1 The first main vocabulary (the components of infrastructural intelligence):

A- First sub-item (smart infrastructure values)

Results recorded (4) cases for each of the possible values (security reliability, improving the quality of infrastructure services), and achieved (3) cases for each of the possible values (user interaction and empowerment, reducing the redundancy of system components to a minimum) while achieving (self-monitoring and accuracy in Decision-making (2) cases of possible values.

B- The second sub-vocabulary (smart infrastructure principles)

• The results recorded achieved (3) cases of possible value (data acquisition, data analysis and processing).

C- Third sub-vocabulary (Requirements for Smart Infrastructure)

• The results recorded (4) cases have been achieved for each of the possible values (diversity in human and economic resources) and 3 (cases) have been achieved for the possible value (drawing inspiration from global experiences, legislating laws and government facilities).

1-2 The second main vocabulary (planning to smarting the infrastructure):

A- First sub- vocabulary (Human Resources Management, Stakeholder Management)

• The results recorded have achieved (4) cases for each of the possible values (effective cooperation among stakeholders) and achieved (3) cases for each of the possible values (regulatory monitoring system and resource planning system (ERP)).

B- Second sub-vocabulary (spatial organization)

• The results recorded have achieved (3) cases for each of the possible values (spatial organization, housing services and transportation components).

C- Third sub-vocabulary (risk management)

• The results recorded have achieved (4) cases for each of the possible values (planning and scheduling monitoring and visualization of project performance, financial and human management).

1-3 The third main vocabulary (Infrastructure monitoring and control):

A- First sub-vocabulary (content and data management tools (software)

• The results recorded have achieved (4) cases for each of the possible values (wideband networks, sensor and sensor technologies, wireless networks, wired networks) within the development of the infrastructure in information management.

• The results recorded (3) cases have been achieved for each of the possible values (actual monitoring at ICTS centers), content and data management tools (software), computer-aided design (CAD).

1-4 The fourth main vocabulary (design to smarting infrastructure):

A- First sub-vocabulary (infrastructure sharing)

• The results recorded (3) cases have been achieved for each of the possible values (sharing services, sharing information).

B- Second sub- vocabulary (comprehensive infrastructure design)

The results recorded (3) cases have been achieved for each of the possible values (safe design and smart design), while the information design achieved one case forming the lowest ratios for each of (simulation, semi-automatic modeling).

2- the overall analysis

2-1 patterns of applied projects

• The results recorded (34) conditions have been investigated for the possible values for each of (infrastructure factors).

• The results recorded have achieved (32) cases of the possible values for each of (planning to infuse the infrastructure).

• The results recorded the achievement of (21) cases of the possible values for both (monitoring and control of the infrastructure).

• The results recorded have achieved (10) status of the possible values for each of (design to whet the infrastructure).

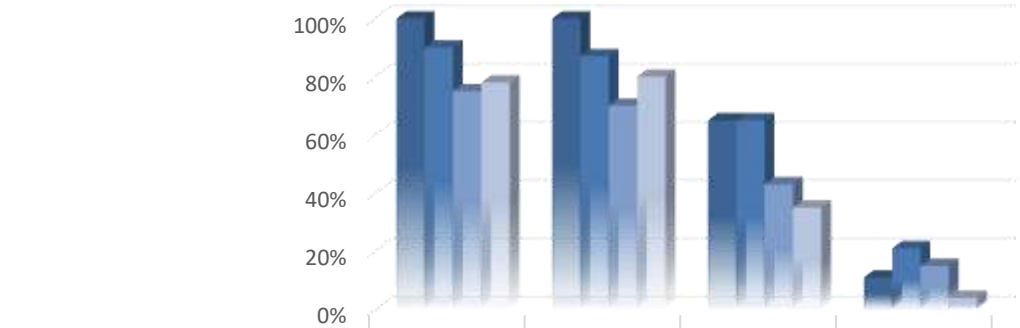
2-2 the main and sub-vocabulary

• The results recorded the achievement of (31) statuses of the possible values for the first main single (constituents of construction intelligence) out of a total of (40) cases, divided into (16) states for the possible values of the first sub-vocabulary (smart infrastructure values) of the total of (20) and (6) Status of possible values for the second sub-vocabulary (principles of smart infrastructure) out of a total of (8).

- The results recorded have achieved (25) cases for the possible values of the second main vocabulary (planning to stimulate the structure) out of a total of (36) cases, divided into (11) cases for each of the possible values for the first sub-vocabulary (human resources management, stakeholders management) and the second sub- vocabulary (Ethical Dimension) from the sum of (13) for each one.
- Results recorded have achieved i (21) cases for the possible values of the third main vocabulary (monitoring and control to develop the performance of the structure) out of a total of (40). The results have recorded verification (20) cases of possible values for the third main vocabulary (design to whet the structure) out of a total of (36) cases, divided into (9) cases for each of the possible values for the first sub-vocabulary (infrastructure sharing) out of a total of (12) and the second sub- vocabulary (comprehensive infrastructure design) has achieved (7) out of a total of (12) for each one.

