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KNOWLEDGE, SKILLS, AND OTHER INDIVIDUAL CHARACTERISTICS OF ACADEMIC RESEARCHERS

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ABSTRACT

This research evaluates and categorizes individual characteristics and abilities that higher education researchers should possess in a knowledge economy. We examine a sample of 319 participants dedicated to the investigating processes from public and private higher education institutions in Puerto Rico. A multivariable analysis is used in which technical successive fractural analysis, cluster, and manova analysis were applied to explore and confirm the principle relevant factors in the abilities and skills studied. From the sample, the researchers identified two groups of students that showed significant differences in their responses and how they categorized their abilities. Student subgroup 1 viewed first-priority to be to "adjust to change, add value to society and the economy, in addition to having the ability to seek for funding to support their investigations." S*tudent subgroup 2 considered first-priority to "adjust to change, add value to the economy and society and become entrepreneurs." Furthermore, this investigation found that professors considered the most relevant category to be "multidisciplinary and practical and that results should be disseminated." They have also balance benefit to the economy and society with quality of life.*

JEL: A2

KEYWORDS: Research Skills, Knowledge Economic, Cluster Analysis, Factorial Analysis, and MANOVA

INTRODUCTION

Knowledge is a central part of every economy. However, with the arrival of globalization, new emerging economies and markets, natural resources shortages and technology advancement many countries are increasingly trying to moved forward to become knowledge-based economies (Bozu & Canto-Herrera, 2009; Medina, 2014; Noel & Qenani, 2013). Unlike any traditional economy approach where capital and natural resources are central to the economic development, its pillars are built upon knowledge as the foundation where science, technology, and innovation drive the economy (Wolfe, 2005 cited as Saleim, 2014).

In a knowledge based economy, knowledge becomes the greatest asset. Knowledge places them in the lead compared to other countries that are still in the transition stage or are lagging behind (Saleim, 2014). In a knowledge-based economy, human capital is a lead actor and a producer of knowledge. Specifically, the workers are defined as knowledge workers. In that sense, universities are an important niche for this kind of worker or human capital. These institutions, through the work of academic researchers, help produce new knowledge that has its use for social and economic development. Academic researchers must count as an important success, achievement of a knowledge-based economy status. Countries must acknowledge the requirements and proposed changes of a knowledge-based economy framework in the development of human capital that will help develop new knowledge (Melnikas, 2013; Noel & Qenani, 2013; Nour et.al, 2015).

This study expands the existing literature and provides a framework or model for the development, attraction and retaining of knowledge workers such as academic researchers. The goals of the study are to: (i) Evaluate and categorize the different skills, competencies, and individual traits that researchers should have in a knowledge-based economy and (ii) Use multivariate analysist to explore, and confirm the main factors and the relevance of the skills and competencies identified.

To achieve the study purpose we administered a survey of 15 questions. The survey was validate by literature and a group of identified experts in the themes of economy, research and the academy. The sample was composed of research professors and students that were active in the tasks of research at different universities in Puerto Rico. The research conducted between 2010 and 2011 involved a sample of 319 participants. The first section of this paper discusses the literature related to skills, competencies, and individual characteristics needed by knowledge workers such as research academics. The second part present the methodology section that describes the multivariate statistical analysis techniques, factor analysis and cluster analysis utilized for the exploratory part of the paper and confirmatory analysis. The last part of the study emphasizes the most relevant findings, conclusions, and limitations.

LITERATURE REVIEW

Knowledge-based economies lead researchers and scholars to pay more attention to intangible resources. Many developed countries confront natural resource shortage and the rapid changes provoke by globalization and all the particularities that it brings to governments and organizations. As a result, a newer focus of resources like technology, information, learning, workers' skills, and experience, cooperation and networking become a competitive advantage to many countries. For that matter, is important to be able to adopt strategies that capture, develop, and retain these new resources (Bedford, 2012). In this scenario, knowledge and academic production represents an intangible resource that provides a sustainable competitive advantage of countries (Castro-Gonzáles, Peña-Vinces & Guillen, 2016 and Manfredi & Antonelli, 2014). Nevertheless, the people, the workforce, and human capital of a country are the only ones that can produce new knowledge. In that sense, countries, organizations, and society itself consider human capital as a source of differentiation and competitiveness. This study emphasizes, identifies and evaluates the requirements established by the literature about knowledge-based economies in terms of skills that will help sharpening the quality of these workforce. The concept of knowledge development as a resource for governments and society is not a new one (Bedford, 2012; Dubina et.al, 2012; Germán, et. al. 2014; Strozek, 2014).

The term knowledge-based economies appears in the discussion of American literature during the sixties with the economist Fritz-Machlup. He describes, for the first time, knowledge as a convenience and attempts to measure the magnitude of its production and distribution within the modern economy, laying the groundwork for what now known as a knowledge-based economy (Medina, 2014). Today, this term is use to explain an economic approach in which knowledge plays a crucial role, and its production is the resource for the growth of a country's economy and society. At the current stage of economic development, accumulated knowledge is a substantial part of the production and a scenario in which organizations, individuals, and communities create, acquire, and spread formal and tacit knowledge. In other words, the creation, dissemination, and usefulness of knowledge are the engine of growth, wealth increase, and employment in a country. There exists no consensus on how to achieve this new approach. Nevertheless, knowledge workers like academic researchers and researchers in general represent an important part of the strategies to endure in this new economy (Andres, et.al. 2015; Germán, et. al., 2014; Medina, 2009; Medina, 2014; World Bank, 2009).

The knowledge-based economy involves both governments and international community in designate activities and policy decisions making regarding knowledge that can provide value to the whole society. The way to achieve this is still confusing and undoubtedly complex (Medina, 2014). It is necessary to

clarify and make tangible the concepts and pragmatisms of this approach. We must learn what defines an efficient work of researchers and what it requires of them to achieve it. Expanding the paradigm where the academic researcher is responsible for developed knowledge that goes beyond what was required in the past, and support quality research and its application to the investigative work. A researcher that is label as a knowledge worker must comply with the characteristics that define it (Dubina, et.al, 2012; Dworak, 2010).

