ISSN: 0974-5823 Vol. 6 No. 3 December, 2021

International Journal of Mechanical Engineering

Presenting a Smart Model of Marketing Status Based on Digital Content in Implementing the Building Management System (BMS) with an Artificial Intelligence Approach

Mohammad Amin Kaviani Pour

Master of Engineering , School of Civil Engineering, College of Engineering, Univ. of Tehran, Tehran, Iran. E-

ABSTRACT

The key purpose of this paper is to present a smart model of marketing status based on digital content in implementing the building management system (BMS) in the country's construction firms by artificial neural networks toolbox and fuzzy logic in Matlab. Effectually, the "BMS components success" status can be numerically and precisely examined by the smart system: from an ideal criticality point of view, if the status of the "temperature control and ventilation system marketing of the BMS (X1)", "closed-circuit surveillance camera system marketing of the BMS (X2)", "emergency power supply and intelligent lighting system marketing of the BMS (X3)", "safety and fire alarm system marketing of the BMS (X4)", and "central antenna and telecommunication signal distribution system marketing of the BMS (X5)" are desirable, that is precisely 0.813, 0.824, 0.819, 0.812, and 0.813 respectively, then the "BMS components' success" status is at "excellent (fifth)" level, that is precisely 0.952. Concerning the linguistic variables' membership functions by the experts, the value 4.76 within a 5-folded range of values in a period defined for the "excellent" linguistic variable, which is the BMS components success status with the programming codes [0.815; 0.812; 0.819; 0.824; 0.813], is precisely calculated as being 0.952.

Key words: *"Building Management System (BMS)"; "Digital Content-Based Marketing (DCBM0"; "The Country's Construction Firms"; "Artificial Intelligence"; "Matlab Programming Environment"*

1. Introduction

Following the fast-paced technological advancements starting from the second half of the twentieth century and their vast usage, the present-day life became exceedingly different from the lifestyle of the previous centuries, dramatically impressed by the said developments (Feyzi et al., 2019; Iddianozie & Palmes, 2020; and Yang et al., 2020). In the meantime, some urban engineering intellectuals believe that by the novel communication, information, and electronic city (the smart building management system) technologies, today's existing problems of the cities shall be addressed on one hand, and these tools shall be driven towards the enhancement of the urban life quality on the other (Feyzi et al., 2019). The building management system is a computer-based system installed inside the buildings to control and supervise the buildings' mechanical and electrical in-built equipment (such as ventilation, lighting, power system, fire alarm, and safety) (Iddianozie & Palmes, 2020; Le et al., 2019; and Mendonça et al., 2017). The building management system is composed of software and hardware components. Hardware is usually implemented specifically by microcontrollers, and software may be specifically constructed for the system. The control and monitoring software may be used for controlling and monitoring the functions of various parts in some of the systems (Touš et al., 2014; and Yudelson, 2008).

Today, conversely, marketing is addressed as the key subject of competition and growth among all businesses (Ghanbarzadeh et al., 2019) and this horizon gained more importance regarding the soaring growth of sciences and the customers' changing habits and behaviors. Today, marketing should achieve a more elevated objective than just selling the products. That is customers' satisfaction and which ultimately leads to their "loyalty" (Rezvani et al., 2019; Yudelson et al., 2008; and Ghanbarzadeh et al., 2019). Considering the massive acceptance of the websites providing online channels and services by the internet users, one of the most instrumental and optimal methods in terms of inexpensiveness, practicality, and attractiveness for the users nowadays is exploiting content-based marketing techniques (Rezvani et al., 2019). The term content-based marketing refers to those activities associated with the websites content production and updating to attract and retain the website users (Müller & Christand, 2019; Bu et al., 2020; and Ghanbarzadeh et al., 2019):

Who do you create the content for?

What advantage does the content offer to the users and which of their problems is it supposed to solve?

How will the intended content become unique?

In which format and where the content will be distributed?

How are you planning to design and manage the production and dissemination of the contents? (Müller & Christand, 2019; and Mirakhorli & Dong, 2018).

The issues addressed by this study may be the doubtful and exhausted decision-makers and managers of the nationwide construction firms in the implementation of the intelligent building management system as a result of combining various marketing strategies for the temperature control and ventilation, closed-circuit surveillance camera, emergency power supply and intelligent lighting, safety and fire alarm, and central antenna and telecommunication signals distribution systems of the BMS in line with the fulfilment of its components' success. On the other hand, the need for utilizing the smart system addressed by this study to increase the trustfulness and reliability of the decisions, as well as the need for multiple specialties through the utilization of the experts' knowledge in various areas to solve the problem of the BMS components' success, made this study premier in presenting an intelligent system for the marketing status smart model based on digital content in the implementation of the BMS called BMS-DCBM.AI.

2. The Theoretical Bases of the Study

The building management system can be used in the buildings, offices, workshops, warehouses, stores, commercial and economic centers, and wherever people are present (Le et al., 2019; and Mendonça et al., 2017). The security systems are implemented in various ways. The use of motion detection sensors or closed-circuit cameras are among the protective methods adopted in the buildings (Xu et al., 2020; Touš et al., 2014; and Yang et al., 2020). The applications of the building management system are as indicated in the following table (Mendonça et al., 2017; Sonawane & Chaudhari, 2012; Xu et al., 2020; and Touš et al., 2014):

Table 1. The applications of the building management system

The applications of the building management system	To protect the building and the lives of people against fire, gas leakage, etc.
To smartly control motions into and out of the building	To protect the building against robbery (security alarm or closed-circuit camera)
To smartly control the amount of light, temperature, humidity, and other flexural parameters of the building	The option of turning the electrical devices on and off remotely (by telephone)
To turn off the lights if no one is in the room	To annually restore all system costs through energy saving
To turn off the electrical devices if not in use	To smartly control watering
To set uprestrictions on using telephone, gas, water, electricity, etc.	Smart voice system
To give alarms if doors, windows, curtains, etc. are open or left open	To control the filters, temperature, and the impact of the sunlight on the pools
To turn off the light if no one is in the room	To protect the building and lives of people against fire, gas leakage, etc.

One of the applications of the sensors used in the building management system is their interaction with the building's information modeling (or their simultaneous use with laser scanning systems) to examine the current conditions of the building and to make decisions to conduct repair and maintenance operations and plan for preventive repair and maintenance measures in the building (Le et al., 2019; and Mendonça et al.; 2017). On the other hand, the possibility of modeling the building information to evaluate the building's energy alongside the energy usage analysis in the building management system can lead to the synergy of this possibility with the two technologies. The sensors used in the building management system are as follows (Iddianozie & Palmes, 2020; Le et al., 2019; Touš et al. 2014; and Yudelson, 2008):

Table 2. The sensors used in the building management system

BMS Sensors	Descriptions
Door and Window Sensor	It is a battery-powered wireless sensor. It is used for indicating that the doors and windows are (left) open. It can also be used to control the motions and give alarm upon unauthorized entrances. Furthermore, it can be used as a temperature sensor in the process of temperature control or as a sensor with binary input.
Flood Sensor	Piping faults are among issues that can exert excessive damages to a building if not duly detected. A solution to detect leakage is to activate flood leakage sensors. The available sensors can inform the user about dangerous leakages or sudden temperature rise or drop with high precision.
Smoke Sensor	Small devices as they are, smoke and heat sensors let the smoke in their detection chamber through their perforated screen, and it takes a little deal of smoke to activate them provided that they are small in size
Motion detector	Motion detectors are of numerous applications in houses and buildings. For instance, they are activated with every motion a person makes and they turn on the lights. They are then deactivated after a predetermined duration and turn off the lights, which reduces the power usage in the buildings or houses.

