Journal of Engineering and Applied Sciences 12 (13): 3349-3361, 2017
ISSN: 1816-949X

"Designing Impact Indicators of the Information and Communications Technology in the Higher Education Institutions"

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Abstract: Now a days, higher education institutions are making important investments on Information and Telecommunications Technologies (ICT), aiming to increase their value proposal and enhance their impact. But they have had trouble to suitable finding the impact of those technologies and their contribution on attaining their strategic goals. Therefore, it becomes necessary to design and construct instruments capable of measuring that impact. This study presents a methodological proposal for designing ICT impact indicators for higher education institutions, on which ICT role in higher education institutions is analyzed. It also presents the different levels that the indicators must have in order to more accurately measure ICT impact. Finally, it presents an example of those indicators design. The methodological proposal presented was designed based on the review from many publications where ICT role on educations is analyzed and also the review of different standards and methodological indicators design proposals, made by recognized international bodies. The most important outcome was the methodological proposal for developing ICT impact indicators, according to the needs and context of higher education institutions for which is determinant being clear about the strategic institution objectives and its ICT goals. The main conclusion from this investigation is the importance of designing ICT impact measurement instruments, in order to ensure a better resource exploitation and increase on the value created by the institution.

Key words: ICT, indicators, impact, management, strategic, measurement, objectives, government

INTRODUCTION

Currently, higher education institutions latently need to measure development, outcomes and impact of plans, policies and projects related to the Information and Communications Technologies (ICT). But its measurement presents a high difficulty level due to the complexity in constructing measurement instruments capable of quantifying outcomes and impacts. This is why there's usually a measurement of the amount of ICT products created such as computers, programs, internet access, among others, high are hard to quantify but don't offer enough information for making suitable decisions that promote value creation in the organization. Therefore, it's fundamental creating this measurement instruments, in order to measure how ICT contribute to attaining strategic objectives of the institution based on its development plan.

In management models, the tool used to measure behavior and performance of systems within an organization is the indicators (Kaplan and Norton, 2005). Therefore, it is the ideal tool to measure ICT impact, although in the case of ICT their design must be carefully made; because it's important to remember that ICT themselves are not and end but a means to attaining strategic objectives within an organization (Aguilera and Erazo, 2009; Crespo, 2008). In addition, the difficulty of actually measuring ICT impact must be taken into consideration because the numeral obtained on the measurements gathered from the indicators, could not necessarily reflect their impact; due to other factors that can also be contributing to the strategic objectives attainment. Therefore, the measurement model must lead to deducing ICT impact without any other exogenous factors. This is why the development of this type of indicators has been quite low as proposed by the united nations ICT task force partnership of measuring ICT for development (United Nations ICT task force partnership of measuring ICT for develoment in 2010).

Different design, measurement models and indicators methodologies have been developed aiming to measure ICT from different perspectives.

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Among the indicators development methodologies that can be used for designing ICT impact indicators, many can be called. One of these is Oslo's manual which aims to provide models for recollecting and interpreting data about innovation a provide guidelines for designing indicators (OECD, 2005). Another methodology is Bogota's manual which is a regional manual of technologic innovation that seeks to normalize criteria and procedures for constructing innovation and technology indicators. A most recent methodology is the indicators formulation for tracking and assessing by Alcaldia Mayor de Bogota, this documents presents a methodology that contributes to formulating indicators for planning, tracking and assessing policies, programs and projects. Finally, a methodological guide can be found for formulating indicators of NPD which aims to establish a guide that explains how to build indicators according to the policy, program or project to be assessed (NPD, 2014, 2009). These methodologies can be useful for designing indicators but it is necessary to engage them to the ICT context. Therefore, various ICT measurement models have been developed.

Some of the ICT impact measurement models are: the ICT measurement model on human development which was built by united nations task force in ICT called "UN ICT Task Force" and the partnership for measuring ICT on development; this model proposes four main elements to be measured (Inputs, Outputs, Efficiency and Outcomes) (United Nations ICT Task Force Partnership of Measuring ICT for Develoment in 2005).