Knowledge Workers and Academic Workers

Countries that look forward to being a knowledge economy or at least to maximizes its human capital intellect need to be clear about what constitutes a knowledge worker. Peter Drucker in his book "The Effective Executive" (1966) described and differentiated the concepts manual worker and knowledge worker. A manual workers work demands more physical ability than intelligence in order to produce goods or services. On the other hand, a knowledge worker works with his mind and intelligence, to deliver ideas, knowledge, and information (Medina, 2014). Knowledge workers include those such as data analysts, product developers, planners, programmers, and researchers who are engaged primarily in acquisition, analysis, and manipulation of information as opposed to in production of goods or services.

An academic researcher uses his intellect to generate knowledge and to pursue truth. Categorizing this type of worker as a knowledge worker is the correct way of see them. Not only because they use their mind and intelligence to generate an intellectual product, but because this production can be use by non-academic institutions (like government and business) in the development policymaking and other commodities (Brew & Lucas, 2009). At the theoretical level, the acquisition of competencies is crucial for productivity, innovation, and living standards. For universities and managers, the role of knowledge workers in attaining management success has been acknowledge. For that matter, it is important to have the right framework to recruit and select, motivate and measure the performance of knowledge workers. The right framework will also come in support of a university with the desire to develop policies for retaining and attracting knowledge workers if they want to survive in the environment in constant change (Gogan, 2014).

This section describes the important of competencies and skills development in workers and the characteristics presented in the literature that can help us describe what means to be an academic researcher in a knowledge-based economy.

Studies about knowledge workers (especially researchers), explain the new demands and requirements of this new economy and the impact on the work done by knowledge workers (Madrak-Grochowska, 2015). Although is not perfectly clear, we must assume that every change in the requirements of a job's results implies the development or acquisition of new skills by the workers.

The development of knowledge workers is essential to a knowledge-based economy. Some theories try to explain the relevance of competencies in the development of individuals. Boyatzis (2008), in his paper *Competencies in the 21st century* describes the theory of action and job performance which emphasizes best-fit maximum performance, stimulation, and commitment area of maximum connection or integration between the worker and the job demands. A theory of performance is the basis for the concept of competency. Maximum performance occurs when the worker's capability or talent is consistent with the needs of job demands and organizational environment. Competencies are useful to identify the best performance of employees. They include descriptions that make it easier to identify how competencies can evolve in parallel with development and improvement of employee performance. Perhaps the most important aspect of competency models is that they align to HR systems across the organization. This includes recruitment, selection, hiring, training, performance management, compensation through development and training of employees. Knowledge Assessment Methodology also emphasizes the importance of research, education, and training. Both constitute two important pillars in its methodology

of a knowledge economy. From the above, it seems that research, education, and training play a key role in the growth of any knowledge economy (Chen and Dahlman, 2005 as cited in Batra, 2009; Schwab, 2013). We wish to know, *which are the necessary skills to develop high-quality research in a knowledge-based economy?* As previously stated, very few authors indicate how demands of the new knowledge-based economy will affect how the researcher performs to add value to the economic development. Moreover, there is no known competency model or framework to explain or guide this development or any strategy needed by organizations for this achievement. The importance of human capital formation, as a fundamental aspect of the knowledge-based economics, is not new, but is increasingly important to achieve this status. This work performance expectations implies a change of paradigm, which as mention before also requires a change in the skills and competencies needed by knowledge workers (Dubina, et al., 2012; Germán, et al., 2014; Tan, 2016; Kulkarni, 2014; Torres et.al., 2015; Wills et.al., 2013). To introduce ourselves to the subject of knowledge workers skills and competencies, it is fundamental to define some important terms. We also discuss different individual characteristics that are fundamental for knowledge workers in a knowledge-based economy.

The Royal Spanish Academy defines skills as abilities, art, neatness, or property with which something done. Skill is the ability and willingness to something" (Medina, 2009). Alvarez & Gallego (cited in Bozu & Canto-Herrera, 2009) defines working competencies as "the set of knowledge, skills, and necessary attitudes to perform a given occupation and the ability to mobilize and apply these resources in a given environment, to produce a definite result "(p. 23). According to De Zubiria (2006 cited in Andrés, et.al. 2015), competencies represent an implicit partly innate knowledge and formally expressed in the expertise to do something.

Knowledge in the management and development literature, is to viewed as a part of the competence profile of human resources. The International Labor Organization (ILO 2007 as cited in Batra 2009), defines competence as ''knowledge, skills and expertise applied and mastered in a specific context''. In that sense, the relationship between education and training as sources of generating competence becomes obvious. Another important interpretation of knowledge is the creation of new products/processes/ technologies or management systems through the processes of research and innovation (Batra, 2009). To remain competitive in today's global economy, the development, and strengthening of competencies, knowledge, and individual characteristics and skills in knowledge workers in general is essential for any country. Academic researchers are not excluded, and need to develop skills, competencies, and individual characteristic accordingly to the requirements of this global scenario.

This section describes different competencies and characteristics identified in the literature that are essential in the development of researchers and knowledge workers. We discuss different skills, competencies and individual characteristics outlined in the recruitment efforts and evaluate what other studies and organization discuss. Countries like Austria, Ireland, Japan, Taiwan, Finland, and the United States use guidelines that include; teaching skills, teamwork, ability to transfer knowledge into something tangible, management and supervisory skills and capacity to identify, assess, and anticipate socials needs and preferences to attract, recruit, and retain knowledge workers (Pineda, 2013; Roberts, 2009)

The Unites States has been highly successful appealing to knowledge workers especially those related to the scientific and academic research. Multidisciplinary participation is one of the criteria for research projects with financial support. Within or external to academia, an investigator must develop networks of horizontal collaboration further beyond his or her institution in which society, private organizations as well as the government participate (Dempsey, 2004; Ennals, 2004; Sharma, 2008; Zagreb, 2008). Ennals (2004) established that multidisciplinary research and collaboration among peers are of extreme importance to a knowledge-based economy. This multidisciplinary approach and collaboration among peers are critical in an economy where knowledge generation is a requirement. Multidisciplinary approaches add value to the results of an investigation. This point of view implies working with the best resources and experts.