One of the key subjects we are witnessing increasingly utilized as technology advances today (Kamalou et al., 2020), is the building management system or BMS. The excessive extensity and advantages this system bears for different environments (Iddianozie & Palmes, 2020; and Le et al. 2019) has made those intending to use the building management system in Iran encounter various questions like what BMS is, how much is its price, and how is it designed (Kamalou et al., 2020). It can be obviously depicted that one of the important challenges humans encounter today is energy efficiency. On the other hand, the limited energy resources and environmental pollutions are among problems engaging the world at the time being (Borhan et al., 2019). In the meantime, solutions should be found to optimize and reduce energy usage while effective measures should also be taken for doing so. Among these measures is using an intelligent building strategy. The utilization of this strategy and adopting intelligent management systems in the buildings lead to a range of savings including time and cost economization and less errors (Touš et al., 2014; and Yudelson, 2008) In general, the purpose of implementing the intelligent management system in buildings can be to adapt the application of the components of buildings with environmental conditions (Borhan et al., 2019). The association of hardware and software shall be disembarked using such protocols as LonWorks, BACnet, XML, SOAP, DeviceNet, MODBUS, USP, LAN, RS-232, etc. The main components of this system are 1) The central controller, 2) the local controller, 3) the internet-based controller, and 4) the sensors. The subsystems of smart building are indicated in the table below (Iddianozie & Palmes, 2020; Xu et al. 2020; and Yang, et al. 2020):

Table 3. The subsystems of smartbuildings

The subsystems of smart buildings	Telephone lines system
Temperature and ventilation control system	Central antenna and signal distribution system
Smart lighting control system	Emergency power feed system
Closed-circuit surveillance camera system	Emergency lighting system
Motion control system	Disaster response system
Fire alarm and distinguisher system	Water, gas, and electricity usage measurement and control system
Data distribution system	Systems integration system

A mechanism of combined energy distribution with heating system and combined power, and transforming light energy to electricity is addressed to facilitate a smart reduction of energy usage in the buildings (Shah Rahmani et al., 2020), which is a cooperative game with a performance resulting in the profitability of the cooperation where a single source of energy receives two forms of energy in the consumption site, which is the heat and electricity energy generator, and the technology of transforming the light energy to electricity works with semiconductors (Mendonça et al., 2017; and Sonawane & Chaudhari, 2012). To minimize the costs of exploiting the cooperation, it is consolidated with the response and demand game, in which the users can simultaneously set up their heat and electricity loads. To support the cooperative game, a two-leveled rewarding plan is designed to serve fairness to the participants and to reduce the computational complexity (Xu et al. 2020; Touš et al., 2014; and Shah Rahmani et al., 2020).

On the other hand, content marketing is different from advertising in many ways. In content marketing, the contents are disseminated in the media owned by the businesses, while if the interested contents are disseminated in other media, they will be called advertisement. Also, the content marketing strategy is more attractive than the advertisement as an aggressive tool, and it does not bother and disoblige the audiences. Moreover, advertisements are too costly, while content marketing does not incur that much of cost (Yudelson, 2008; and Bu et al., 2020). Content marketing helps businesses exploit reliable and economic sources to increase their website traffic and lean manufacturing, and to manage those sources. Weblog posts are not the only means of increasing website traffic. The reasons why adopting the content marketing strategy is important are as follows (Müller & Christand, 2019; Mirakhorli & Dong, 2018; Sonawane & Chaudhari, 2012; and Hollebeek & Macky, 2019):

1. Trust-building for the visitors: the more the audiences trust the information it provides, the more likely they would purchase the products. Also, when the readers constantly read the contents of a brand, their viewpoint would change about it, not only in terms of credit but also the interest they develop for it.
2. Brand awareness: one of the most common purposes of content marketing is to elevate brand awareness. The main objective is for the audiences to see their valuable produced content and to make a response. This would imply a business's extent of specialty (Mirakhorli & Dong, 2018; Rezvani et al., 2019; Yudelson, 2008; and Bu et al., 2020).
3. SEO improvement: by producing high-quality content, more visitors would be attracted to the website and the traffic would increase. The search engines' algorithms are constantly changing. But as far as businesses constantly produce related and informative content with suitable keywords and updating of the contents, it will be placed on topper place in the search engines. This would lead to an increased number of visitors through SEO improvement (Müller & Christand, 2019; and Mirakhorli & Dong, 2018).
4. Lean manufacturing or marketing lead: building trust and awareness are the requirements of every business. But perhaps the most important purpose of the majority of businesses is lean manufacturing as a result of content marketing. Content marketing makes the unfamiliar individuals reach out to the business through the useful and informative information included in the content. To translate the website and weblog traffic into

lean and agile manufacturers and ultimately to train lean manufacturers in the purchase cycle and turn them into purchasers is among the most important objectives of content marketing (Mirakhorli & Dong, 2018; Hollebeek & Macky 2019; and Yudelson, 2008).

5. Attracting ideal audiences: lean and agile producers play an extremely important role in the marketing process, while incompetent manufacturers lead the business nowhere. A business should attract real customers. The positive point about content marketing is that only those parties interested in the business and its professional ground would follow the business content. Therefore, those who search materials about the commercial establishment's business in their browsers would see its content and register in the related forms, and they are the ones whom the sales team should invest in (Yudelson, 2008; and Mirakhorli & Dong, 2018).
6. Turning the visitors into lean and agile manufacturers by training lean and agile manufacturers through the customer journey. The customer journey includes three main steps namely awareness, consideration, and decision-making. Considering the presented content would help the audiences in every step of the customer journey to follow the customer to the end of the sales funnel (Müller & Christand, 2019; and Sonawane & Chaudhari, 2012).

The present study goes on by presenting its internal and external history up to 2020:

In their study in 2020, Iddianozie et al. presented a business model of assessing the role of smart sustainable cities to address the semantic heterogeneity in the building management systems using discriminant models. They reflected that the building management systems previously used in the smart cities only in massive buildings with vast mechanical, electrical, and piping systems for economic considerations, can now be used in every building of smart cities.

In another study Bu et al. carried out in 2020, digital content-based marketing was analyzed as an accelerator of the WOM electronic marketing technique in culinary tourism. They have depicted that important subjects of digital content-based marketing include the basics of electronic marketing, the online consumers' behavioral pattern, digital commerce marketing context, various methods of online marketing, online marketing technologies, customer relations management (CRM), techniques of communication with the customers, varieties of online advertisements, costs and benefits of marketing communication and the standards of electronic marketing, and "internet-based marketing" in culinary tourism.

Müller & Christand conducted a research in 2019 in which they studied the impact of content marketing, sponsored and generated content by the user on the trade brand's responses. In fact, they reported that "internet-based trademarks", "websites", "content", "website enhancement", "web-based advertisements", "the visitors' behavior analysis", "direct marketing", "e-commerce", "public relations and the press", "marketing research and studies", "marketing discussions", and "internet connection" hold an important position in content marketing sponsored and generated by the users.

A study by Li et al. in 2019 identified and reviewed the association of the smart-building management system and the business model of the internet-of-things (IoT) in Vietnam. They have explained that one of the important factors that economically justifies the building management systems is the utilization of the internet-of-things to economize energy consumption.

In their study in 2017, Mendonça et al. provided a model to assess the role of marketing in material construction of artifacts based on a case study on a Portuguese navigational system company. They have explained that construction artifacts hold the following properties: cutting hardware costs; improving flexibility to the ambient changes.

Sonawane et al. conducted a research in 2012 to identify and study the associations of marketing relations with product-based marketing in residential buildings business. They expressed that high costs of water, electricity, gas, telephone, and other bills as well as the existing need for more savings in their consumption require a smart controlling system.

In Yudelson's research carried out in 2008, the relationship of marketing experiences in the field of green building marketing was identified and studied. They explained that a smart green building has the following facilities: the possibility of utilizing smart systems of lighting control to make special lightings and to control the light switches by remote controls.

In a study by Kamalou et al. in 2020 in which address the implementation of the building management system, they tried to concisely review and carry out the BMS system for a vocational training institute in Minab city. In Iran, those who seek to carry out building management systems, face various questions including "what is BMS", "how much is the price of BMS", and "how the BMS is designed".