Based on the model proposed by United Nations, Enrique in 2008, proposes the advanced model for measuring ICT impact this model keeps the same four elements from the basic model but establishes the need of complementing the model with factors that do not correspond to the ICT due to the need of evaluating the impact of those non-ICT factors (Crespo, 2008). Another interesting model is the one for measuring ICT policies impact towards social inclusion, developed by IMPOLIS project which is intended to build an Integral Control Panel (ICP), capable of obtaining information of ICT policies impact (Sebastian *et al*., 2012). Although, these methodologies may be quite useful, in the higher education field, it is necessary to consider certain characteristic elements of the educational context, such as teaching and learning practices. Therefore, Kikis *et al*. (2010) propose the Impact Measurement Model of ICT on college education (Avila and Erazo, 2011) which proposes as methodology to develop the model within three stages, diagnostic, assessment and educational field and as a final step, conclusions and recommendations. Other methodologies for assessing ICT impact and appropriation on education are presented in the studys "ICT appropriation indicators in educational institutions" which presents a methodological proposal for assessing ICT indicators on education through a guided process by professor (Patino and Gomez, 2013) and the one in the study "assessment of ICT integration on higher education: fundamentals for a methodology", this study proposes a methodology that allows studying the incorporation of Information and Communications Technologies (ICT) on higher education, from the technological post implementation organizational behavior scope (Nolasco and Ramirez, 2016).

In regards to the development of ICT indicators themselves. The main ones are enunciated as follows. Key indicators of information and communications technologies-partnership of measuring ICT for development (United Nations ICT Task Force Partnership of Measuring ICT for Develoment in 2010) which contains 46 ICT indicators. Another one is the manual for the measuring of Information and Communications Technologies (ICT) on education ((UNESCO, 2009) which contains 59 main indicators and 89 supplementary. There are also the basic indicators of information and communications technologies ICT for Colombia which established 33 ICT indicators.

In regards to the development of ICT indicators in educational institutions, very few have been developed. Among these are "observatory of technologies on education in patagonia: the indicators elaboration and selection process", this work describes the indicators elaboration process applying the delphi technique, intending to orient educational policies that tend to promote digital inclusion, it will study the ICT access and use (Gonzalez *et al*., 2013). There is also the study called "assessment of the ICT use on education for development. Gathering best practices indicators through factorial analysis", this study gathered a group of quality indicators of the formative programs with ICT education (Gutierrez *et al*., 2014).

As observed, there are different works about indicators development. There have also been developed different investigations on which some theoretical models have been made which aim to measure the ICT impact on human development and some specifically for education. But these models have remained in the theoretical context and their effectiveness for making these measurements has not been proved and moreover, no tools have been created based on these models, also there has been very few work creating ICT impact indicators on education.

This research doesn't show either how the process of developing these indicators has been made or how they integrate the model, methodology and final development of ICT impact indicators on higher education institutions. Therefore, this study is intended to present a methodology according to the specific needs of higher education institutions with all the elements that are both theoretical and practical for developing these measurement instruments, showing an example of their development based on a practical case such as the development of ICT impact indicators for Universidad Distrital Francisco Jose de Caldas.

MATERIALS AND METHODS

The methodology developed on the investigation is made up by three stages: State of the Art review, design and building of the construction methodology of ICT indicators for higher education institutions and at last, the construction of ICT indicators for universidad distrital. The stages are explained as follows.

State of the art: There was a review and analysis of the main ICT management indicators developed by international bodies and methodologies proposed for their development in contexts such as public policy and especially in regards to education. Based on the methodologies analyzed, determined which were the most suitable ones for developing this investigation's objective. Among the methodologies analyzed are the methodology for formulating indicators for tracking and assessment, methodological guide for formulating indicators (NPD, 2009). Conceptual framework for measuring ICT impact on education (Kikis *et al*., 2010), Cobit 5 (ISACA, 2012), Balance Score Cards (Kaplan and Norton, 2005).

