Investigational Model to Generate Aggregate Value in Eco-sustainable Housing Development

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Abstract

Purpose – Conventional materials and procedures in worldwide construction sector is a paradigm that requires change. Constructors usually do not take the adventure of testing novel techniques and materials in their construction projects and, as a result, profits are usually given in terms of time and cost savings. The purpose of this article is to introduce a model to add aggregate value in eco-sustainable dwelling construction through ecological sustainable value chain and hypothesis settlement. *Design/methodology/approach* - A review of the literature was done in databases using keywords. The selection of sources includes scientific articles and case studies based on different methods and contexts which were carried out.

Findings - The findings suggest the implementation of the training of both the employee who works in the construction and the client regarding self-sustainable construction. A significant improvement was obtained based on the commercial relations of suppliers, the client, and also with the construction company. Finally, innovation in at least one of the six proposed aspects was carried out: new technologies, including eco-technologies, the quality of materials (including the eco-sustainable ones), the segmentation of the demand for eco-sustainable housing and its new ways of marketing and financing. They were, however, proposed for added value generation for the development of eco-sustainable housing. *Originality/value* - A model for the generation of added value in the construction of eco-sustainable housing was elaborated based on the relationships between human and relational capital, training, and the generation of aggregate value.

Keywords: Aggregate value, eco-sustainable housing, value generation

Introduction

The construction sector worldwide with traditional procedures and materials is a paradigm that requires change (Isunza & Dávila, 2011). Builders usually do not venture trying new techniques and materials in their construction projects and, although significant innovations have been made recently in terms of materials and construction procedures, instead of improving sustainability, their benefits usually occur in terms of time savings and project costs reduction (Bueno & Rossignolo, 2011). From their point of view, buildings are built with the overall objective of generating economic benefits, leaving aside the welfare and health of the users as some of the construction materials commonly used are related to health disorders (Villa, 2009).

The lack of sustainability in civil projects is a problem of considerable dimensions. In agreement with the International Energy Agency (IEA) in developing countries by 2030, 1.4 billion people will lack access to electricity, 2.6 billion people will be consuming traditional biomass for their basic heating and cooking needs, and 1.5 million people - most of them women and children- would have died prematurely due to in house air pollution and fires (IEA, 2015).

Housing in marginalized and vulnerable areas has been neglected by the official bodies responsible for supporting its inhabitants. Support policies have been characterized by their inefficiency and lack of continuity, ignoring the complexity of local needs and customs (Re et al., 2004). Building costs in marginalized areas are affected by low demand, population dispersion, and inadequate road infrastructure (GEA, 2010). In marginalized areas, poverty reaches 53.3% of households, 70% of the Economically Active Population (EAP) is informal, 60.8% of the total population is considered in heritage poverty, and 47% of population lives in housing without legal possession. On the other hand, in regards to the origin of the resources in acquiring their home, 0.72% of these households were purchased through a loan from the state, 0.68% by a bank, and 88.7% was built with its own resources. Regarding self-construction, 48% of these dwellings were built by an owner's relative (GEA, 2010).

Worldwide, buildings, and construction activities consume around 3,000 million tons of raw materials, which is 40% of the total raw materials yearly consumed on the planet (Hussain & Kamal, 2015). Construction industry consumes about 25% of wood extraction worldwide, 40% of stone, sand and gravel, and 16% of water. It generates 50% of greenhouse effect gases (GHG) and acid rain causing agents (idem).

Additionally, energy consumed for the extraction, transport, manufacture of building materials and assembly of structures, makes construction industry to be responsible for the highest contribution to global

warming through the emission of CO_2 during production (Hussain & Kamal, 2015). In developing countries, 90% of this energy comes from non-renewable resources (Villa, 2009).

In Mexico, Brazil and Ecuador, urban growth causes increase of the electric power demand for transportation, industry, and housing (Barragán & Ochoa, 2014). At present, housing sector consumes 16.2% of the energy generated in Mexico (CONAVI, INFONAVIT and SHF, 2013). Unless the situation changes, it will be aggravated; by 2050, it is expected that there will be 122,000,000 inhabitants distributed in 50,000,000 homes; 11,000,000 new homes will be needed to build; and 9,000,000 will be needed for renovation (INEGI, 2010), posing a challenge to housing development entities.