The research of Shah Rahmani et al. in 2020 shows that energy usage behaviors in terms of heat and power can be adjusted by the consumers to reduce the cost of response and demand game, and while the profit improves, the costs are cut. The retrospective findings are provided in the form of tables and charts. This model of game algorithm assists in the evaluation of pros and cons of energy sharing in the building.

The purpose of the study conducted by Borhan et al. in 2019 was to become familiar with the definitions, to recognize the components and equipment related to the smart management system, to do investigations on economics, technical requirements, and the utilization of this system to control and optimize energy consumption. Finally, the subjects will be further understood by the statistics, figures, and schematic analysis. The research method of this paper is of descriptive-analytic type and the contents are collected through desk surveys.

The 2019 study of Feizi et al. investigated if the theory of smart city based on the electronic city models proposes a set of desirable residence standards including sustainable development, popular participation, and empowering urban integrity. This article intends to study lighting and smart systems.

Finally, the following table compares the most important results and findings of the present study with those of the most relevant studies in the theoretical literature:

Table 4. A comparison between the results of the most relevant studies with those of the present study

Comparison of the findings of the study																
Case study on the Iranian construction firms	Validation of the research	Expert system	Fuzzy logic	Statistical analysis	Artificial neural networks	Matlab programming environment	Central antenna and telecommunication signal distribution system marketing of the BMS	Safety and fire alarm system marketing of the BMS	Emergency power supply and smart lighting system marketing of the BMS	Closed-circuit surveillance camera system marketing of the BMS	Temperature control and ventilation system marketing of the BMS	Digital Content-Based Marketing (DCBM)	Building Management System (BMS)	marketing	Construction	Source
-	*	-	-	-	-	-	-	-	-	*	*	-	*	-	*	Iddianozie & Palmes. 2020
-	*	-	-	-	-	-	*	*	-	-	-	-	*	-	*	Le, et al. 2019
-	*	-	-	-	-	-	-	-	*	-	-	-	-	*	*	Mendonça, et al. 2017
-	-	-	-	-	-	-	-	-	*	-	-	*	-	*	*	Sonawane & Chaudhari. 2012
-	-	-	-	-	-	-	-	*	-	-	*	-	-	*	*	Yudelson, 2008
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	The present study

A review on the theoretical basics and background of the study revealed that despite research gaps in knowledge domains of the temperature control and ventilation, closed-circuit surveillance camera, emergency power supply and intelligent lighting, safety and fire alarm, and central antenna and telecommunication signal distribution system marketing of the BMS aiming for the success of the BMS components, and lack of a system to provide the managers with decision-making recommendations, the innovations of the present study to fill the existing research gaps is well understood. A review on the accomplished modeling projects available at the Scopus, ScienceDirect, Springer, Irandoc, and the Islamic World Science Citation Center databases, as well as the dissertations archived at Tehran University, it was revealed that no similar study is conducted aiming to provide a smart model of digital content-based marketing position in the implementation of the building management system (BMS) with an artificial intelligence approach.

3. Methodology

This is an applied-modeling study in purpose, because on one hand it precisely describes the concepts and rules associated with the smart model of digital content-based marketing in the implementation of the BMS, and on the other hand the association of these concepts and rules are assessed and determined by the experts. One of the most important reasons to use artificial neural networks and the fussy system in this paper is that the real world matters bear a complicated structure that shows ambiguity and uncertainty in their definition and understanding. Ever since man could think, he has always encountered ambiguities in various social, technical, and economic matters (Lin & Lee 1996; and Keshavarz Mehr, 2012). The human brain defines and validates the phrases by considering various factors and on an inferential thoughtfulness basis, the modeling of which in mathematical language and formula is an extremely complicated task, if not impossible. The linguistic variables are depicted based on the linguistic (verbal) values encompassed by a set of terms (terms/terminology), given that the linguistic terms are properties for linguistic variables. The term "linguistic variables" refers to those variables whose verified values are the human and machine language words and sentences instead of numbers (Lin & Lee 1996; and Keshavarz Mehr, 2012). A fuzzy number is a specific fuzzy set where x takes true values of R set member and its membership function is $\mu_{\tilde{A}}(x)$ as follows (Azar and Faraji, 2010; Lin & Lee 1996; and Keshavarz Mehr, 2012):

Formula (1)

$$A'=\{(x, \mu_{\tilde{A}}(x)) \mid x \in X\}$$

The following classification draws that how the fuzzy logic and neural system are associated from this point of view (Lin & Lee, 1996; Mishra & Mohanty, 2016; Keshavarz Mehr, 2012; and Moayer & Bahri. 2009):

Concurrent Neuro-Fuzzy Models: the neural network and fuzzy system interact on a single task, but not affecting one another. None is used to determine the other's parameters. In this model, the neural network is usually adopted to preprocess the fuzzy system's input or output.

Cooperative Neuro-Fuzzy Models: the neural network is used to determine the Fuzzy system's parameters. These parameters include fuzzy rules, the weight of the rules, and the fuzzy sets.

Hybrid Neuro-Fuzzy Models: the neural network and fuzzy system are combined in a harmonic architecture. This model can be referred to as a neural network with fuzzy parameters, or a fuzzy system with distributed learning. ANFIS, ANNBFIS, NEFClass, and FLEXNFIS are some examples of this model.

Finally, regarding the applications of the smart system designed in this study, 5 phases of its design are considered in the light of the studies carried out by (Lin & Lee, 1996; Keshavarz Mehr, 2012; Mishra & Mohanty, 2016; and Moayer & Bahri. 2009) as follows:

1. To model the concepts of BMS components success context to identify the input and output variables and to draw their associations
2. To define the qualitative variables through linguistic constraints and to allocate them with numbers and fuzzy sets and their membership functions
3. To design a smart system based on the definitions and designs carried out by Matlab software: this phase includes extracting expertise rules and their evaluation by the experts and establishing a fuzzy rule base and an inferential search engine with access to the fuzzy rules.
4. To design a user interface and the fashion of displaying the options and to use the designed smart system

5. To choose a method of defuzzification to convert the numbers and fuzzy sets to a decisive value for a real-world study of the system function.