Design of the methodology of ict indicators construction for higher education institutions: These inputs obtained from reviewing the state of art, propose a construction methodology of ICT indicators for higher education institutions. The methodology contains two main stages, the first one is the creation of ICT dimensional objectives and these are key elements for specifically creating CIT indicators which is the second stage.

Constructing ICT indicators for universidad distrital: Having developed the methodology and as a final stage, the case of Universidad Distrital was applied for which the development strategic plan 2008-2016 was considered (Concejo Superior Universidad Distrital in 2008) from DU and the telecommunications and computer master plan (Concejo Superior Universidad Distrital in 2013) from the University as a base for creating the ICT impact indicators and that way developing the indicators according to the University requirements. There were a total of 156 ICT indicators designed.

Conceptual model for measuring ICT impact on higher education: This study presents the conceptual framework used as a base for measuring ICT impact on education and to be more accurate on higher education institutions such as Universidad Distrital.

Multi-dimensionality of ict on education: As starting point, it is necessary to make clear that ICT impact on education is the multi-dimensionality. This means ICT affect different areas on higher education institutions, from administrative to academic. Therefore, Kozma (2008) establishes the following five strategies to ensure a positive ICT impact on education: infrastructure development is necessary with the purpose of guaranteeing access to schools, networks and resources for learning; teachers education both initial and on duty is a prior requirement for education ability to use ICT in learning processes; technical support is needed in both administration and pedagogical mastery; study pedagogical plans and scopes may have to be changed intending to pay attention to educational changes with ICT and content development is necessary in order to ease the ICT, the interactive potential can offer in the teaching and learning process.

Due to ICT Multi-Dimensionality and its complexity (Johannessen, 2010) states ICT on education must be analyzed under three perspectives. The first one refers to ICT access such as computers access and broadband available. The second perspective refers to the way on which ICT is used on teaching and learning. Finally, the third one is about the impact of ICT on teaching and learning. These are related to the learning results and learning strategies (Johannessen, 2010).

Therefore, Erstad (2010) stated it's necessary to introduce different levels for analyzing ICT impact on education, the division consists for three levels macro, meso and micro. The macro level refers to the national and local dispositions for developing ICT on education. The meso level refers to the institutional and learning environments of the institution. Finally, the micro level is centered on the practices and outcomes (collective and individual) of teachers and students.

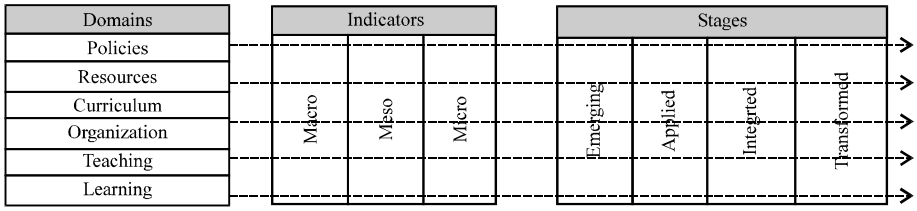

Fig. 1: Conceptual framework for measuring the ICT impact on education adapted from Kikis *et al*. (2010)

Conceptual framework: Considering the premises shared Kikis *et al*. (2010) established a conceptual framework to determine the ICT impact on education. This is divided into three areas, domains, indicators and stages. A diagram of this can be observed on Fig. 1.

Domains: There's a total of six domains that must fully cover the integration and use of ICT on education. These domains are explained as follows.

Policies: Refer to any type of strategies related to the application of ICT and its effective use. This could take place in a national policy level as well as institutional level such as in universities, schools, etc.

Resources: This domain refers to the ICT infrastructure in terms of hardware, Software, network, capabilities and any type of digital resource used for teaching and learning.

Study plan: Refers to the ICT integration level in the curriculum including courses about the effective use of ICT.

Organization: This term refers to the organization measurements for implementing the ICT and its use. An example of this is the use of content/learning management systems for educational purposes.

Teaching practices: This domain characterizes the use of ICT in teaching practices, pedagogical practices, etc.

