Toward an articulation in the quadruple helix: teaching and research linked to higher education demand

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Abstract
This research analyzes teaching and research from higher education suppliers and demanders, by interviewing 31 main organizations from the quadruple helix (government, business, academia and society), and then using the MARCIAS tool for Mapping Actors, Relations, Chains, Informants, Applications and Solutions. Results showed favorable opinions for holistic systems of relationships.

Keywords: Higher education supply and demand, Quadruple helix

Introduction
There is an increase in international research in higher education (HE) about topics such as value chain, supply chain, supply and demand of both HE professional and research, employability and rate of return of HE professionals, applicability and rate of return of research, the degree of reaction to the HE professional and research demand, HE-secondary education (SE) and HE-employers links, among others (Habib, 2010; Pathak & Pathak, 2010). On the other side, although there is no national research in Honduras, there has been an increase in the involvement of HE demanders/users (e.g. employers) toward HE suppliers, especially with some higher education institutions (HEIs) and some areas of knowledge. This is fostered greatly by evaluating the potential development of more flexible and vocational types of learning, using intra and inter-institutional operations and satisfying all sector involved in the HE processes (HE input providers, HE demanders, etc.).

The value chain is the combinations of activities, operating in an organization, which acting together add value to the demanders, by the outputs of such activities (Porter, 1985). In order to focus this concept to education, one has to consider three issues in relation to value: 1) it is subjective experience dependent on the context; 2) it occurs when the needs are satisfied by the supply of HE professionals and research/project (products, resources, processes and services of teaching and research); and 3) it is an experience that flows from the demander, regardless that the supply flows from the institution recipient of resources. Thus, one has to consider also the supply chain, which generally consists of one or many input providers that deliver such inputs to one or many suppliers (e.g. producers of goods and services) in order to process and deliver the
end results to one or many demanders that use or benefit from them (i.e. supply flow of goods and services, from the supply source to the user/demand). Opposed to the supply flow, the value chain has a demand flow (also known as demand chain) of value (parallel together with flows of orders/request and money) from the demander to the supplier, in a way of demand (Feller et al., 2006). Besides, there must be a flow of bidirectional flow among all players in the chain. Finally, the interconnection of the value chain (i.e. in its links to society) to the two supply chains (teaching and research) involved in the HE may be considered as a value and supply system (Porter, 1985).

Furthermore, the use of the value chain (links to society) in HE may improve the effectiveness on the resulted professionals and projects/research, with the highest possible value to society. Likewise, it is important the efficient of both of HE supply chains (teaching and projects/research) in order to produce professionals and project outputs of quality, respectively.

In addition, compared to other sectors, the services of education have something peculiar, since their production are bidirectional (it flows both directions), due to the demander-input provider duality. For instance, the main provider of its most precious input is at the same time its major demander: when a student demands to be a HE professional (i.e. he/she benefits or uses HE services), at the same time he/she must put himself on the line as the main input that will be transformed into such professional in the HE process (Habib and Junghirapanich, 2010).

Beyond the innovative view of the value and supply chains applied in HE, this paper tries to explore the importance of the quadruple helix articulation (government, business, academia and society) in order to establishes a relationship foundation for a system not only oriented by the demand of HE professionals and projects, but also integrated totally.

Thus, this paper establishes foundations to link input-HE-output by focusing in the quest to find a systemic model that integrates value and supply chains, allowing to articulate HE to both its providers in the entry of HE inputs and its demanders in the output of HE results, and showing a greater efficiency and effectiveness in operations of the HE three fundamental functions: teaching, research and society links? This is answered by an exploratory research, which looks to structuring and identifying basic relations among the mentioned concepts, proposing a model that measures the integration of HE to all involved players. Such model prepares the way for the empirical study that allows future descriptive and causal research.

Therefore, next section (2) presents a literature review. In epigraph 3, this paper proposes a systemic model of value and supply chains. Finally, section 4 sets out some conclusions and final considerations, pointing out implications and future research to follow up, mentioning part of the methodology that must be followed in order to do an empirical research from the proposed model.

**Theoretical background**

The study of the value chain allows seeing HE homogeneously (Porter 1985). Besides, such value view gives HE a better understanding on how its different parts function together by: 1) recognizing that activities within an organization are not independent but interdependent; and 2) in order to give demanders the best possible added value.

Moreover, the value chain helps in how to fulfill goals such as: the supplied
services may not be product sales, nonetheless they are still important, and 2) the value chain may help to obtain the maximum from resources that may be limited.