The construction of conventional -non ecological- dwelling has a substantial impact on water consumption. In Mexico, the availability per person has decreased from 18,000 m^3/inhabitant in 1950 to only 4,090 m^3/inhabitant in 2010. Water is also unevenly distributed, being as high as 22,393 m^3/inhabitant/year at the southern border region, while the Valley of Mexico has only 160 m^3/inhabitant/year (CONAGUA, 2011).

Green housing projects are the closest approach to eco-sustainable housing in Mexico. However, this is a recent concept with practically no legislative precedent in our country. Besides, green houses are not necessarily eco-sustainable and, as a result, environmental damage and an irrational land use are common in many cities (Isunza & Dávila, 2011).

The Center for Research and Documentation of the House (CIDOC) reported in 2015 that some challenges persist regarding the current state of housing in Mexico. Among them, the increase in dwelling are located far from the basic urban services coverage. From January to May 2015, subsidized housing in these areas amounted to 94,400 homes, 14,300 over the same period of the previous year (Sociedad Hipotecaria Federal, 2015). All of these dwellings have a significant disadvantage because they are located far away from work centers, schools, and health services. As a result, they are less attractive to the buyer. In addition, no relationship exists between urban planning and real estate development (Sociedad Hipotecaria Federal, 2015).

The Concept of Value

In economic terms, value is created when the owner's wealth is increased. In this way, when good decisions are taken and, as a result, an economic return greater than the cost of the capital used is generated, a higher value is created (Jiménez, 2013). In modern capitalist society, however, there has been a change in the perception of value; products are no longer valued for their usefulness, use value, or price, but primarily by a value of significance. This has a profound impact on people’s lives because when they buy a product or use a service, they are not only acquiring that product but

they are creating an identity with it; also, they are permeating other cultures and satisfying their desires, which incidentally have become demands (Gómez, 2010).

Within the concept of value, innovation and technology are highly valuable resources as they are used to improve the links between human beings and their environment. It is referred to as the humanization of technology. In the sign value economy, a product or service design must contribute in increasing the value for the user; however, this is achieved through this product or service entire package user perception (Gómez, 2010).

According to Porter (2012), value is the amount that buyers are willing to pay for what a company provides them and it is measured by total income, as well as being a reflection of the product's scope in regards to the price and the units that can be sold. As a result, a company is profitable if the value it imposes exceeds the costs involved in creating the product.

Value Generation

The generation of value (GOV) is a goal where customers are the most important objective and all interests must be united in relation to people's welfare. This concept must be linked to efficiency (Porter, 2012). Currently, different companies lead their processes towards this goal. At the end, the real significance of GOV for companies is related with the opportunity to remain in the market and grow, as well as being a fundamental concept in modern financial management (Jiménez, 2013).

Nowadays, due to tendencies derived from market globalization, the strategy involved with value generation must satisfy the organizational expectations, having an understanding that the organization is the space where diverse groups of interest converge (Zapata, 2013).

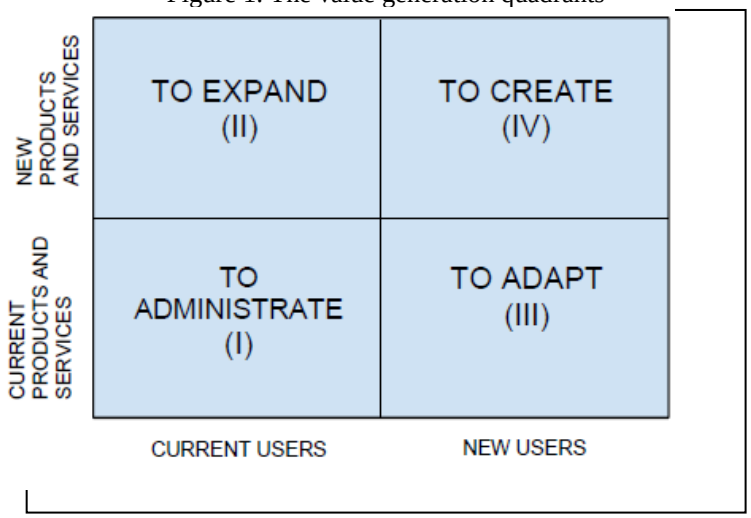
Since every organization is unique, there are different ways to generate value and make them grow. However, all of them are dependent on different factors; this ranges from the characteristics of the economic sector, industry or business organization to the inherent intrinsic qualities (Álvarez & Mori, 2010).