Learning: It is centered on the use of ICT by the pupil (student, etc.) (Kikis *et al*., 2010).

Indicators: The indicators field determines what is done in three levels that are macro, meso and micro which refers to the same three established by Erstad (2010). Macro for national level, meso for institutions and micro for individuals.

Stages: In regards to the stages field, it indicates the maturity level of ICT on each of the domains. This is based on the morel matrix which breaks into four maturity levels that are: emerging, applied, integrated and transformed (Severin, 2010).

Emerging: This refers to the development or creation of policies related to ICT for promoting access, use and application of these. For example, the live digital policy by the Colombian government.

Application: This maturity level is on which the ICT policies have already been implemented as well as the projects related. For example, building computer labs in the Compartel Project of the universal access policy by the Colombian government.

Integration: This refers to whether the ICT products created by the policies such as computers, internet access, computer labs, among others have been incorporated to the daily life habits of individuals to which the policy is intended.

Transformed: This is stage occurs when the policy has already been assessed and enhanced, according the needs that were not considered in the initial policy and were found during its development.

This conceptual framework is quite a useful tool for elaborating indicators and determining the ICT impact on higher education institutions. But it's necessary to keep in mind that ICT themselves are not an end but a means to attaining that end as enunciated on the world summit on the information society in 2003 ICT must be considered a means, not an end themselves. In favorable conditions, these technologies can be an effective instrument to increase productivity, generate economic growth, create jobs and foment employability as well as improving everyone's life quality. Therefore, ICT must ensure the objectives and strategic goals compliance in organizations and in this specific case, in higher education institutions. This is why the indicators construction methodology, besides covering the dimensions described on the conceptual framework, must measure the compliance of the organization goals. Now, the methodology for constructing ICT indicators for higher education institutions is proposed as follows.

Proposed construction methodology of ict indicators for higher education institutions: The methodology to be used is a top-down system, it can be called this way

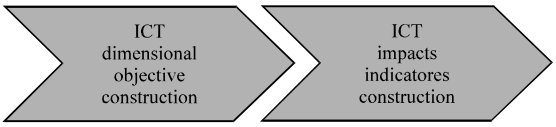

Fig. 2: Phases ICT indicators construction methodology

because the design starts on the top of the organization's hierarchic structure down to reaching the ICT on the lower part of the structure. This way, it directly relates to the methodology enunciated by ISACA in their Cobit 5 standard, TI Governance with the tool called goals cascade because the general objective from both methodologies is the same which is to align the ICT objectives to the corporate goals (ISACA, 2012).

Although, the same goals cascade tool enunciated on Cobit 5 standard can be used, higher education institutions have additional elements that are worth distinguishing and highlighting, due to the same social impact of these and their contribution to society's development. This is why the dimensions structure established on the conceptual framework remains.

The proposed methodology consists of 2 phases, the first one is in charge of generating the ICT dimensional objectives and the second one, based on the dimensional objectives, the ICT indicators are created. The phases are sequential as observed on Fig. 2.

Dimensional objectives construction: The starting point is to review the organization's strategic objectives that must be embodied on the Development or Strategic Plan, based on which the organization's strategic axes are generated which helps to construct the Balance ScoreCard (BSC). The second step will be constructing or developing the ICT strategic objectives that contributeand sustain the strategic objectives of the organization. Based on the ICT strategic objectives, the ICT strategic axes are set, each ICT strategic axes will have their respective ICT projects on which they're sustained on. The strategic axes and their respective projects are crossed with each Domain, contemplated on the conceptual framework (Policies, Resources, Curriculum organization, Teaching and Learning) which allows the ICT dimensional objectives to be aligned with the organization's strategic objectives.

The conceptual framework of ICT impact measurement contemplates three levels, macro, meso and micro; since the objective is to construct indicators for a higher education institution, only meso and micro levels are considered. If desired for example, to analyze the ICT impact on national government; it would be necessary to consider the macro level. The alignment process of ICT dimensional objectives is graphically described on Fig. 3.