3- All vocabulary in general

The results recorded have achieved (97) cases of possible values overall for all major and sub-items of total (186). (Fig. 5)



	A	B	C	D
the components of infrastructural intelligence	100%	100%	65%	11%
planning to smarting the infrastructure	90%	87%	65%	21%
Infrastructure monitoring and control	75%	70%	43%	15%
design to smarting infrastructure	78%	80%	35%	4%

Figure (5) Results of the four-vocabulary test within the application vocabulary

Conclusions:

Through the theoretical side, the research has reached to the following conclusions:

- The research has confirmed that the availability of infrastructure services in an integrated manner has an impact on the quality of life in housing projects, a goal that is achieved through efficient management of the infrastructure that is an organized and integrated process to be controlled and monitored from the initiation stage of the project through planning, implementation and operation, up to monitoring Periodic maintenance. This integration process is based on the integration of all project management branches from time, scope, quality, project costs management, incoming management and communications.
- The research has indicated that it is possible to make a leap in technology in the developed countries and to face the increasing urban expansion in developing countries in order to face the challenges and achieve the future balance. By integrating smart systems technology in the context of physical assets, which is called as " smart infrastructure", which provides a comprehensive design for each of (human resources, technical and information service structures, technological and knowledge innovation, environmental through resource management).
- Smart infrastructure can be described as the backbone of cities and contemporary complexes, driven by a wireless sensors network.
- Previous proposals for contemporary infrastructure services participated in the study of the effective role of smart systems in controlling the operations of smart infrastructure assets services, but the extent and diversity of these solutions with ambiguity of vision in the presence of an integrated general framework represents a base that encircles and joins the work of this set of solutions within one framework. This calls for the need for an integrated management platform. Therefore, the previous, diverse, and intertwined proposals formed a basic information base for shaping the theoretical framework for solving the research problem.
- Achieving the smart management vision by shifting from "system to systems" with benefits greater than the sum of its parts through the integrated management of infrastructures, its operations and transactions of its citizens will be one of the specific features of any smart housing project, which is one of its most important applications: the open data system, the Internet of things , smart networks achieve smart governance.
- Through the theoretical side, the strategy for smarting the existing and new housing complexes can be defined in two stages:

1- Technical intelligence: includes finding an internal smart network connected to sensors that are installed in all aspects of the complex, to collect information and data on movement on the internal roads of the complexes, and energy consumption rates and natural resources.
2- Information Intelligence: Achieving information intelligence requires three main stages:

- Create a local cognitive space for the digital economy and provide digital content, broadband communications and digital services, B- Promote search and innovation in the field of information and communication technologies, C- Enhance the quality of life for individuals, smart transport, electronic health care.
- Through the results of the practical application, we conclude that there is a discrepancy in the application of solutions to achieve integrated management associated with smart systems between the four research samples. In general the ratios of infrastructure intelligence increased, as they represent the principles and the legal and legislative framework, and they serve as a cornerstone for achieving the infrastructure for services, and achieved the model (A) The highest ratios in achieving the basic elements , planning, design, monitoring and control to smarting the infrastructure. This proves the validity of the research hypothesis, and we conclude the adoption of the achievement of integrated management related to the role of smart systems in managing infrastructure for housing projects on complex essential elements for infrastructure, with planning, design, monitoring and control to smarting infrastructure.
- As for the application models, the duukso District Housing Project has achieved the highest proportions and within the four vocabularies of the application (essential elements, planning, design, monitoring and control to make the structure smart) and with a rate of up to 89%. Thus, it is considered a smart housing project based on an intelligent infrastructure for technical services presenting a good standard of living and high quality of services to its residents, achieving solutions to meet the challenges facing the contemporary infrastructure sectors and a reference that draws benefits from its experience in establishing smart housing projects.
- Global projects have achieved a higher rate in terms of achieving (the elements of infrastructural stimulation), as it became clear that diversity is available in human and economic resources, smart distribution of resources, provision of the security aspect, and adopting inspiration from global experiences with legislation, government facilities and international participation. Whereas, the paragraph “Infrastructure stimulation” came next in terms of achieving resource management and stakeholders, spatial organization, risk management and events. Whereas, the paragraph (Monitoring and Control for Building stimulation) came last in terms of creating protocols, forecasting and information management, as the work of smart systems is shown in an integrated manner in these projects.
- As for the local project in the new city of Basra, it achieved a good percentage as an experiment to stimulate the local structure in planning to stimulate the structure with a partial investigation in the design to stimulate the structure with a clear weakness in the implementation of the principles and structure stimulation requirements, which determines the urgent need for attention locally in preparing the elements of stimulation to promote and elevate the local structure.

Recommendations

• The necessity of having legislations, and legal facilities and adopting the principles and protocols for converting existing contemporary cities and housing complexes from traditional to smart one.

• The importance of the planning vision: Any attempt to stimulate the infrastructure requires the presence of advance planning of resources, management of stakeholders and human resources, and site and geographical planning.

• Design: The shift in design methods must be ensured by using the principles of smart and security design, using geographic location by investing underground space, and joint use of land and equipment.

• Technology stimulation: The necessity of introducing contemporary technology and developing a plan for dealing with the Internet, deploying sensors devices and enabling individuals to deal with them.

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