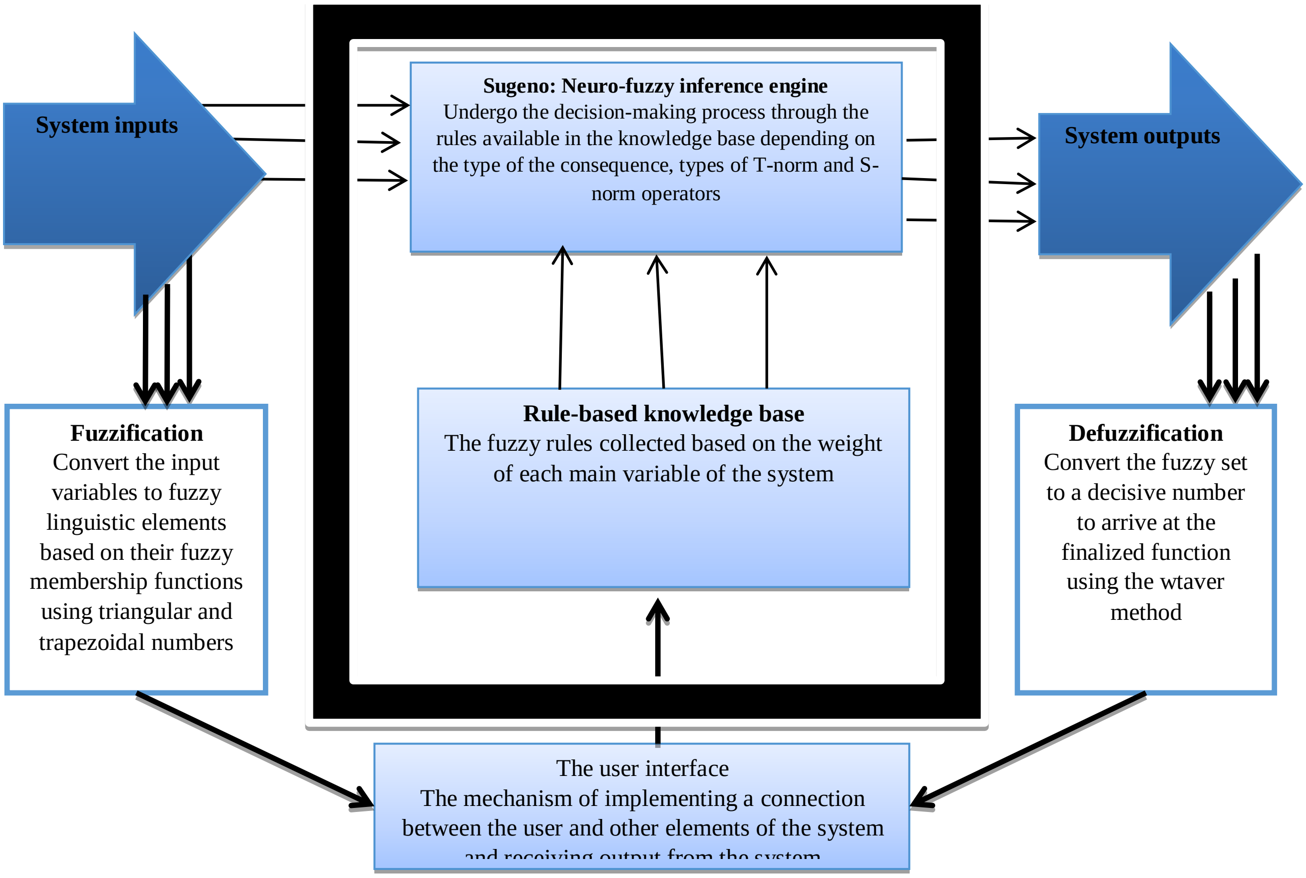


Chart 1. The structure of the smart system of the study

The below table shows the validation tool of the smart system for the BMS components' success (BMS-DCBM.AI) to assess the responses of the system hereby studied:

Table 5. The validation tool of the smart system

Rule number	**The input elements of the smart system**					**The output elements of the smart system**	**analysis**
	and ventilation system marketing of the BMS	closed-circuit surveillance camera system marketing of the BMS	power supply and intelligent lighting system	safety and fire alarm system marketing of the BMS	telecommunication signal distribution system	Success status of the BMS components	
.							
.							
.							

4. Data analysis and system design

The population of this study can be divided into two main groups including group number one consisted of expert professors, and group number two consisted of experts operating in the nationwide construction industry or similar posts in a construction company. Finally, after handing out 100 questionnaires, the sample of the study encompassed 96 available experts willing to cooperate through a combination of two sampling methods of nonprobability targeted sampling (judgmental) and snowball sampling. The data of the measurement tool number 1 (the modeling tool of the study), and number 2 (the validation tool of "the smart system for the smart model of digital content-based marketing position in the implementation of the BMS") were collected in early summer of 2020 and late summer of 2020 respectively.

Based on the expertise comments and experiences of the managers and senior expert in the nationwide construction firms, as well as those of the university professors, the most critical criteria related to the variable of "temperature control and ventilation system marketing of the BMS (X1)" include presenting precise HVAC information to the customers with an average of 5.80, and customer services for the HVAC system with an average of 5.91; the most important criteria related to the variable "closed-circuit surveillance camera system marketing of the BMS (X2)" include CCTV system installation and deployment services with an average of 5.93, and CCTV instructions training services with an average of 5.92; the most important criteria related to the variable "emergency power supply and intelligent lighting system marketing of the BMS (X3)" include website content on UPS with an average of 5.91, and brand management of the UPS with an average of of 5.95; the most important criteria related to the variable "safety and fire alarm system marketing of the BMS (X4)" include utilizing fire sprinkler system with an average of 5.83, and utilizing the building data security system with an average of 5.67; the most important criteria related to the variable "central antenna and telecommunication signal distribution system marketing of the BMS (X5)" include DBMS building database services with an average of 5.91, and services related to the building's telephone lines with an average of 5.91. From another perspective, the ranking of the study variables based on the weighted average of the ideal criticality of its indicators includes closed-circuit surveillance camera system marketing of the BMS with the weighted average of criticality equivalent to 5.765, emergency power supply and intelligent lighting system marketing of the BMS with the weighted average of criticality equivalent to 5.730, central antenna and telecommunication signal distribution system marketing of the BMS with the weighted average of criticality equivalent to 5.703, temperature control and ventilation system marketing of the BMS with the weighted average of criticality equivalent to 5.690, safety and fire alarm system marketing of the BMS with the weighted average of criticality equivalent to 5.682 as calculated respectively. While the variables concluded by the study, based on the weighted average of the functioning status of its indicators are emergency power supply and intelligent lighting system marketing of the BMS with the weighted average of status equivalent to 4.903; closed-circuit surveillance camera system marketing of the BMS with the weighted average of status equivalent to 4.752; central antenna and telecommunication signal distribution system marketing of the BMS with the weighted average of status equivalent to 4.683; safety and fire alarm system marketing of the BMS with the weighted average of status equivalent to 4.577; temperature control and ventilation system marketing of the BMS with the weighted average of status equivalent to 4.562 as determined. The table of the study variables reliability figures indicates its high reliability proportionate to its data collection tools:

Table 6. The information related to the study variables reliability figures

Study variables	Chronbach's α	Number of items
Temperature control and ventilation system marketing of the BMS (X1)	0.916	6
Closed-circuit surveillance camera system marketing of the BMS (X2)	0.909	6
Emergency power supply and intelligent lighting system marketing of the BMS (X3)	0.924	6
Safety and fire alarm system marketing of the BMS (X4)	0.863	6
Central antenna and telecommunication signal distribution system marketing of the BMS (X5)	0.926	6
The overall reliability of the study variables	0.983	30

Here, the average Chronbach's α is over 0.9 for the study variables, which shows that the reliability of the study's modeling tool is ideal. In the present study, a smart system is a system whose input information may be imprecise, that is the input information of a fuzzy system are in form of fuzzy sets or numbers. On the other hand, a fuzzy system's processes may be carried out imprecisely. One of the most renowned and practical imprecise processes in fuzzy systems is the use of fuzzy rules base. In a fuzzy rules base, every rule is defined by an "if-then" format. Regarding the application of the smart system designed by this study, five phases of the smart system design of the study are lastly considered as follows:

Phase one – identifying the system input and output variables: the input and output variables of the smart system were defined after the model of the smart system proposed by this study was finalized. The input variables of the smart system for the BMS components success are temperature control and ventilation; closed-circuit surveillance camera; emergency power supply and intelligent lighting; safety and fire alarm; and central antenna and telecommunication signal distribution systems marketing of the BMS, all under the governance of the organization's information technology. The output variable of the smart system is "the BMS components' success". Regarding the model proposed by this study and the implementation of the experts' comments in assessing the model, the input and output variables of the smart system can be loaded on the system.