The ICT dimensional objectives designed, must be verified and validated by the organizational structure with the highest hierarchy within the organization in charge of the ICT governance which is the ICT Strategic Committee (ICT-SC), defined by ISACA on Cobit 5.0 standard as: "a group of senior executives assigned by the council to ensure the council is involved and constantly informed about the issues and most relevant decisions of TI." (ISACA, 2012). In this validation process, possibly the dimensional objectives can be modified, therefore, this stage of the process would be retaken once the dimensional objectives are consolidated and approved by the ICT-SC. This process is described on Fig. 4.

Constructing ICT indicators: For each ICT dimensional objective, there can be one or many ICT impact indicators created, depending on the case which must aim to measure the ICT dimensional objective compliance. The ICT impact indicators construction process, based on the dimensional objectives, it's recommended to be built by a specialized group entrusted by the ICT-SC but their validation must be made by the ICT-CE. This specialized group creates de ICT impact indicators, based on ideas generation strategies which must be based on teamwork and collective intelligence for example brainstorming. When creating the ICT indicators they must be validated by the ICT-SC in case of disagreement with the indicators designed, the members for the strategic committee will be able to modify the indicators and validate them or refer them back to the specialized group, so they can modify it based on the recommendations given by the ICT governance, this cyclic process repeats until the ICT impact indicators are consolidated and validated. This process is described on Fig. 5.

ICT impact indicators construction for universidad distrital: The kick start on the indicators construction process as indicated in the methodology is to set the objectives and strategic axes of the organization. In this case, the reference is the Development Strategic Plan 2008-2016. This is briefly explained as follows.

Strategic development plan 2008-2016: The strategic objectives set by the institution are the following.

Objective 1: To articulate the actions of Universidad Distrital with the ones from other educational, scientific, business, politic and cultural institutions intending to lead the formulation of public policies and social impact actions in institutional fields.

Objective 2: Extend the coverage through the diversification of educational modalities and knowledge