Changes and challenges that encompass living in a globalized world expand the scope of the work done. Academic researchers in a knowledge-based economy must generate investigations and report their results. In addition, those results or scientific performance translate into benefit for the author country's economy and society (Abu Said, et al., 2015; Eliasson, 2005; Noel & Qenani, 2013; Zagreb, 2008). However, the Knowledge Workers Forum (2006, cited in Salem, 2014) argues that knowledge work is complex, and those who perform it require certain skills and abilities as well as familiarity with actual and theoretical knowledge. These workers must be able to find, access, recall, and apply information, interact well with others, and possess the ability and motivation to acquire and improve these and other skills. The importance of one or more of these characteristics may vary from one job to the next. However, all knowledge workers need the following: (i) Factual and theoretical knowledge**,** (ii) Finding and accessing data, (iii) Ability to apply information, (iv) communication abilities, (v) Motivation and (vi) Intellectual proficiencies (Knowledge Workers Forum, 2006 cited in Salem, 2014).

Academic researchers are instrument of change and innovation (Gurrola et. al., 2015). To achieve that purpose they must develop skills related to change management, teamwork, collaboration and be a creative person (Dang & Umemoto, 2009; Van Winden & Van den Berg, 2004). Peter Drucker, in his description of a knowledge worker, defines that key determinants of their productivity are management and organizational practices, information technology, and workplace design. Individual characteristics that people have such as honesty, hard work, integrity, teamwork, and resilience affect productivity. According to Quesada (2008), being a researcher in a knowledge-based economy is not only to be define as knowledge managers and processes' administrators. The academic researcher is an instrument of change and innovation (Dang & Umemoto, 2009; Van Winden & Van den Berg, 2004). That is a very different view of how an academic research perceived outside universities. Academics conduct research out of intellectual curiosity and with the aim of generating knowledge. Nevertheless, when knowledge is regarded as a type of resources that can traded as goods to enhance economic development, then many characteristic discussed earlier became crucial to achieve success (Brew & Lucas, 2009; Lenaghan, 2016; Liz & Wilson, 2012).

Facilitating research processes and providing direct support to adopt novel ways to investigate are characteristics required of a researcher in a knowledge economy (Andrés, et. al. 2015). Developing a global vision to identify the preferences and needs of society and the economy both at the domestic and global scenario is also essential to quality (Regets, 2007). According to experts, a researcher must be part of all processes that involve generating an investigation (Howells, 2002, cited as in Van Winden & Vanden Berg, 2004). The development and strengthening of skills and competencies related to the dissemination of their work is substantial if they add value to the work done. In this regard, the literature shows that countries like Taiwan, Japan, and South Korea have been active in promoting and educating their researchers in the creation of patents and the publication and dissemination of results (Yang et. al., 2005). Skills that go beyond their expertise such as collaboration, creativity, tolerance, appreciation of diversity, and other social skills are important parts of any high-quality higher education system (Dempsey, 2004; Medina, 2014). Ennals (2004) establish that a multidisciplinary approach and collaboration among peers are critical in an economy where knowledge generation is a requirement. This point of view implies working with the best human resources and experts to be a collaborative person. Skills that go beyond their expertise such as collaboration, creativity, tolerance, appreciation of diversity, and other social skills are important parts of any high-quality system higher education (Dempsey, 2004; Medina, 2014; Schwab, 2013).

Puerto Rico, like other countries should seek new ways to stay and be competitive on the global stage. In that sense, the development of human capital such as knowledge workers should be a priority and consider on its agenda for economic growth. The shortage of researchers compared to the needs in the area of research and development is a problem that afflicts not only Puerto Rico but also many other nations who try to break into this new form of economy (Comella et. al., 2008; Medina, 2009). According to Swarp (2007, cited in Medina, 2014), countries like the United States and the European Union have had great

success in attracting knowledge workers, such as academic researchers, are changing the focus of what is important about a good researcher.

Social factors such as an aging workforce, government policies, tightening immigration laws, new emergence economics, besides establishing strategies to attract researchers represent areas of opportunity for the country and its universities. This study contributes to the review of literature on the work of academic researchers under the new requirements of knowledge-based economies. The study results assist in determining which skills, knowledge, and skills must be developed or promoted for research so that the fruit is of benefit to the economy and society. Demand for comprehensive talent management strategies is at an all-time high for any organization including universities. The next part presents the methodology section that describes in detail the multivariate statistical analysis techniques, factor analysis and cluster analysis utilized for the exploratory part and confirmatory analysis. The last part of the study emphasizes on the result analysis, the most relevant findings, conclusions, and limitations.

DATA AND METHODOLOGY

As part of the study, a questionnaire was administered to 319 researchers in Puerto Rico's public and private universities who are dedicated to research activities. There were 245 master and doctoral students and 74 faculties from public and private higher education institutions in Puerto Rico. This instrument was constructed using a Likert scale in which one is total disagreement and five total agreement. A copy of the questionnaire is included in the appendix of this study. We collected the data during the period from 2010 and 2012.

Multivariate analysis is used in this explorative-confirmative study. This technique permits a simultaneous multi-measure analysis of individuals and objects under study to create knowledge that can assist in a well and informed decision-making process (Castro-Gonzáles, Arias & Irizarry, 2016; Cuadras, 2014; Hair, Black, Babin, & Anderson, 2010). The following criteria are used in the design and sequential procedures of the techniques: a) identify if the 76.80% of the sample who were graduate students responded to similar subgroups. From the cluster analysis in the general students' sample, several sub-groups show similar characteristics. As a consequence, there was similar average by using the square Euclidian distance in the matrix (Fernández, 1991; Hair et al., 2010).

After the two subgroups of students had been identified, the researchers proceeded with the following criteria of the study b) a factorial analysis was carried out to each selected group from the previous cluster. The factorial analysis is a technique to lower some unobserved variables. It serves to find homogeneous variables from some observed variables. As defined, factor analysis is a statistical method used to describe variability among observed, correlated variables regarding a potentially lower number of unobserved variables called factors (Hair et al., 2010; Pérez & Medrano, 2010; SPSS-Hispanoportuguesa, 2010). After this procedure, the following phase included c) using a factorial analysis to the responses from the professors who were 23.20% of the sample. The aim was to identify categories that these investigators perceived as factors of importance and thus perform a comparative analysis of the primary factors identified among the three subgroups.