Phase two: defining the qualitative variables by using linguistic constraints and allocating them with fuzzy numbers and sets, and membership functions. The table and figure indicate the linguistic variables, fuzzy values, and membership functions of triangular and trapezoidal numbers associated with the input and output variables of the smart system studied here, inside 3 and 5-fold spectrums:

Linguistic variable	Persian equivalent	Membership functions of triangular numbers
Low	کم	(0.3 0.15 0)
medium	متوسط (معمولی)	(0.7 0.5 0.3)
High	زیاد	(1 0.85 0.7)
ANFIS system training data		
0,0,0,0,0,0		
0-0.05,0-0.05,0-0.05,0-0.05,0-0.05,0.1		
0.05-0.15,0.05-0.15,0.05-0.15,0.05-0.15,0.05-0.15,0.2		

0.15-0.30,0.15-0.30,0.15-0.30,0.15-0.30,0.15-0.30,0.3
0.3-0.4,0.3-0.4,0.3-0.4,0.3-0.4,0.3-0.4,0.4
0.4-0.5,0.4-0.5,0.4-0.5,0.4-0.5,0.4-0.5,0.5
0.5-0.6,0.5-0.6,0.5-0.6,0.5-0.6,0.5-0.6,0.6
0.6-0.7,0.6-0.7,0.6-0.7,0.6-0.7,0.6-0.7,0.7
0.7-0.8,0.7-0.8,0.7-0.8,0.7-0.8,0.7-0.8,0.8
0.8-0.9,0.8-0.9,0.8-0.9,0.8-0.9,0.8-0.9,0.9
0.9-0.95,0.9-0.95,0.9-0.95,0.9-0.95,0.9-0.95,0.95
0.95-1,0.95-1,0.95-1,0.95-1,0.95-1,0.99
1,1,1,1,1,1

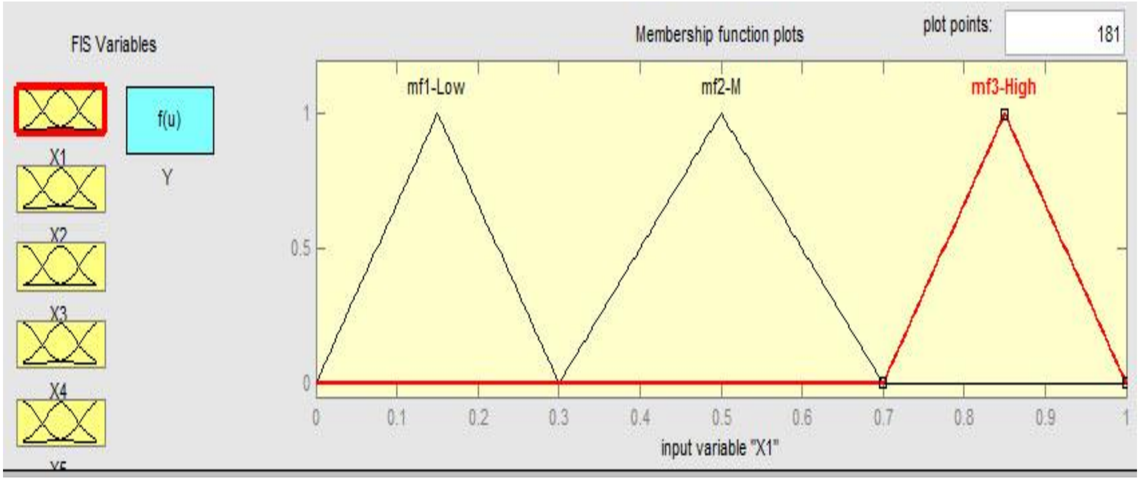


Figure 1. Partitioning of the smart system's input variable – fuzzy values associated with linguistic variables (membership functions of triangular numbers)

Phase three: designing the smart system's knowledge base – this phase includes extracting expertise rules and their evaluation carried out by the experts, and establishing the fuzzy rules base. The fuzzy rules base is a set of "if-then" rules which is seen as the heart of the smart system, because the rest of the fuzzy system components use these rules effectively and efficiently. The possibility of different statuses between the main variables of the smart system is considered equal here. The starting point of establishing a knowledge base in a fuzzy system is to collect a set of fuzzy if-then rules from the experts or the knowledge of the context under question, and the next phase would be incorporating these rules into a single system. The manner of generating the knowledge base rules of the smart system's main module is as follows:

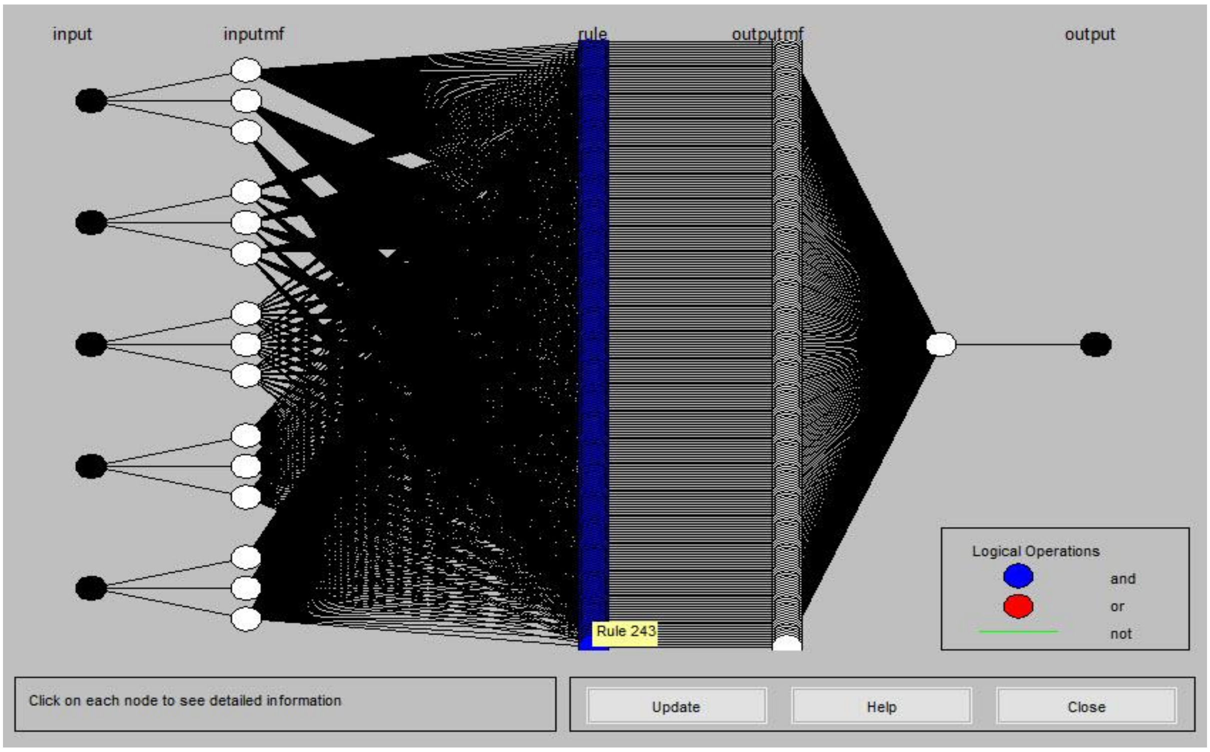


Figure 2. Automatic generation of neural rules of this system's knowledge base by ANFIS toolbox

Regarding the nature of the smart system's input variables aiming for BMS components' success, the possibility of different statuses between the main variables of the smart system are considered equal here. All of this smart system's knowledge base rules are generated by ANFIS toolbox and MatLab software using fuzzy logic and artificial neural network calculations. Ultimately, the number of the fuzzy rules of the smart system's module "BMS components' success" is equivalent to 243 due to the presence of 5 main variables of 3 statuses each. The related figure of the fuzzy rules base of the smart system's module is as follows:

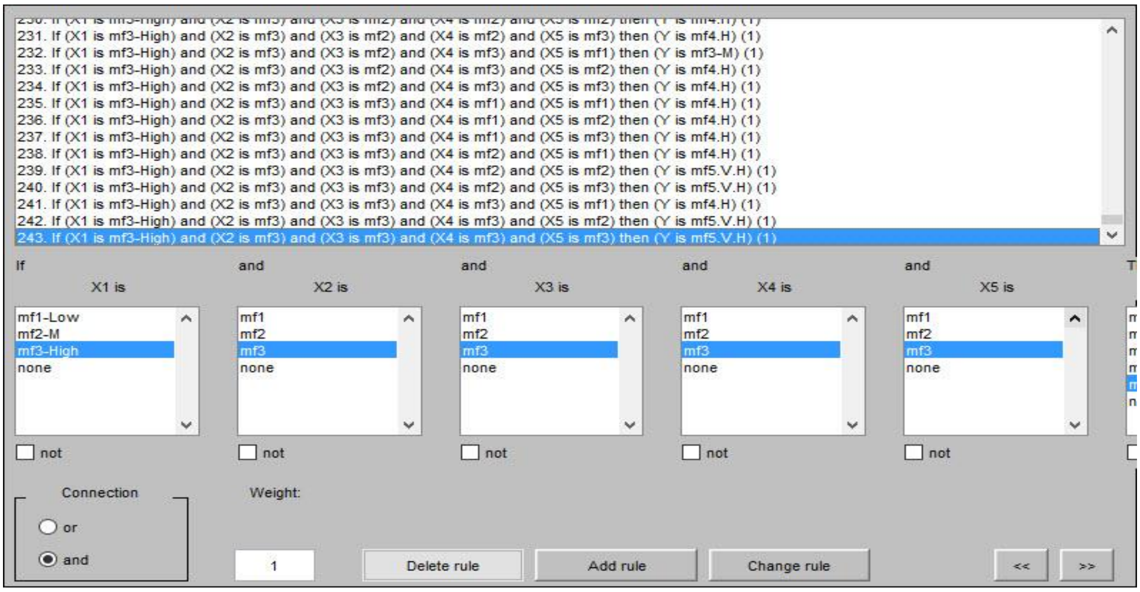


Figure 3. Fuzzy rules in the knowledge base of the system module

Phase 4: designing smart system's inference engine – at this stage, the wtavar method is selected for defuzzification to convert the fuzzy numbers and sets into a decisive value, for real investigation of the system function. The below figure shows the smart system's inference engine:

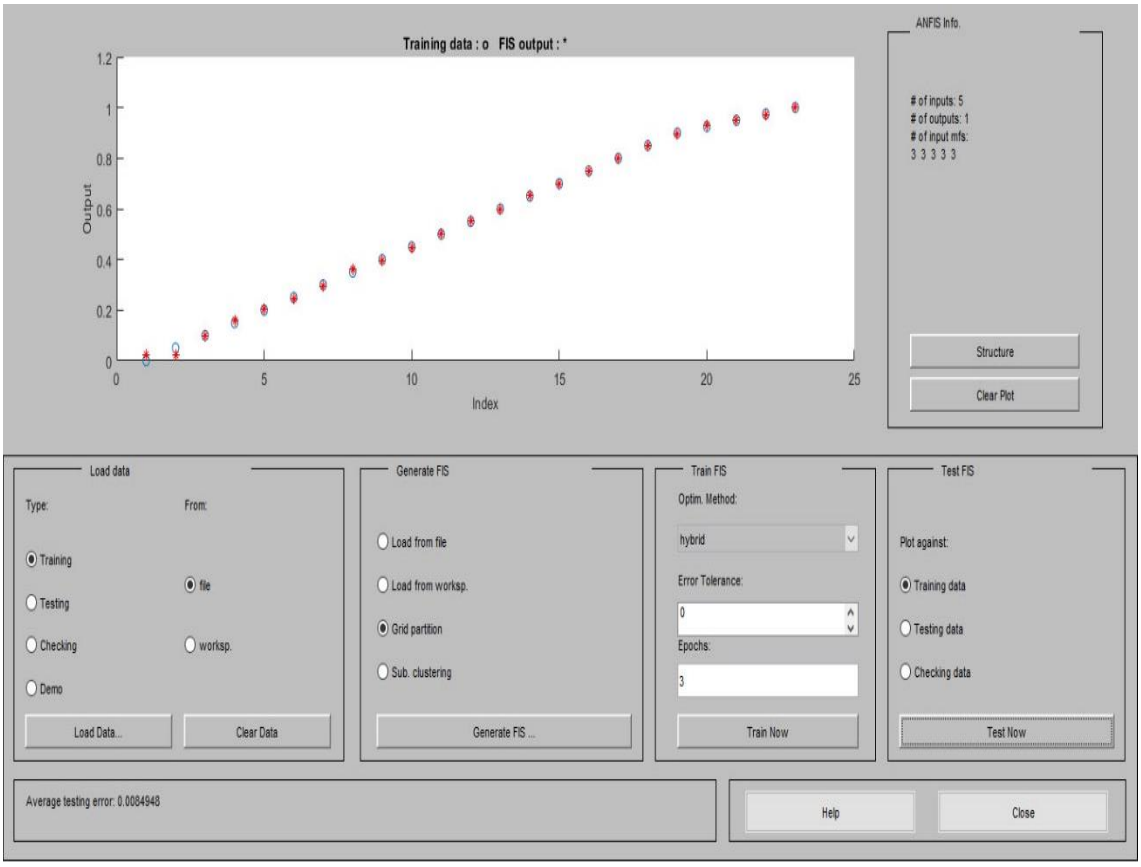


Figure 4. The smart system's inference engine

By MATLAB software, the inference based on the rules available in the smart system's knowledge base is addressed. The average error of the test data in the smart system's inference engine aiming to generate the smart model of digital content-based marketing in the implementation of the BMS is calculated to be 0.0085 (less than 1 percent), which shows the substantially high precision of the neural network and fuzzy logic calculations of this paper. The most important reason for using the Sugeno inference engine (instead of Mamdani) is that in the Mamdani inference engine, the segment for selecting the implication type (to collect fuzzy rules for the sake of inference and conclusion) is not fixed. In Matlab software, Min is used to select the implication type, because the Prod operator shortens and impairs the fuzzy set. The defuzzificator available in the smart system converts the fuzzy output into a decisive number. Wtaver method is used in the defuzzification part of MATLAB software, because the said defuzzification helps reduce the complexity of the problem and the calculation time. At this point, we select the "Max" method of fuzzy rules aggregation using the "And" operator in MATLAB software. By doing so, a more precise sum of each set of output rules is considered, and not just part of them.

Phase five: describing how to use the designed smart system and analyzing its outputs – to analyze the behavior of the system's output variable "BMS components' success" of the smart system, and the analysis of the smart system's output may be carried out in a numeric (precise) and linguistic way. To determine the weight of the system's input values, the information related to the ideal and operational weight of each main variable of the study are provided:

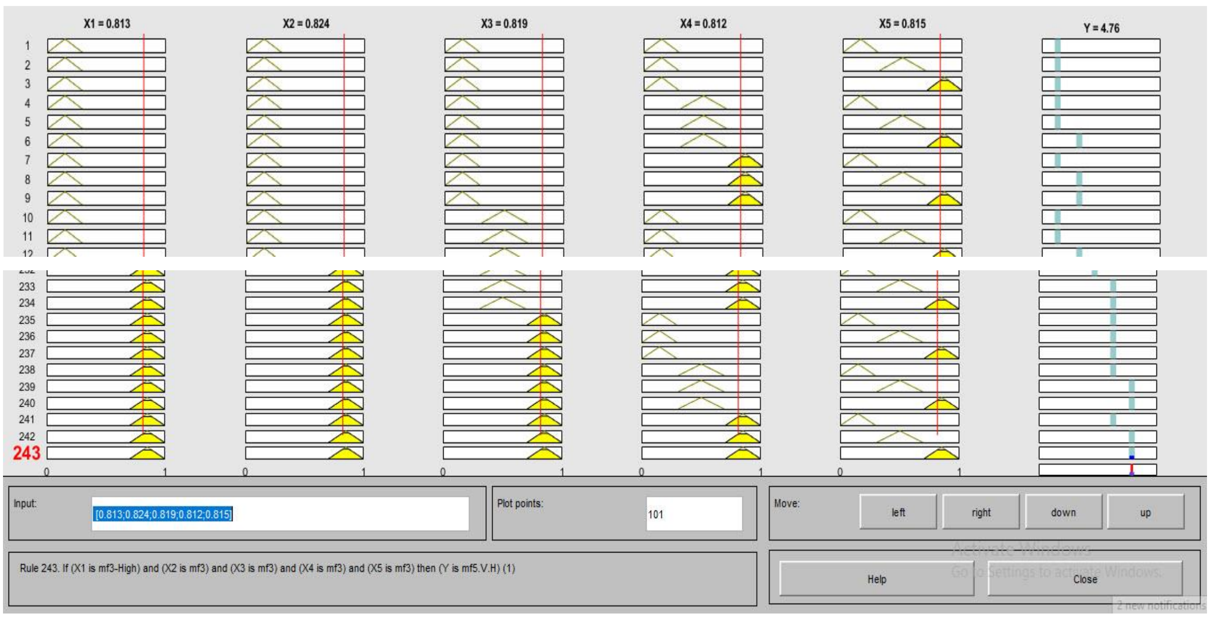
Table 8a. The information related to the ideal weight of each main variable of the study