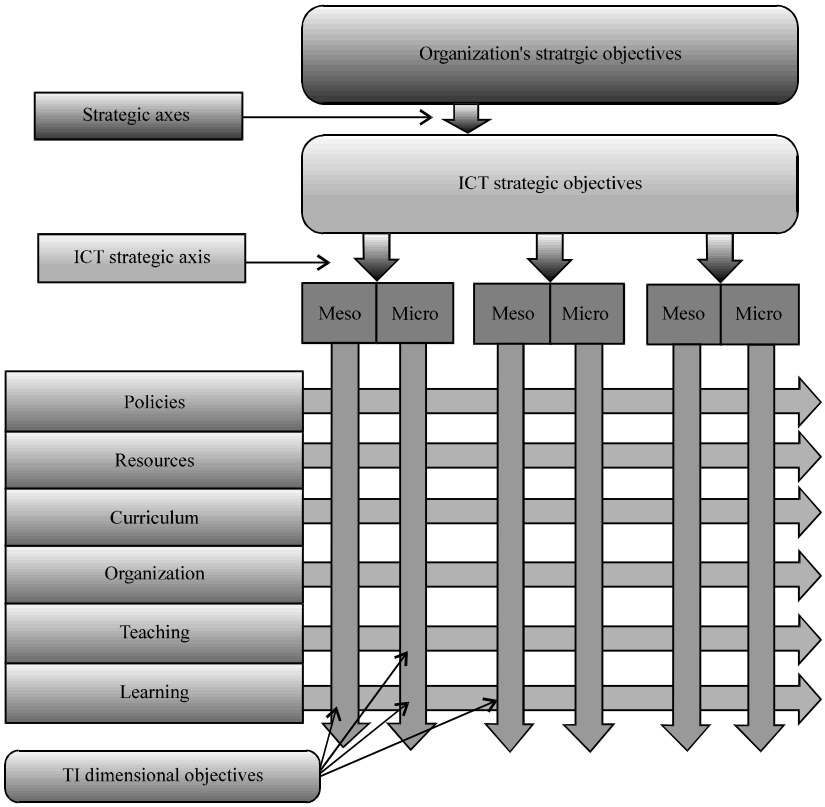

Fig. 3: ICT dimensional objectives alignment

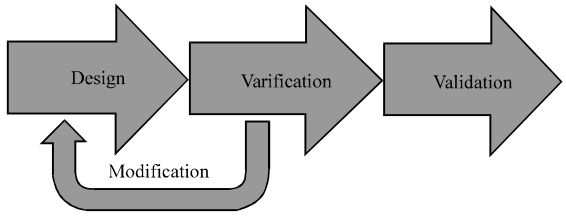

Fig. 4: ICT dimensional objectives construction process

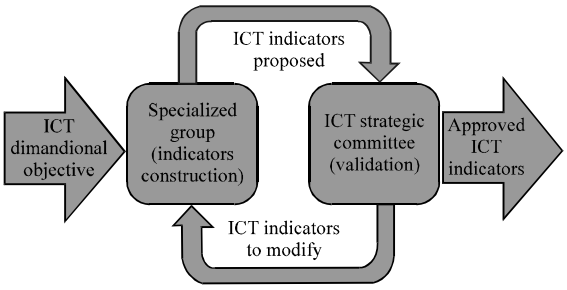

Fig. 5: ICT indicators construction process

fields; pertinent teaching levels and cycles, by developing internal and inter mechanisms, national and international that generate conditions for social inclusion under quality and efficiency premises.

Objective 3: Generate the academic conditions for the Universidad distrital to project as an investigation university of high impact on problem solving in the city-region and the country forming integral professionals in diverse knowledge fields and a continuous education programs offer.

Objective 4: Planning strategies to guarantee a suitable resource assignment by the state, rationalize its execution and increase and diversify income generation.

Objective 5: Lay the ground for reaching an inclusive, pertinent and transparent management that recognizes the participation and contributions from actors of academic community, supported in an organic structure, suitable for the development of missionary functions and the diverse dimensions of Universidad Distrital.

Objective 6: Reckon on a physical, technological of connectivity and educational sources infrastructure in order to guarantee the development of the missionary functions of Universidad Distrital, communication and

institutional wellness (Concejo Superior Universidad Distrital in 2008). Based on this strategic objectives the Universidad Distrital established a set of policies. This policies are the following.

Policy 1: Articulation, context and strategic projection.

Policy 2: Academic management for social and cultural development.

Policy 3: High impact investigation for local, regional and national development.

Policy 4: Modernization of administrative, financial and human talent management.

Policy 5: Governance, democratization and coexistence

Policy 6: Physical development and technological infrastructure of the University (Concejo Superior Universidad Distrital in 2008) (Academic Vice rectory, 2007).

Considering the strategic plan for development the high council of the university constructed and enacted the Computer and Systems Master Plan DU (DU-CaSMP). The CaSMP-DU is the document on which the ICT projects and strategic axes are established that were developed during the period of 2012-2018. The DU-CaSMP was developed based the Development strategic plan, therefore, it's aligned to the du strategic objectives. Coming up, there is a summary of the computer and systems master plan.

Computer and systems master plan DU: The computer and telecommunications master plan was adopted through the agreement 01 on 2013 from the high council of Universidad Distrital and its validity runs for 5 years. The computer and telecommunications master plan aims to be a prospective, strategic and operational framework that allows to align the decisions, the architecture and the investments in terms of computer and communications technologies in regards to the missionary objectives of the university. The computer and telecommunications master plan has the following strategic objectives.

Objective 1: Implement an ICT governance model.

Objective 2: Implement an ICT management model service-based.

Objective 3: Develop an ICT strategic integration plan to learning processes.

Objective 4: Reorient the development of the institutional information system based on a new conceptual design.

Objective 5: Improve the ICT infrastructure.