The final criterion was d) to confirm the hypothesis of the study, an analysis of variance (MANOVA) Multivariate used. It is a generalization to the models of simple analysis of variance (ANOVA) as well as to other models, which have some variables larger than one at the same time (multivariate). MANOVA is a technique that simultaneously allows the contrast of mean differences (centroids) of two or more dependent variables (Cuadras, 2014; Fernández, 1991; Hair et al., 2010; J. Pérez, 2004), which helped in the resolution of the hypothesis proposed for this study.

The investigation resulted in the identification of three groups, including each group's variables average vector labeled as Students 1, Students 2, and Professors. Consequently, a null hypothesis proposed for the study confirmed that no significant differences exist among the vectors averages of each group. Therefore, all the vectors are the same. This assumption led to the hypothesis for the study that indicated that differences existed among the vector means of the sub-groups as identified from the analysis. The mathematical expressions of the hypothesis are:

$$H_0: \mu_1 = \mu_2 = \mu_3 \quad (1)$$

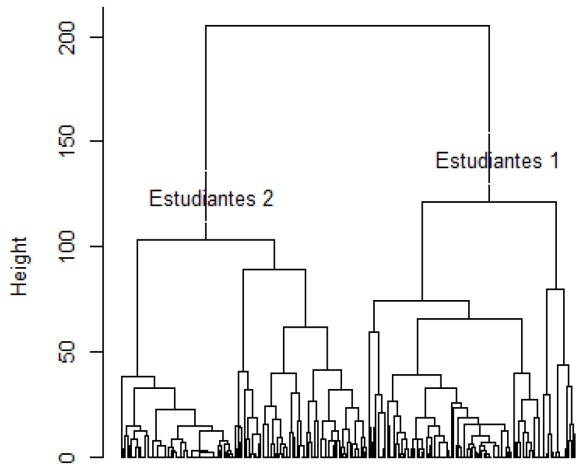
$$H_1: Not\ all\ are\ equals \quad (2)$$

RESULTS AND DISCUSSION

Graduate Students: Cluster Analysis

A cluster analysis was completed from the graduate students' general data to verify if there were any subgroups of individuals with mutually exclusive characteristics. The Euclidean squared distance technique (Fernández, 1991; Hair et al., 2010) used the Ward's hierarchical distance square method. Two groups clearly identified by a Euclidean strategic cut at 150, in which the responses were different. The first group formed by 112 students identified as Students 1(53 men and 59 women) and distributed to 15 doctoral students and 87 Master's degree students. Students whose average responses were different to the second subgroup composed of 133 students identified as Students 2 (77 men and 56 women) of those 42 were doctoral students, and 91 were Master's students. Figure one, corresponds to R® "output" known as a dendrogram. The graphic clearly identified the two subgroups of students. Two factorial analysis implemented to the subgroups to determine the principle categories stated by each group.

Figure 1: Cluster Analysis Dendrogram for Graduate Students



This figure shows the output ® program of cluster analysis. Two groups of graduate students, each cluster with similar characteristics. The first cluster called "students1" is comprised of 112 students (53 men and 59 women) and the second "students 2" which is slightly larger shaped identify by 133 students (77 men and 56 women).

Graduate Students Sub-groups: Factorial Analysis

The primary results of the study obtained by the use of the R® statistical analysis software. Before the development of the factorial analysis, researchers measured the levels of internal reliability of the items used in the questionnaire (Moscoso, Lengacher, & Knapp, 2012). Internal reliability of the items was

calculated and measured with the Alpha of Cronbach, according to Moscoso et al., (2012). This value should be larger than 0.7, which establishes that the instrument has adequate internal reliability. In this case, the items obtained 0.8371 alpha Cronbach and a standardized alpha Cronbach of 0.842. The data indicated internal reliability of the responses to the questions. Before doing a factorial analysis, the literature recommends testing for the adequacy of the sample by the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO). This group obtained a 0.80 relevance to do a factorial analysis (Hair et al., 2010; Moscoso et al., 2012; E. Pérez & Medrano, 2010). Bartlett's sphericity test confirmed the potential to perform a factorial analysis because the "p-value" of this test was 1.17×10^{-171}, which is much less than the level of significance of 0.05 used for this investigation.

Taking into consideration the KMO measurement and Bartlett's sphericity test, a factorial analysis was an appropriate technique to employ in this study. The next step was to obtain the most relevant results after the previous tests performed. A factorial analysis used to get data regarding the perception of each subgroup about the abilities and skills that investigators should possess in the knowledge-based era.

Students 1

The Student 1 subgroup was composed of 25 doctoral students (22.3%) and 87 master's degree students (77.7%) totalling 112 respondents. The gender distribution was 53 men and 59 women. As presented in Table 1, five principal factors were observed that explained 66% of model variance. Among these factors, there were three categories. The first component had a variance of 16.6% comprised of the variables V15, V14, V12, and V13. The second group V3, V5, and V11 provided an explained variance of 13.9%. A third principal factor composed by V4, V9, and V10 produced an explained variance of 13.9% as well. The explained variances presented in Table 2.