In addition to show how HE may improve each link, the value chain is quasi-universal for every organization, providing a way to examine internal processes and identifying processes that may be better provided by player different than current ones. Taking Porter (1985), this paper considers the following two general clusters of value activities that may be applied in a value and supply system (Figure 1):

1. Fundamental functions: they are involved directly in the production and delivery of goods and services. In HE there are three fundamental functions to supply professionals and studies: teaching, research and society demand links.
2. Supportive activities: they have the potential to increase the efficiency and effectiveness of the fundamental functions, but they are not directly related to supplying services (HE professionals and research).

![Figure 1 Fundamental Functions and Supportive activities in a Value and Supply System (Adapted from Porter, 1985)](image)

Figure 2 shows the following parts of the fundamental functions:

- **Input logistics:** they receive and store inputs. The distribution to production (i.e. goods and services) is according to need
  - Recruitment, admission, registration, research purposes, grants, etc.
- **Operations:** they are the processes to transform inputs into finished goods and services
  - Teaching, research, counseling, tutoring, etc.
- **Output logistics:** storage and distribution of finished goods and services.
  - Graduation, publications, placement, performance, etc.
- **Marketing & sales:** identification of needs of users and sales generation.
  - Recruitment, technology and knowledge transfer, RD&I
- **Service:** support to users post-sales of goods and services.
  - Academic support, society services, alumni support, D&I support

Likewise, the following components are part of the supportive activities from the Figure 2 above:
Infrastructure and facilities: organizational structures, control systems, administration management, financial management, etc.

Human resources (HR): employee recruitment (search and hiring), training, development, and compensation (provision for academic and administrative units).

Technology development: technologies to supportive activities that add value (IT management and other technologies, class management, research resource management).

Procurement: input purchase such as educative materials (stationary, instruction materials, etc.), supplies and equipment (furniture, computers, network equipment, etc.)

Information of support goods and services.

Supply chain on a Value and Supply System

A HE value and supply system requires coordination and information among all players involved, who share processes forward (users as demand) and backward (HE input providers as the initial part of supply). The use of IT allows the possibility of designing a value and supply system coordinated to fulfill all strategic, planning and operational objectives from the HEIs, establishing effective and efficient relationships, not only inside the HEIs but also outside (Sandelands, 1994). For this, it may be established that the fundamental objective of such HE system must be to improve the condition of the product, process or service that delivers to the HE beneficiary/user/demand (e.g. professionals, society, etc.) (Habib & Jungthirapanich, 2008). That is why HEIs need to have a degree of knowledge about the players involved in the system (i.e. HE providers, HEIs, HE users), from whose coordination depends HE service performance (i.e. achievement of desired results from the chain).

Thus, being knowledge (i.e. education’s main product) intangible, it differs from any product from manufacturing industry. On top of knowledge, effective and efficient education also makes a lot use from experience and personal ethics. The other is system definition itself, as said in the previous section, contrary to what easily definable a manufacturing value and supply system would be (where each participant in the chain receives inputs from a set of providers, then it process such inputs in order to deliver the results to a set of users), a HE system is a bit more complicated. Besides having HE input providers and HE suppliers as part of the HE supply side, and HE demanders as part of the HE demand side, the system defines also a bidirectional flow for a duality input provider-demander, since some of its main input providers (supply) are simultaneously demanders (demand), and vice versa, some demanders have to provide themselves as input inbound to HE service processes (Sampson, 2000). Specifically, students demand to be professionals (potential user), and/or some finished HE results (professionals and projects) provide themselves for further process. For further detail on players of the system see Figure 2 and next sections.
Due to space restriction, this paper is limited to HE results (professionals and research) and their link to society demand). Therefore, the following propositions are set forth:

P1. There are relationships between HE professionals and society  
P2. There are relationships between HE research results and society

Methodology
Sample and categories
The qualitative phase of the research relies on the interview as data collection instrument with two objectives: 1) to get an overview of the informants; and 2) to obtain groupings of the most important knowledge areas according to economic activities.

The interview is a qualitative technique to collect a lot of information and establishes a closer and more directly relationship between the researcher and the research subject (Mayorga, 2004). The semi-structured issues for the interview were previously elaborated, from established research premises from the sections above (Cerda, 1998).

The advantages of the interview are as follows: i.-fast and easy handling, ii.-short terms and low cost, iii.-appropriate tool to interview a limited number of informants, iv.-indispensable tool to develop the analysis, to fix the logic of action and identify representatives. Likewise are some limitations in the application of the interviews: i.-limited number of people can be interviewed by maintaining a reasonable cost, ii.-problem with the representativeness of informants, iii.-information must be verified.