Jacoby and Rodríguez (2007) created a value generation model with four quadrants and two axes of action: products and users. With these axes, each organization can be able to develop a strategy that subsequently serves to generate value in their businesses using their internal potential (Figure 1).

With the objective of an internal company element which could be considered as a source of sustainable competitive advantage, Ruiz (2012) adapted from Barney (1991) a model were some conditions such as value, scarcity, difficult to imitate, and the difficultly substitutable must be fulfilled. As a result, that element could be considered an added value generator. From

all the internal elements of a company, the part of the collaborators is the one that complies with those conditions relatively easy (Ruiz, 2011).

Figure 1. The value generation quadrants



Source: Jacoby and Rodríguez, 2007

Human Capital

Human capital can be defined as "the combination of experience, professional skills, knowledge, leadership skills, innovation and initiative, adaptability, etc. that resides in each and every one of the individuals of the organization" (Benavides, pp. 105, 2012).

Relational Capital

Relational capital can defined as “the capital originated from the value given by organization for their relationships with the environment -providers, customers, shareholders, state entities, consumer associations, social agents, among others-" (Benavides, pp. 105, 2012).

Coremberg (2013) cites some changes that cause a reconfiguration of the chain value in the construction sector:

1. New technologies: outsourcing and industrialization of stages and inputs.
2. Quality of inputs.
3. Segmentation of the demand.
4. New claimants and investors.
5. New forms of marketing.
6. New forms of financing.

Value Engineering

Nowadays, value engineering is defined as the systematic application of techniques recognized by multidisciplinary teams to identify the function

of a product or service; they immediately establish a value for this function, then generate alternatives through creative thinking and finally, provide the necessary functions and profitability at the lowest possible cost (Sharma and Srivastava, 2011). Nevertheless, the methodological approach used for evaluating value engineering remains under discussion. For example, Borkenhagen (1999) suggested that the value implementation engineering in a product or service consists of eight phases, while Sharma and Srivastava (2011) proposed only five phases, including what Borkenhagen previously suggested separately.

Design of a Model for Generating Added Value in the Construction of Eco-sustainable Housing

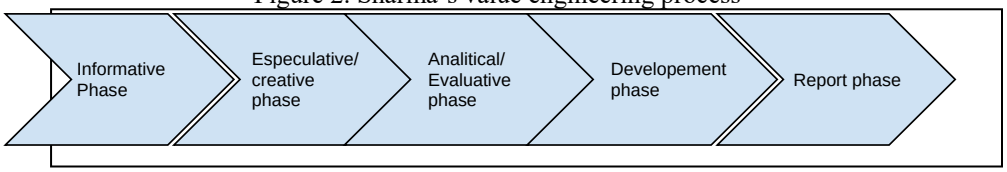
The model proposed in this research is intended to help the housing construction companies engaged in a highly competitive environment, adapting their production process, and produce or increase value added in eco-friendly homes. Reviewing the quadrants of value generation (Figure 1), two scenarios can be identified: a) to generate value in a dwelling already built and b) to generate value in a new dwelling.

Based on the scope of this investigation, the model of the second scenario will be designed. Here, the construction company has the opportunity to implement changes before start dwelling construction process. Therefore, this corresponds to the CREATE new products and services and ADAPT existing products and services quadrants.

Human capital is considered both by the construction company and by the client as a value generator and with training, human capital becomes difficult to replace, scarce, and difficult to replicate (Ruiz, 2011; Benavides, 2012).

Then, the proposed model will cover the five stages of the value engineering process (Figure 2) proposed by Sharma and Srivastava (2011).

Figure 2. Sharma's value engineering process



Source: Own elaboration (2017) based on Sharma and Srivastava (2011)

Description of the Phases

Information Phase: The team collects as much information as possible regarding the product, its design, and its manufacturing process.

Speculative / Creative Phase: The team uses group interaction to identify alternative ideas for the achievement of a function in a system or subsystem.

Evaluation / Analytical Phase: The ideas obtained in the speculative / creative phase are displayed on a blackboard and are evaluated by the team looking for those that show a greater potential regarding cost savings and better implementation in the project, which are selected to be studied later.

Development / Recommendation Phase: The ideas selected in the evaluation / analytical phase are retaken and their descriptions are elaborated. A sketch is elaborated to establish the life cycle and its estimated cost to be able to support the proposed recommendations of the engineering of value.

Reporting Phase: The team presents the results of the development / recommendation phase to managers or to the government through an oral presentation at the end of the workshop. They attached a preliminary report while the final report is integrated and when is finished, it is sent by the team leader.