Table 1: Principal Components with Rotation Varimax of Students 1 Subgroup

Variable	F1	F1	F3	F4	F5	h2
V15	0.802	0.016	0.229	-0.019	-0.046	0.699
V14	0.756	0.027	-0.053	0.074	-0.383	0.727
V12	0.684	0.247	-0.263	-0.019	0.175	0.628
V13	0.684	0.081	0.286	0.198	0.201	0.635
V3	0.067	0.811	0.268	0.016	0.070	0.740
V5	0.044	-0.692	0.389	0.046	0.043	0.636
V11	0.336	0.692	0.106	-0.027	0.120	0.618
V4	0.272	-0.034	0.756	-0.104	0.222	0.707
V9	0.015	0.002	0.727	-0.102	-0.401	0.701
V10	-0.088	0.195	0.612	0.226	0.268	0.543
V1	0.312	0.301	0.328	0.179	0.245	0.387
V8	0.006	0.041	0.036	0.846	-0.009	0.719
V6	0.179	-0.392	-0.130	0.708	0.275	0.779
V7	0.090	0.294	0.120	0.561	-0.528	0.703
V2	0.029	0.178	0.166	0.088	0.782	0.680

This table shows the results from output R® of the factorial analysis. Only 5 factors explain 66% of model variance. The first factor in importance is composed by V15, V14, V12 and V13 with 16.6%% of variance; the second factor is formed by the variables V3, V5 and V11 which explains 13.9% variance of the model; the third group formed by V4, V9, V10 and V1 explains 13.0% of variance.

In the Student 1 group, the first factor with greater explained variance from the clustered variables was the knowledge-based economy. Investigators "must be aware that the results should adjust to change and add value to the economy and society and must have the ability to search for funding to finance their investigations". The next factor of importance was the results should "be converted into public good, be internationalized, and assist in the development of the economy and society". For this third factor, investigators should "have technological knowledge, investigate within a practical approach, and be

respectful of intellectual property. These three primary factors added up to explain 44.4% of the variance of the model and an accumulated 67% in proportion to the 5 elements.

Table 2 Variance Explanation of the Principal Components of Students 1 Subgroup

Item	F1	F2	F3	F4	F5
Weight SS	2.490	2.088	2.083	1.692	1.549
Proportional Variance	0.166	0.139	0.139	0.113	0.103
Cumulative Variance	0.166	0.305	0.444	0.557	0.660

This table shows the variance explanation of the principal components of Students, 1 Subgroup; the third row represents the individual variance for each of the 5 factors and in the fourth row the accumulated variance of the factors is presented. The intercept of column F5 and Cumulative variance is 0.660 which represents 66% explained variance.

Students 2

The Students 2 subgroup composed of 42 doctoral students (31.5%) and 91 master's degree students (68.4%) for 133 respondents. The gender distribution was 77 men and 56 women. As seen in Table 3 five main factors explained their variance at 58.9% of the model. Three categories were relevant among these factors: the first component had a 15.5% of the variance and comprised by V14, V1, V15, and V2; the second group included V6, V13, and V7 with variance explanation of 13.4%. The third main factor contained the following variables V11 and V3 with an explained variance of 12.1%. Table 4 illustrates the explained variances of this subgroup.

Table 3: Principal Components with Rotation Varimax of Students 2 Subgroup

Variable	F1	F1	F3	F4	F5	h2
V14	0.765	0.151	-0.004	0.146	0.066	0.634
V1	0.680	0.234	0.216	0.088	-0.043	0.574
V15	0.620	-0.242	-0.220	-0.034	0.485	0.728
V2	0.572	0.223	0.267	0.018	-0.048	0.450
V12	0.434	-0.059	0.423	0.246	0.025	0.432
V4	0.428	0.068	-0.049	-0.046	-0.085	0.199
V6	0.133	0.794	0.114	-0.085	-0.012	0.669
V13	0.261	0.727	0.277	0.002	0.042	0.675
V7	0.132	0.679	-0.346	0.200	0.065	0.642
V11	-0.034	0.110	0.772	0.086	0.181	0.650
V3	0.134	0.035	0.748	0.011	-0.065	0.583
V9	0.037	-0.142	0.195	0.741	-0.031	0.610
V8	-0.062	0.387	0.089	0.702	0.216	0.701
V10	0.244	0.000	-0.205	0.542	-0.317	0.495
V5	-0.056	0.104	0.100	-0.015	0.874	0.788

This table shows results from output R® of the factorial analysis. Only 5 factors explain 66% of model variance. The first factor in importance is composed by V14, V1, V15 and V2 with 5.5%% of variance explained. The second factor is formed by the variables V6, V13 and V7 which explains 13.1% variance of the model. The third group formed by V11, V3, V9, V8 and V10 explains 12.1% of variance, among the most important.

The group's first factor with greater explained variance was that the investigators, "must be aware that the results should adjust to change and add value to the Economy and Society and eventually become entrepreneurs". The second factor of importance in this group considered was that investigators should "have a well-developed technological infrastructure, be multidisciplinary, and have the ability to search for funds to investigate. Finally, the third factor, the results should "be converted into public good, and be internationalized". These three primary factors added up to a 44.4% of the variance of the model and an accumulated 69.5% in proportion to the 5 elements.

Professors: Factorial Analysis

This group was composed of 58 professors with a doctoral degree (78.4%) and 16 with Master's degree (21.6%) for a total of 74 respondents. The gender distribution was 48 men and 26 women. Previously, the level of internal reliability in questionnaire items was measured (Moscoso et al., 2012). Cronbach's alpha value was calculated and obtained 0.8212 alpha Cronbach and a standardized alpha Cronbach of 0.8299. The data indicated internal reliability of the responses to the given questions. Before doing a factorial analysis, the literature recommends testing for the adequacy of the sample by the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) was 0.71. This value is closer to the inferior limit of acceptance and reiterated through Bartlett's sphericity test. A "p-value" de 3.12×10^{-44}, a very low to the value used for this investigation of 0.05 which confirmed the Barlett law strength to perform a factorial analysis on the sample of professors (Hair et al., 2010; Moscoso et al., 2012; E. Pérez & Medrano, 2010).

Table 4: Variance Explanation of the Principal Components of the Students 2 Subgroup

Item	F1	F2	F3	F4	F5
Weight SS	2.322	2.008	1.810	1.484	1.207
Variance Proportional	0.155	0.134	0.121	0.099	0.080
Variance Cumulative	0.155	0.289	0.409	0.508	0.589

This table shows the variance explanation of the principal components of Students, 2 Subgroup. The third row represents the individual variance for each of the 5 factors and in the fourth row the accumulated variance of the factors is presented. The intercept of column F5 and Variance Cumulative variance is 0.580 which represents 58% explained variance.