The actors interviewed were from the quadruple helix (government, business, academia and society): i.-employers, ii.-union schools, iii.-research grant makers, iv.-research units, v.-administrative authorities, vi.- higher education authorities, vii.- middle school authorities. To select an institution for the interview, two factors were considered:
1) its link in the HE value and supply chain; 2) and its economic activity.

In total there were 31 organizations representing the 16 general levels of the International Standard Industrial Classification of All Economic Activities from the UN (See http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=2&Top=2&Lg=1, last seen on 7-5-13): 1) Agriculture, hunting and forestry; 2) Fishing; 3) Mining and quarrying; 4) Manufacturing; 5) Electricity, gas and water supply; 6) Construction; 7) Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods; 8) Hotels and restaurants; 9) Transport, storage and communications; 10) Financial intermediation; 11) Real estate, renting and business activities; 12) Public administration and defense; compulsory social security; 13) Education; 14) Health and social work; 15) Other community, social and personal service activities; 15) Private households with employed persons; 16) Extra-territorial organizations and bodies.

The data was collected by means of semi-structured questionnaires, which had nine questions around the categories and subcategories shown on Table 1.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Category</th>
<th>Subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Professional Profile</td>
<td>Knowledge Area</td>
</tr>
<tr>
<td>2</td>
<td>Higher education</td>
<td>Processes</td>
</tr>
<tr>
<td>3</td>
<td>Secondary Education</td>
<td>Processes</td>
</tr>
<tr>
<td>4</td>
<td>Higher Technical Education</td>
<td>Processes</td>
</tr>
<tr>
<td>5</td>
<td>HE Efficiency</td>
<td>Added value</td>
</tr>
<tr>
<td>6</td>
<td>Competitive Market</td>
<td>Added value</td>
</tr>
<tr>
<td>7</td>
<td>HE effective results</td>
<td>Pertinence</td>
</tr>
<tr>
<td>8</td>
<td>HE effective results</td>
<td>Supply levels</td>
</tr>
<tr>
<td>9</td>
<td>HE supply by economic</td>
<td>Research Fields</td>
</tr>
</tbody>
</table>

Table 1. Categories and sub-categories for the interview
Method of analysis
For the analysis of the interviews, the research team developed a system called Mapping Actors, Relations, Chains, Informants, Applications and Solutions (MARCIAS), as innovating mechanism in the process of analysis in qualitative research that seeks efficiency in terms of time and test results.

MARCIAS is defined by IIES (2012) as a tool of information processing questionnaires that allow (interviews) for data analysis formats chains into value and supply chains. The strength of MARCIAS is that it is running on a web environment that allows easy import of data required and automatically manipulate Concepts, Relations, Indexes, Applications, Actors and combinations the same thus achieving a qualitative analysis of the information entered into the system.

Results and discussions
The methodology used for analyze the interviews in this research was in the first instance to define the general concepts and then establish the corresponding relationship to the research proposition. Twenty three concepts for each analysis were introduced to the system so that they had the appropriate identification for the development of relations. Table 2 shows the different concepts that were established and considered. Thus, after the content of the interviews was introduced in MARCIAS, the next was to proceed to develop the relations in the system.

Table 2. List of constructs for propositions analysis: higher education supply & demand

<table>
<thead>
<tr>
<th>No.</th>
<th>Construct</th>
<th>Link</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teaching</td>
<td>Higher Education</td>
<td>University teaching</td>
</tr>
<tr>
<td>2</td>
<td>Research</td>
<td>Higher Education</td>
<td>Refers to university research, the challenges of research in higher education, and the general perception of this in the Higher education</td>
</tr>
<tr>
<td>3</td>
<td>Students</td>
<td>Higher Education and supplies</td>
<td>Students as inputs of higher education</td>
</tr>
<tr>
<td>4</td>
<td>Academics</td>
<td>Higher Education</td>
<td>Is defined as the actual college students said.</td>
</tr>
<tr>
<td>5</td>
<td>University</td>
<td>Higher Education</td>
<td>the university as an institution of higher education process</td>
</tr>
<tr>
<td>6</td>
<td>Results</td>
<td>Higher Education</td>
<td>General view of the results of research in higher education.</td>
</tr>
<tr>
<td>7</td>
<td>capacities</td>
<td>Higher Education</td>
<td>Capabilities as determining factors in the competitiveness of professionals</td>
</tr>
<tr>
<td>8</td>
<td>Skills</td>
<td>Higher Education</td>
<td>Skills desirable in a college degree.</td>
</tr>
<tr>
<td>9</td>
<td>Facilities</td>
<td>Higher Education and primary users</td>
<td>Referring to the infrastructure which have universities for efficient process of Higher Education</td>
</tr>
<tr>
<td>10</td>
<td>Deficiency</td>
<td>Higher Education and primary users</td>
<td>Deficiency as the counterpart of efficiency to be looking at the process of Higher Education</td>
</tr>
<tr>
<td>11</td>
<td>Effective</td>
<td>Higher Education</td>
<td>Referring to the perception of the effectiveness of the process of professionalization.</td>
</tr>
<tr>
<td>12</td>
<td>Cost</td>
<td>Higher Education</td>
<td>From the point of view that improving the joint decrease costs.</td>
</tr>
<tr>
<td>13</td>
<td>Produce</td>
<td>Higher Education and primary users</td>
<td>Products are generated in the process development of Higher education.</td>
</tr>
</tbody>
</table>