Description of the Proposed Model

In the model proposed in this work, information collected on traditional construction materials and procedures is used in the creative stage where innovative ideas regarding new technologies are identified, including eco-technologies, the quality of inputs or materials including the eco-sustainable materials, the segmentation of the demand for eco-sustainable housing, and the new ways of marketing and financing it. In addition, as much information as possible regarding human capital (client and employees) and relational capital (client and suppliers) were considered as both human capital and relational capital.

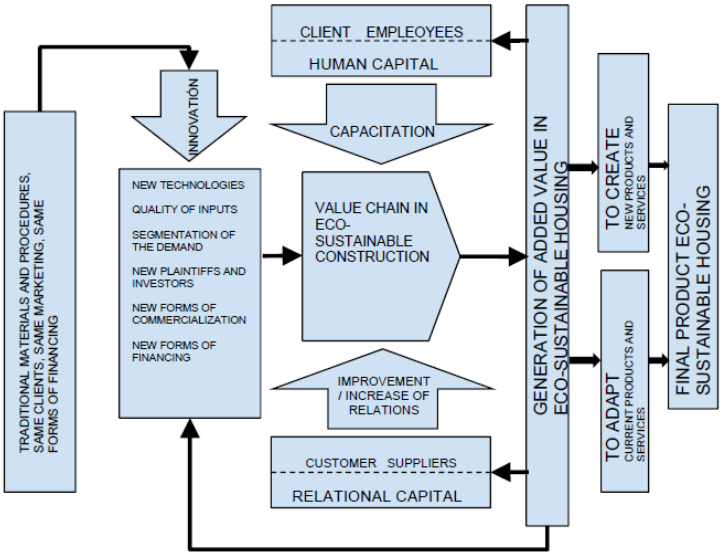
In the case of human capital, training strategies on the subject of eco-sustainability will be proposed and in the case of relational capital, strategies will be proposed to improve or increase relations with the company.

Then, these alternatives pass to the analysis and evaluation stage in order to choose those that are relevant and viable. If none of them is considered relevant and/or viable, the model returns to the creative phase again.

Once the most viable alternatives have been chosen, those are passed to the development stage. In this stage, they are alternatives that can help to create a new eco-sustainable housing or to adapt the construction of a traditional new home for an eco-sustainable housing.

Finally, at the last stage, we can report the achievements regarding the generation of the expected added value in the construction of housing (Figure 3).

Figure 3. Value-added generation model for the construction of eco-sustainable housing proposed



Source: Own elaboration, 2017

Methodology

For this research work, the literature review was focused on two databases: Elton B. Stephens Company (EBSCohost) and Web of Science (WOS). From these databases, 126 scientific articles and 10 corporate reports were obtained. 30 of these sources contributed to the development of this research. These sources are based on studies performed in different parts of the world: France, Peru, United States of America, Ecuador, Colombia, Brazil, Mexico, India, Switzerland, Argentina, and Spain. Some of these articles show a relationship between resources and value. The Barney model (1991) is a very interesting article which, despite its year of publication, is considered relevant by Ruiz (2012), who adapted his model for the generation of sustainable value as a consequence of organizational ethics in a company.

The information obtained from sources published between the period of 1991 and 2013 that relate resources to value (Table 1), help to envision that there could be a positive relationship between the client and the employees - human capital - with the added value and the Relational capital - the client and the suppliers – and with the added value generated both in the final product.

The information obtained from the sources published between 2009 and 2015 period that relate the material resources and some administrative resources with the value (Table 2), is useful to see the relevance of the materials quality and the innovation process with the value generated in the final product.

Table 1. Studies result conducted on the relationship between resources with value