The results for this part obtained are shown in Table 5, which illustrates the factorial analysis of the results for the professors' group. This chart corresponds to the results. Using the Varimax method the variables were rotated to guarantee multicollinearity (SPSS-Hispanoportuguesa, 2010). From fifteen variables analyzed from the professors' group, only five factors are well represented. They have an explained variance level of 69.6% from the total. The first element represented by the questions V12, V9, V7, V8, and V15 have an explained variance of 21.4%. The second factor comprised of the questions V6, V7, and V4 contributed with 13.7% of the variance of the model. The third element, constituted by questions V13, V14, and V10, explain12.6% of the variance in the model (See Table 6). The group's first factor with greater explained variance was that the investigators "should be multidisciplinary, practical, and their investigation results should be internationalized, and add value to the Economy and Society along with the quality of life". The second factor was "have a good technological infrastructure manage efficiently the basics of technology to contribute to the development of the Economy and Society". The last and third factor has to do with how investigators should "respect intellectual propriety, accept change, and be able to search for funding to investigate. These three factors add up to 44.4% of the variance of the model and an accumulated 69.5% in proportion to the 5 elements.

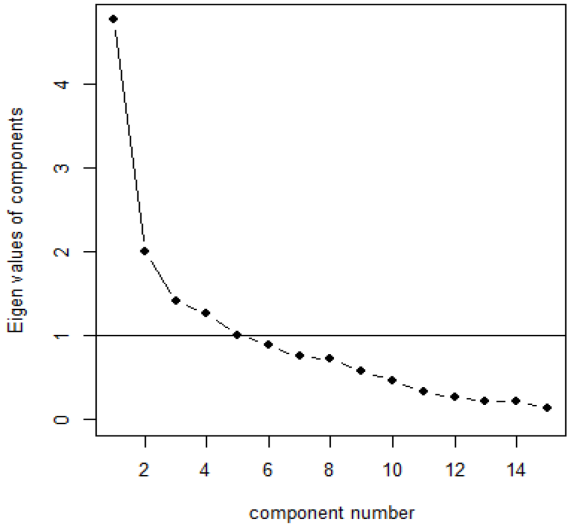
Figure 2 represents a screen plot to distinguish the five factors that explain approximately 70% of the sample's variance. However, the first three elements have a 68.8% level of explained variance of the five factors that demonstrates their importance over the explained variance. A cluster analysis not performed to respect the variability rule for practical researchers. It states that for each variable there should be at least ten responses. Therefore, if this study had 15 variables, the rules would suggest having 150 replies (Cuadras, 2014; Hair et al., 2010).

Table 5: Principal Components with Rotation Varimax of the Subgroup Professors

Variable	F1	F2	F3	F4	F5	h2
V12	0.790	0.167	0.254	0.275	0.161	0.819
V9	0.768	0.107	0.160	0.000	0.229	0.679
V7	0.767	0.087	-0.001	0.383	0.027	0.743
V8	0.766	0.128	-0.115	-0.100	0.186	0.660
V15	0.629	0.057	0.409	0.188	-0.081	0.608
V6	0.133	0.869	-0.058	-0.063	-0.034	0.782
V5	0.146	0.857	-0.012	0.131	0.167	0.801
V4	0.133	0.528	0.502	-0.039	0.167	0.579
V13	0.087	-0.251	0.686	0.309	0.060	0.640
V14	0.434	-0.117	0.658	0.103	-0.034	0.646
V10	-0.055	0.246	0.624	0.017	0.249	0.516
V1	0.050	-0.108	0.104	0.870	0.032	0.783
V2	0.341	0.217	0.188	0.769	0.050	0.792
V11	0.166	0.000	0.107	-0.087	0.818	0.716
V3	0.150	0.167	0.107	0.186	0.761	0.675

This table shows results from output R® of the factorial analysis. Only 5 factors explain 69.5% variance of the model. The first factor in importance is composed by V12, V9, V7, V8 and V15 with 21.4%% of variance explained. The second factor is formed by the variables V6, V5 and V4 which explains 13.7% of model variance. The third group formed by V13, V14 and V4 explains 12.6% of variance.

Figure 2: "Scree Plot" Principal Components for the Professors



This figure shows a scree plot that helps visualize the relative importance of the factors, a sharp drop over the horizontal line in the plot signals that subsequent factors are ignorable, so it shows that only considering 5 factors can have an explanation of 69.5% of the variance of the model.

Table 6: Explanation of the Variances of the Principal Components of Professors Group

Item	F1	F2	F3	F4	F5
Weights SS	3.208	2.060	1.888	1.787	1.496
ProportionalVariance	0.214	0.137	0.126	0.119	0.100
Cumulative Variance	*0.214*	*0.351*	*0.477*	*0.596*	*0.696*

This table shows the variance explanation of the principal components of Professors group. The third row represents the individual variance for each of the 5 factors and in the fourth row the accumulated variance of the factors is presented. The intercept of column F5 and Variance Cumulative variance is 0.696 which represents 69.5% explained variance.

Confirmatory Analysis of the Three Subgroups: Students 1, Students 2, and Professors

To resolve the working hypothesis, Manova multivariate variance analysis was performed among the three subgroups. The alternate hypothesis affirmed differences in the averages of the three subgroups under study. The results of this analysis are in Table 7. The table is divided into four sections: a, b, c, and d. Section A of the table corresponds to the results of the Manova analysis among the subgroups of Students1 and Students 2. We observe the *p value* = 2.2×10^{-16} is much smaller than the level of significance for this research which has been (0.05), therefore, it was recommended to accept the alternate hypothesis, and can be affirmed that significant statistical differences exist among these two subgroups. Section B of the table corresponds to results of the Manova analysis between Students 1 and Professors. The value of *p* of 5.22×10^{-13} affirms that significant statistical differences exist between these two subgroups. In section, C, which corresponds to Students 2 vs. Professors the p- value is minimal. It confirms that significant differences exist between these two groups under study. Finally, the alternate hypothesis was accepted. Through the general Manova Analysis to the three subgroups because its *p-value* is on the order pf 2.20×10^{-16}, which is a subtle value compared to the level of significance in the study.