1 Organized and corrected for spelling and consistency of ideas.
<table>
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<tr>
<th>No.</th>
<th>Construct</th>
<th>Link</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Professional</td>
<td>Higher Education</td>
<td>Referring to the perception of the required profile and relevant professionals.</td>
</tr>
<tr>
<td>15</td>
<td>Opportunities</td>
<td>Higher Education</td>
<td>Referring to the importance of research training as a means to create opportunities.</td>
</tr>
<tr>
<td>16</td>
<td>Competitiveness</td>
<td>Higher Education</td>
<td>As a result of training process</td>
</tr>
<tr>
<td>18</td>
<td>Development</td>
<td>Higher Education and primary users</td>
<td>Referring to the development of research</td>
</tr>
<tr>
<td>19</td>
<td>Perception</td>
<td>Higher Education</td>
<td>Perceptions of the higher education system</td>
</tr>
<tr>
<td>20</td>
<td>Value</td>
<td>Higher Education, primary users and society/employer</td>
<td>The added value that results obtained Higher education in the development of the relevant processes.</td>
</tr>
<tr>
<td>21</td>
<td>Innovation</td>
<td>Higher Education</td>
<td>Innovation as a mechanism to support the joint and improve the results of Higher education</td>
</tr>
<tr>
<td>22</td>
<td>Society</td>
<td>Higher Education and society/employer</td>
<td>Society and linking with higher education</td>
</tr>
<tr>
<td>23</td>
<td>Experience</td>
<td>Higher Education</td>
<td>Experience as a factor that adds value in the process of teaching, learning and the results of the higher education</td>
</tr>
</tbody>
</table>

The relations were establishing based on each proposition. The outputs were considered for the specific analysis of the research proposition, and were analyzed considering the conceptualization and the various relationships of concepts that were established above, so that results of the orientation relationships were according to the scope of the investigation.

As outputs from MARCIA’s analysis, one can obtain summary tables of the relationships created for each of the concepts. Thus, the program synthesized the basic information on which a qualitative judgment is issued about the results of different combinations. Figures, 3 & 4, show the software printouts with the summary tables and the discussion of the results. Figure 3 reflects the positive relationship found between professional and society, giving strong support to P1. On the other hand, Figure 4 presents the description of the positive relationship between research results and society giving support to P2.
Figure 3. Proposition 1: professionals-society

Figure 3. Proposition 2: research-society
Conclusions
As a starting point, the holistic model allowed synthetizing support literature for HE value and supply chains, input providers and the HE demanders. This was the first stage for the qualitative tests for practices, relationships, information flows, performance, etc. among all of them. Therefore, this first empirical component allowed developing database of information about HE operations in Honduras, along with all involved players from the quadruple helix (government, business, academia and society). This database was used for propositions about the HE integrated value and supply system and its relationship to the demand of both HE professionals and research.

Hence, this paper found the use (consciously or nor, partial or total) of some fundaments for the integration of value and supply chains, by some of such players. Besides, the accumulated knowledge in this research may be transferred to HE sector, employers, supporters, input providers, and society in general, by means of the dissemination of its results.

Finally, the results obtained with MARCIAS, as a support tool in the qualitative stage of the research, established in a timely manner the different aspects that characterize the relationships of the actors in the quadruple helix of higher education.2

Acknowledgments
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Bibliography

2 You can visit www.gov.iies-unah.org to display in the Executive Summary the different characterizations of the results of MARCIAS.