Study variables	Weight average	Fuzzy weight
"Temperature control and ventilation system marketing of the BMS (X1)"	5.690	0.813
"Closed-circuit surveillance camera system marketing of the BMS (X2)"	5.765	0.824
"Emergency power supply and intelligent lighting system marketing of the BMS (X3)"	5.730	0.819
"Safety and fire alarm system marketing of the BMS (X4)"	5.682	0.812
"Central antenna and telecommunication signal distribution system marketing of the BMS (X5)"	5.703	0.815

Table 8b. The information related to the ideal weight of each main variable of the study

Study variables	Weight average	Fuzzy weight
"Temperature control and ventilation system marketing of the BMS (X1)"	4.562	0.652
"Closed-circuit surveillance camera system marketing of the BMS (X2)"	4.752	0.679
"Emergency power supply and intelligent lighting system marketing of the BMS (X3)"	4.903	0.701
"Safety and fire alarm system marketing of the BMS (X4)"	4.577	0.654
"Central antenna and telecommunication signal distribution system marketing of the BMS (X5)"	4.683	0.669

The following figures represent the behavioral analysis of the smart system's input and output variables:



After the smart system design was completed, the outputs and results of the smart system hereby studied were compared with the comments of 18 aforesaid experts by a separate measurement tool. Since the experts' comments are depicted based on the output variable's membership functions (with 5 MFs), therefore to examine the presumption of the system's outputs accuracy, the percentage of the difference between the outputs of the smart system hereby studied, which is BMS-DCBM.AI and the average of the experts' comments can be used. The last difference between the outputs of the smart system hereby studied and the average of the experts' comments was not significant, that is equal to 0.065. Since there is no sufficient reason to accept the zero presumption, therefore the contrary is accepted, that is, there is no significant difference between the average of the experts' comments and the outputs of the "smart system".

5. Conclusion

One of the most important results of the study entitled "designing a smart system for the BMS components' success" is that the status of "BMS components' success" can be numerically and more precisely analyzed, concerning the rules of the knowledge base of the smart system's main module based on the weight calculation of each main variable, using the experts' comments:

From an ideal criticality point of view, if the status of the "temperature control and ventilation system marketing of the BMS (X1)", "closed-circuit surveillance camera system marketing of the BMS (X2)", "emergency power supply and intelligent lighting system marketing of the BMS (X3)", "safety and fire alarm system marketing of the BMS (X4)", and "central antenna and telecommunication signal distribution system marketing of the BMS (X5)" are desirable, that is precisely 0.813, 0.824, 0.819, 0.812, and 0.813 respectively, then the "BMS components' success" status is at "excellent (fifth)" level, that is precisely 0.952. Concerning the linguistic variables' membership functions by the experts presented in the above tables, the value 4.76 within a 5-folded range of values in a period defined for the "excellent" linguistic variable, which is the BMS components' success status with the programming codes [0.815; 0.812; 0.819; 0.824; 0.813], is precisely calculated as being 0.952, because in building management systems, the users are provided with various security solutions: using closed-circuit cameras or motion sensors, video recording in the event of any motion within the surveillance range of the camera, activating the alarms, or reporting entry of intruders to individuals or the police station if it is received from different cameras remotely and through the internet and observed on the video screen, receiving reports of all activities during the day (doors opening and closing, the number of entries and exits, etc.) through e-mail or SMS, the option of turning the electrical devices on and off, increasing or lowering the temperature, humidity, and light by telephone or SMS.

On the other hand, From a function status point of view, if the status of the "temperature control and ventilation system marketing of the BMS (X1)" is medium, that is precisely 0.652, the status of "closed-circuit surveillance camera system marketing of the BMS (X2)" is medium, that is precisely 0.679, the status of "emergency power supply and intelligent lighting system marketing of the BMS (X3)" is desirable, that is precisely 0.701, the status of "safety and fire alarm system marketing of the BMS (X4)" is medium, that is precisely 0.654, and the status of "central antenna and telecommunication signal distribution system marketing of the BMS (X5)" is medium, that is precisely 0.669, then the "BMS components' success" status is at "medium (third)" level, that is precisely 0.684. Concerning the linguistic variables' membership functions by the experts indicated in the above tables, the value 2.34 within a 5-folded range of values in a period defined for the "medium" linguistic variable, which is the BMS components' success status with the programming codes [0.669; 0.654; 0.701; 0.679; 0.652], is precisely calculated as being 0.468, since the content-based marketing is a part of the marketing and development strategy of the business enterprise which focuses on the generation and distribution of valuable, related, and integrated contents, generally aiming for attracting new audiences and retaining the old ones. Through this strategy, attracting the audiences is accomplished by providing valuable content. To have successful content-based marketing, you will need accurate planning.

Eventually, the final model of the present study in the light of the studies conducted by Iddianozie & Palmes (2020), Le et al. (2019), Mendonça et al. (2017), Sonawane & Chaudhari (2012), Xu et al. (2020), Touš et al. (2014), Yudelson (2008), and Yang et al. (2020) was established as indicated in the following chart:

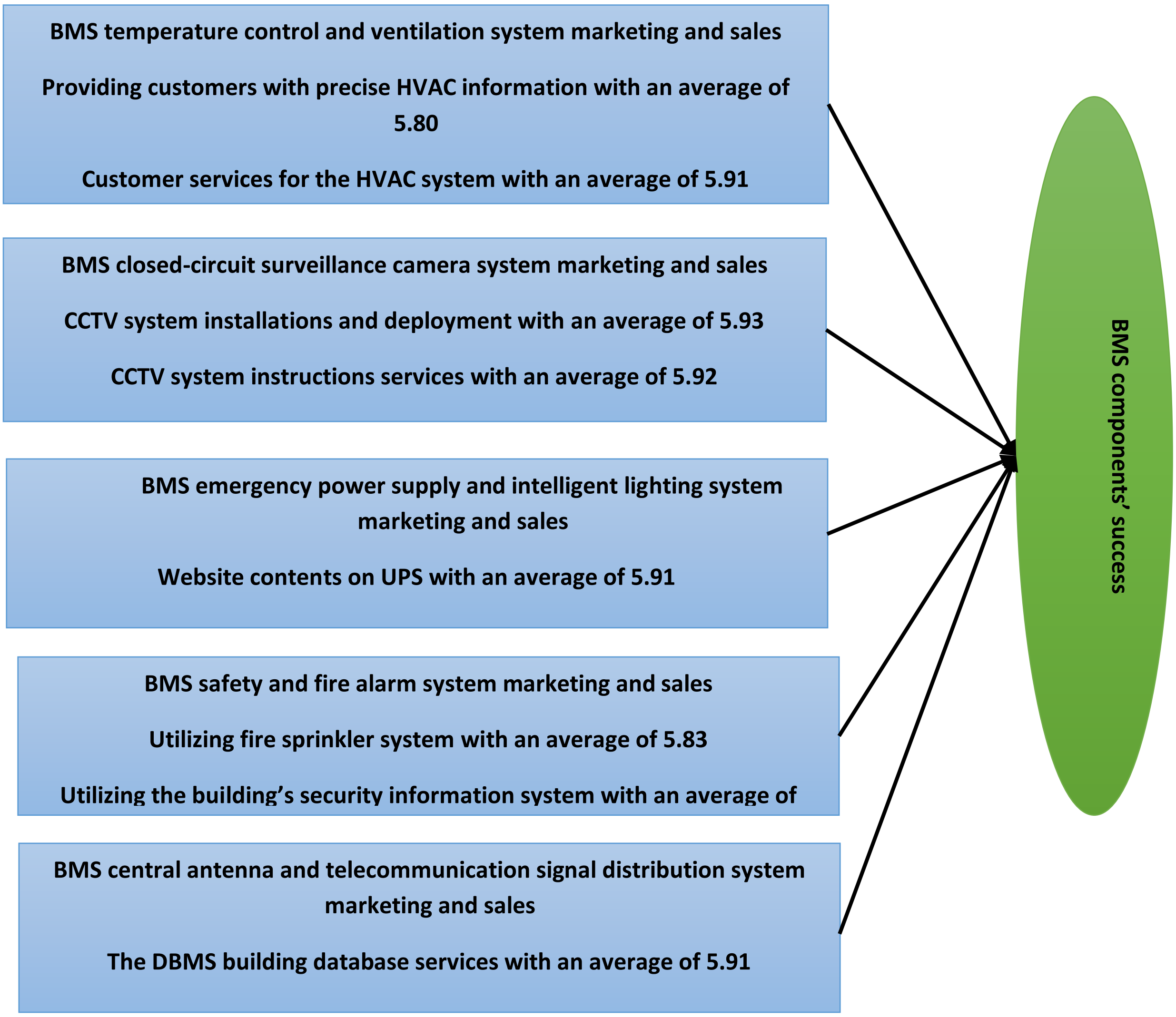


Chart 2. The final model of the study

Given the above, the most important suggestions and recommendations for the next studies may be put as follows:

To utilize ontology in comprehensive modeling of the BMS components' success,

To adopt fuzzy multi-criteria decision-making (MCDM) techniques for network ranking of inter-model association of the BMS components' success,

To utilize data envelopment analysis (DEA) to model the efficiency of the BMS components' success,

To utilize the Dynamics (Vensim) system for dynamic modeling of the BMS components' success.

References

1. Iddianozie, Chidubem & Paulito Palmes (2020). "Towards smart sustainable cities: Addressing semantic heterogeneity in Building Management Systems using discriminative models", Sustainable Cities and Society, November 2020.
2. Le, Duc Nha et al. (2019). "Smart-building management system: An Internet-of-Things (IoT) application business model in Vietnam", Technological Forecasting and Social Change, April 2019.
3. Mendonça, Pedro X., et al. (2017). "Marketing in the material construction of artifacts: A case study of a Portuguese navigation systems company", Technology in Society, November 2017.
4. Mirakhorli, Amin & Bing Dong (2018). "Market and behavior-driven predictive energy management for residential buildings", Sustainable Cities and Society, April 2018.
5. Sonawane, Madhulika Ajay & Arvind Chaudhari (2012). "Relationship of Marketing to Product-Based Marketing a Trend of Residential Construction Business", Procedia - Social and Behavioral Sciences, 2012.
6. Touš, Michal, et al. (2014). "Book chapter: Improving the Energy Management of a Building Complex through Utility System Modelling", Computer Aided Chemical Engineering, 2014.
7. Xu, Quanqing, et al. (2020). "Book Chapter 8: An effective blockchain-based, decentralized application for smart building system management", Real-Time Data Analytics for Large Scale Sensor Data, 2020.
8. Yang, Chih-Hao, et al. (2020). "A mixed activity-based costing and resource constraint optimal decision model for IoT-oriented intelligent building management system portfolios". Sustainable Cities and Society, September 2020.
9. Yudelson, Jerry, (2008). "Book chapter 8: Experiences of Green Building Marketing", Marketing Green Building Services, 2008.
10. Bu, Yi, et al. (2020). "Digital content marketing as a catalyst for e-WOM in food tourism". Australasian Marketing Journal (AMJ), In press, corrected proof Available online, 16 January 2020
11. Hollebeek, Linda D. & Keith Macky, (2019). "Digital Content Marketing's Role in Fostering Consumer Engagement, Trust, and Value: Framework, Fundamental Propositions, and Implications", Journal of Interactive Marketing Volume 45, February 2019, Pages 27-41
12. Müller, Johannes & Fabian Christandl, (2019). "Content is king – But who is the king of kings? The effect of content marketing, sponsored content & user-generated content on brand responses". Computers in Human Behavior Volume 9, 6 July 2019, Pages 46-55
13. Dias, Joaõ Pedro & Hugo Sereno Ferreira, (2017). "Automating the Extraction of Static Content and Dynamic Behaviour from e-Commerce Websites". Procedia Computer Science, Volume 109, 2017, Pages 297-304
14. Lin, Chin-Teng & C. S. George Lee, (1996). "Neural Fuzzy Systems: A Neuro-Fuzzy Synergism to Intelligent Systems Hardcover", Publisher: Prentice Hall; Har/Dskt edition (May 1, 1996)
15. Mishra, Rabi Narayan & Kanungo Barada Mohanty, (2016). "Real-time implementation of an ANFIS-based induction motor drive via feedback linearization for performance enhancement". Engineering Science & Technology, an International Journal, In Press, Corrected Proof, Available online, 28 September 2016
16. Moayer, Sorousha & Parisa A. Bahri, (2009). "Hybrid intelligent scenario generator for business strategic planning by using ANFIS". Expert Systems with Applications, Volume 36, Issue 4, May 2009, Pages 7729-7737

17. Borhan, Alireza and Tabaian, Seyedeh Marzieh, (2019), Intelligent Building Management System (BMS) and Analysis of the Effect of Intelligent Systems on Energy Productivity and Costs, Sixth National Congress of Civil Engineering, Architecture and Urban Development, Tehran.
18. Shah Rahmani, Mohammad Reza and Zarisafi Kermani, (2020), A Review of Fatemeh Bazi's Practices in Energy Consumption in the Management System, Building of the 9th International Conference on Information Technology, Computer and Telecommunication.
19. Kamalo, Abbas and Abbaszadeh, Mohammad and Amandari, Omid and Ahmadi, Mansour, (2020), implementation of building management system or BMS, the second conference of mechanical, electrical and computer engineering.
20. Faizi, Mohammad Farbod and Selouki, Amir Hossein and Elmi, Seyed Mohammad Javad, (2019), on the benefits of building management system, National Conference on New Sciences and Technologies in Water, Energy and Environment, Tehran.
21. Rezvani, Mehran. Seyedeh Fatemeh Mirtaheri and Marzieh Rezaei, (2019), The Effect of Using Content Marketing to Visit Website Website in Emerging Internet Businesses (Case Study: Yekta Kitab Website), Bi-Quarterly Journal of Consumer Behavior Studies 6(1)
22. Rahmanabadi, Mehran and Shaghayegh Karmian, (2019), The effect of social media content marketing on the intention of customers to buy online, International Conference on Progress in Management, Business, Economics and Finance, Turkey, Arvin Alborz Conference Business.
23. Ghanbarzadeh, Ali; Ali Asghar Tabavar and Masoud Dehghani, (2019), The effect of content marketing on online shopping in Irancell (Irancell's customer case study in Mashhad), National Conference on Economics, Development Management and Entrepreneurship Support for Iranian Goods, Zahedan, Zahedan work. Industrial Representation of Sistan and Baluchestan
24. Azar, Adel and Hojjat Faraji. (2010). Fuzzy Management Science. Kind Book Publishing Institute. Iran Center for Management and Productivity Studies (affiliated to Tarbiat Modares University). Fourth edition
25. Sanjotvar Rajaskaran, Viji Alakshami Pai, Mahmoud Keshavarzmehr (translator). 2012. Neural Networks, Fuzzy Logic, Genetic Algorithm: Composition and Application. Publisher: Noorpardazan. ISBN: 978-964-975-162-7.