Table 7: Manova for Three Subgroups Students 1, Students 2, and Professors

A. Students 1 Vs. Students 2						
	Df	**Pillai**	**Approx F**	**# Df**	**Den Df**	**Pr(>F)**
as.factor(gr)	1	0.6606	29.715	15	229	<2.20E-16
Residuals	243					
B. Students 1 Vs. Professors						
	Df	**Pillai**	**Approx F**	**# Df**	**Den Df**	**Pr(>F)**
as.factor(gr)	1	0.4051	7.7175	15	170	5.22E-13
Residuals	184					
C. Students 2 Vs. Professors						
	Df	**Pillai**	**Approx F**	**# Df**	**Den Df**	**Pr(>F)**
as.factor(gr)	1	0.2792	4.9317	15	191	4.05E-08
Residuals	205					
Third Sub-groups Manova						
	Df	**Pillai**	**Approx F**	**# Df**	**Den Df**	**Pr(>F)**
as.factor(gr)	2	0.67043	10.186	30	606	2.20E-16
Residuals	316					

This table shows the results of Manova. Section A corresponds to the subgroups Students1 and Students 2, with a p value = 2.2×10^{-16} and a level of significance of 0.05. Section B corresponds to Students 1 and Professors. A p-value of 5.22 x 10-13 affirms that significant statistical differences exist between these two subgroups. Section C, is Students 2 vs. Professors and as stated its p- value is minimal, confirming that significant differences exist between these two groups. In section D the alternate hypothesis accepted for the three subgroups because its p-value is 2.20×10^{-16}, less than 0.05.

In addition to the previous statistical evidence, there were noticeable differences in corresponding values among the vectors' averages. Table 8 represents the values of the standards corresponding to each group's analysis. It considered as X1, X2, and X3 to the vectors of the average values in the subgroups Student1, Students 2, and Professors respectively. The last three columns in Table 8 correspond to the values of the standard deviation of the mean vectors.

Table 8: Values of Vectors' Averages and Standard Deviations of the three Subgroups

Variable	mX1	mX2	mX3	sX1	sX2	sX3
V1	3.24	3.41	3.2	0.86	1.07	1.13
V2	3.59	4.32	4	0.81	0.67	1.16
V3	3.77	4.07	3.99	0.94	1.12	1.2
V4	3.92	4.56	3.86	0.83	0.64	1.11
V5	3.86	4.54	4.55	0.66	0.63	0.64
V6	3.79	4.72	4.5	0.75	0.54	0.67
V7	4.33	4.77	4.58	0.66	0.56	0.72
V8	4.28	4.9	4.58	0.59	0.3	0.62
V9	4.21	4.68	4.35	0.54	0.57	0.9
V10	4.16	4.56	4.42	0.64	0.71	0.76
V11	4.01	4.55	4.58	0.89	0.71	0.76
V12	3.74	4.72	4.38	1.02	0.48	0.92
V13	3.54	4.29	3.53	0.78	0.95	1.26
V14	3.78	4.57	4.14	0.64	0.57	0.8
V15	3.79	4.65	4.32	0.9	0.65	0.97

This Table shows the following: the first three column represents the mean values of the vectors groups as mX1, mX2, and mX3 that corresponds the subgroups Student1, Students 2, and Professors respectively. The last three columns correspond to the values of the standard deviation of each mean vectors.

CONCLUSIONS AND LIMITATIONS

The goals of this study were to; (i) Evaluate and categorize the different skills, competencies, and individual traits that researchers should have in a knowledge-based economy; (ii) Use multivariate analysist to explore, and confirm the main factors and the relevance of the skills and competencies identified. To achieve the study purpose we administered a survey of 15 questions. The research conducted between 2010 and 2011 obtained a sample of 319 participants. The analyses performed were multivariate statistical analysis techniques, factor analysis and cluster analysis utilized for the exploratory part and confirmatory analysis.

The conceptualization is that investigators "must be aware that the results should adjust to change and add value to the economy and society and have the ability to search for funding to finance their investigations." This result is an important finding of the subgroup Student 1. The following factor of importance this group considered was that the results should "be converted into public good, be internationalized, and assist in the development of the Economy and Society." For this third factor, investigators should "have technological knowledge, investigate within a practical approach, and be respectful of intellectual property. These three primary factors added up to a 44.4% of the variance of the model and an accumulated 67% of the proportion of the 5 elements.

Subgroup b) Students 2 identified, and the first factor with greater explained variance, that investigators, "must be aware that the results should adjust to change and add value to the Economy and Society and eventually become entrepreneurs." The second factor of importance in this group was that investigators should "have a well-developed technological infrastructure, be multidisciplinary, and have the ability to search for funds to investigate. Finally, by the third factor, results should "be converted into public good, and be internationalized". These three primary factors added up to a 44.4% of the variance of the model and an accumulated 69.5% in proportion to the 5 elements.

Professors were the third subgroup in which the greatest explained variance was for the variable: "should be multidisciplinary, practical, and their investigation results should be internationalized, and add value to the economy and society along with the quality of life." The second factor of importance that was that investigators should "have a good technological infrastructure manage efficiently the basics of technology to contribute to the development of the economy and society". The last and third factor has to do with how investigators should "respect intellectual propriety, accept change, and be able to search for funding to

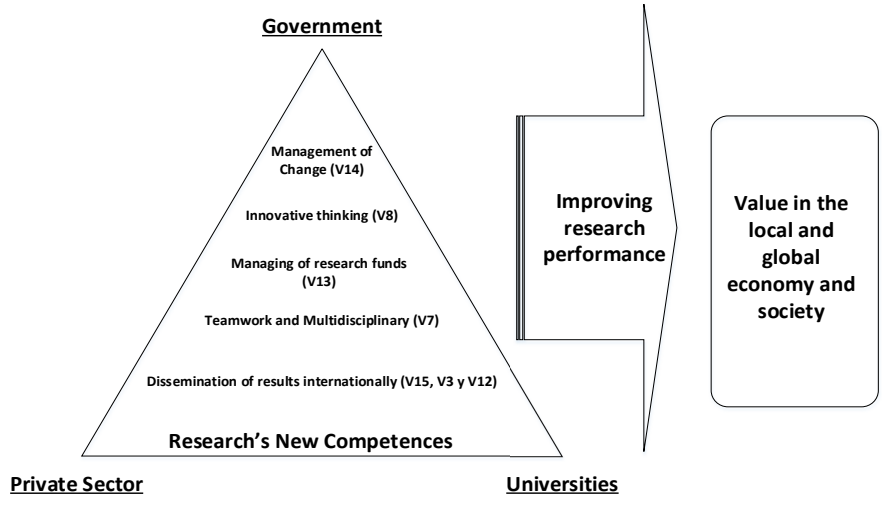
investigate." These three factors add up to 44.4% of the variance of the model and an accumulated 69.5% in proportion to the 5 elements.