Authors	Variables/ Component	Contribution	Findings
Álvarez et al., 2010	Innovation, Value generation	He related global management to innovation management and the identification of the key elements necessary to implement competitive innovation that creates value in organizations.	Competitive innovation is based on an efficient management of the culture of innovation, teamwork, competitive innovation aligned with strategy, innovation management and leadership. The collaborators are those who create value, for organizations and for customers.
Borkenhagen, 1999	Value, Value engineering	Applied value engineering to different highway projects in the United States.	Value engineering is an effective technique to reduce costs and to increase productivity and quality without adversely affecting project design or environmental goals.
Coremberg, 2013	Value chain in construction, Added value	Realized a reconfiguration of the value chain in construction.	The concepts that result in a reconfiguration in the value chain are: New technologies, Quality of inputs, Segmentation of the demand, New claimants and investors, New ways of marketing, New forms of financing.
Jacoby and Rodríguez, 2007	Generation of value, Innovation	Generated a value generation model based on the relationship between the intention to grow and innovation.	With this model, each organization can plan and develop its strategy that will later serve to generate value in their businesses using their internal potential.
Porter, 2012	Value chain, value	Generated a model of chain of value adaptable to the general industry.	Value chain model.
Re, Blasco Lucas, and Albarracín, 2004	Sustainable housing	They proposed a type of bioclimatic housing for the conditions of the arid San Juanino.	Bioclimatic housing proposal with improvements regarding the local construction process.
Ruiz et al., 2012	Value	Adapted the Barney model (1991) for the generation of sustainable value as a consequence of organizational ethics.	The generation of value through organizational ethics.

Sharma and Srivastava, 2011	Value, Value engineering	Implements five stages for the value engineering process.	The process of value engineering involves: Informative, creative, analytical, development and reporting phase.
Zapata et al., 2013	Human capital, generation of value	Determined the measure of profitability of the human resource on the generation of business value measured in cash flow.	There is a direct relationship between the results of the value indicators and the profitability of human resources.

Source: Own elaboration with information of the cited authors, 2017

Table 2. Results of studies conducted on the relationship of material and administrative resources with value

Authors	Variables / Component	Contributions	Findings
Benavides, 2012	Intellectual capital, Human capital	Designed a model that allows to measure and value the Return on Investment (ROE) of the Intellectual Capital of a company.	Intellectual Capital is the knowledge applied to work to generate value for the company. Provide structure and internal coherence to the Intellectual Capital construct, identifying its components and its most relevant dimensions, proposing the most relevant indicators for its measurement.
Barragán and Ochoa, 2014	Ecological housing, Low cost	He analyzed the feasibility of building social housing with basic bioclimatic characteristics, under particular economic and environmental conditions in the city of Cuenca, Ecuador.	Confronts the climate information with the psychosometric diagram, which allows to determine the most efficient bioclimatic strategy for the study area.
Bueno and Rossignolo, 2011	Energy efficiency in housing	They propose an analysis of the LEED for Homes system with the objective of establishing the points in which this tool can be effective or not in	The application of the LEED for homes system is limited and therefore unsuitable for housing in the Brazilian context.

		the evaluation of North American housing buildings in the Brazilian context.	
Hussain and Kamal, 2015	Sustainable materials	He made a study of the different aspects to be covered by the sustainable materials and created a tool to help choose the appropriate construction materials.	Sustainable buildings must be designed, constructed, maintained, remodeled and demolished using the principle of their life cycle through the efficient use of the natural resources required.
Isunza and Dávila, 2011	Innovation, Ecotechnologies, sustainable housing	Conducted an investigation about the challenges facing housing programs in Mexico.	The scope of local governments in search of sustainable housing is very limited. The role of housing agencies must move from suppliers or distributors to promoters of technological diffusion. There is a gap between suppliers and customers. Need for social innovation.
Villa, 2009	Green building, Quality control	Investigation on the importance and implications of the development of green housing in Colombia.	Little attention to the environmental issue by developers, buildings are often inefficient in terms of energy

Source: Own elaboration with information of the cited authors, 2017

Conclusion

In conclusion, this article identifies, for a construction company first, the relationship between its human capital with eco-sustainable housing training and its relational capital with the improvement or increase in its commercial relationships. On the other hand, it also shows the relationship between such training like the improvement or increase in commercial relationships with the generation of added value in the construction of eco-sustainable housing.

Three strands were proposed for the generation of added value based on the development of eco-sustainable housing. With the aforementioned scientific literary review, a significant relationship was found between the variables proposed in the hypothesis. These three aspects are: implement the training of both the employee who works in the construction and the client regarding self-sustainable construction; Achieve an improvement in the

commercial relations of suppliers and the client also with the construction company; and finally, innovate at least one of the six proposed aspects: new technologies, including eco-technologies, the quality of materials or materials including the eco-sustainable materials, the segmentation of the demand for eco-sustainable housing, and the new ways of marketing and financing it.

Finally, a model for the generation of added value in the construction of eco-sustainable housing was elaborated based on the aforementioned relationships between human capital, relational capital, training, and the improvement of relationships with the generation of aggregate value.

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