As the findings revealed, to have an productive and efficient research performance, research's results; should have an impact to the local and global economy as well as society (V15, V3, and V12), researchers work should adjust to change (V14), researcher need to search for funding (V13), and be multidisciplinary and innovative (V7 and V8). Finally, this investigation found differences in the values of the average vectors in the variables between the three groups. Thus, there exist different categories of each subgroup's analysis that could be due to their academic formation or their experience with the research topic.

The findings contribute to the proposed model or framework describe in Figure 4, which can guide the development of additional skills and support different individual's characteristics for the improvement of researchers work. Perhaps the most important aspect of competency models is that they align HR systems across the organization. This includes recruitment, selection, hiring, training, performance management, compensation through development and training of employees. The framework suggests that to achieve development, and strengthening of the investigative work, it needs the support and collaboration of three areas: the private sector, universities, and Government.

The quality of academic research depends greatly on strengthening existing units of research, funding, accreditation and the extension of postgraduate's opportunities with relevance in the creation of knowledge (Andrés et. al., 2015). Research, of any kind should contribute to the growth of global, regional, and local knowledge. Currently, differences between these two scopes is perceptible variables of cultural accommodation, and its tenets and discoveries must allow greater equity between people and accelerated progress of the well-being of societies (Gurrola et.al, 2015; Hossain, 2015). From this point of view, the findings of this research have implications for academics that pursuit a research career, human resources managers in universities, and the government.

Figure 3: Academic Researcher's Development Framework



This figure describes a framework suggested to achieve the development and strengthening of the investigative work. It needs the support and collaboration of three areas in particular: the private sector, the universities and the Government.

For the academic researcher the results imply the development and strengthening of skills that perhaps are not considered so important for research development because they are not related to technical skills. Researchers should develop aspects related to social skills to complement their work. Skills needed to collaborate with other researchers in or out of universities, a global vision to perceive changes in social

preferences, and be a good administrator to manage successfully his work. The goal is to transcend the boundaries of universities to influence society and in particular, the country's economy. This is interesting because is not the way academics in general work. In many universities, knowledge developed, or intellectual production stay within the university or are shared only with other academics, professionals, organizations, or associations. Rarely, do these intellectual productions transcends to the rest of society and the government. In that sense, the results of this investigation serve as a roadmap for research that wants to succeed and recognize as a knowledge worker.

At the institutional level, such as universities and research centers and the managers in areas such as human resources, our results provide a roadmap that allows the establishment of new models of competencies or a framework for scholars and academic researchers work and incentive systems. More important, the results suggest that human resource managers in academic institutions need to revisit academic job descriptions and specifications. A job description outlines the primary duties and responsibilities of a given position in a company, while a job specification outlines the qualities and qualifications (knowledge, skills, abilities, competencies) required of someone in the role. Both are useful in practices such as recruitment and selection, training and development, incentive and compensation systems. Abu Said (et al. 2015), prove there is a significant relationship between the effect that has organizational support and the successful academic.

Human resources managers and university managers in general will be more effective in finding opportunities and establishing career paths for academic researches as knowledge workers. It also allows universities to have new elements of judgment when recruiting or inviting researchers or establishing professional development policies to address the knowledge worker for a more efficient and practical research performance. The results serve as a framework for the development of incentives that allow universities and research centers to promote behaviors specifically desired, and multidisciplinary approaches to add value to the result of an investigation. This is why the creation of incentives should aim at foster collaboration between disciplines and not stifle it (Tan, 2016). Research collaboration occurs within institutions (across disciplines) and across different sectors (academia and industry, for example). In today's knowledge economy and global scenario, collaboration emerges to meet professional, political, economic, and social demands. The growing importance of interdisciplinary fields and various external forces have given rise to intra-institutional and even inter-sector collaborations that allow knowledge to be pooled and transferred (Brew & Lucas, 2009). Is important that human resources managers and universities management establish evaluation systems that consider this multidisciplinary approach and provide the means to achieve it.

Government involves an opportunity to improve its national competitiveness at the global level. Governments should strengthen the initiatives of results' dissemination at a local level and achieving greater global exposure on the work completed. Governments should promote initiatives and incentives to create greater mobility in researchers. This is important because mobility to other countries can help improve our work and bring back to our society a professional that not only works well but his work is of value for the development of the local economy. Another goal is to develop initiatives in which the academic work becomes a focal point to attract and retain talents and other knowledge workers. For countries seeking to become a knowledge-based economy, this implies identifying the best education systems that integrate work skills necessary for the development of knowledge worker. Four pillars of the Knowledge Economy Framework (World Bank, 2009) are established include an economic incentive and institutional regime that provides permit efficient mobilization and allocation of resources and stimulates creativity and incentives for the efficient creation, dissemination, and use of existing knowledge. In addition, governments should develop educated and skilled workers who can continuously upgrade and adapt their skills to efficiently create and use knowledge. These strategies help create a consciousness in the people, that knowledge and intellectual work generated through research in universities can and should influence society and contribute to the economic growth of a country.

This study has limitations. The first limitation refers to the poor comprehension of the participants about the concept of knowledge economies. The second limitation relates to the lack of cooperation of many academics to participate and complete the questionnaire. Further investigations can be directed to researchers only and expand to other countries to see if cultural difference impacts the view of work, competencies and individual skills of an academic researcher in a knowledge- based economy.

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