Objective 6: Foment the professional development of the university community members in ICT fields related to the deployment of the DU-CTMP (Concejo Superior Universidad Distrital in 2013). The ICT strategic plan establishes 4 strategic axes that are:

Axis 1: IT governance and model based on services. The master plans rules the ICT integration through services destined to support the value chain and institutional support.

Axis 2: Governance and control of the master plan. Requires creating a governance and control team for the master plan development that will be established in its directing instrument.

Axis 3: Missionary and support services through ECOSIIS. Through this axis there will be visible logos made of the policies and IT Government management implementation on the Master Plan execution.

Axis 4: IT services management. It comprehends the rearrangement, based on a service-centered model of the working fields specialized in IT, inside the Institution. (Concejo Superior Universidad Distrital, 2013).

Based on the strategic axes set, the High Council determined 13 strategic projects that sustain these axes, the projects and their relation to the axes can be observed on Table 1.

Having established the strategic Axes and alongside to the projects they're sustained on, it's possible to create the indicators. Now, the construction will be presented. Their construction will be made axis by axis.

ICT strategic indicators: The final step on creating ICT impact indicators is crossing the strategic axes and their respective projects with every dimension which will set the ICT dimensional objectives which helps the ICT dimensional objectives to be set these objectives are verified and validated by the ICT strategic committee and next to this process each indicator is designed.

As mentioned in the methodology for each ICT dimensional objective, one ore many ICT impact indicators can be created which must aim to measure the ICT dimensional objective compliance. It's also important to highlight that the indicators presented are an indicators proposal and it doesn't necessary imply their settlement

because they must be validated by the IT strategic committee within the organization. In Universidad Distrital the committee playing the IT strategic committee role is the DU computer and systems committee and in this stage of the process it can present changes. Table 2 presents the designed indicator denomination alongside with its ICT dimensional objective and dimension. For the strategic axis 1 corresponding to IT Governance y service-based model, there are 36 indicators proposed, 6 by each dimension, this axis as it was already mentioned is made up by 3 strategic projects (DU-ICT governance, DU-ICT normative framework, DU-ICT services catalogue). The indicators proposed are looking to determine the impact of these projects in the University where the main objective summed up is to determine the implementation level of ICT governance in the University and the ability of ICT to generate value on the main stakeholders of the institution. The main stakeholders are in this case: high council, administrative personnel, teachers and students. Table 3 presents the ICT impact indicators for strategic axis 2. On the strategic axis 2 Government and Control to Developing the Master Plan, there 12 impact indicators proposed. This axis is made up by only one strategic project (governance and control of the computer and telecommunications master plan). The main objectives of this indicators is to measure the penetration level and use of mechanisms and tools of government and control of the 1 and T Master Plan in the institution. Table 4 presents the indicators of the strategic axis 3 Missionary and Support Services through ECOSIIS which is made up by 3 strategic projects (ECOSIIS DU institutional information system, ATENEA-Knowledge management and Business Intelligence System, PLANESTIC).

For the strategic axis 3 missionary and support services through ECOSIIS, there are 36 indicators proposed which aim to determine the axis impact with the 3 projects that make it up. The objective of this 36 indicators is to measure the appropriation level of the three projects in the main stakeholders of the University.

Table 1: Strategic axes relation and projects on I. and t. Master plan. Adaptation (Concejo Superior Universidad Distrital, 2013)

ICT strategic axis	ICT estrategic project
Axis 1; IT governance and service-based model	ICT-DU governance
	ICT-DU normative framework
	ICT-DU services catalogue
Axis 2; Governance and control of computer and control to master plan's development	Governance and control of computer and control to master plan's telecommunications master plan
Axis 3; Missionary and support through ECOSIIS	ECOSIIS DU Institutional information system
	ATENEA-knowledge management and business intelligence system
	PLANESTIC
Axis 4; IT services management	IT Institutional Management System ICTIMS
	TEDO-Technological Dominance of institutional architecture
	IMDAS-Institutional Model For Developing Software
	RITA network
	Secure DU information security management system du data network

Table 2: Axis 1 ICT Indicators, TI governance and service-based model

Dimension/ICT dimensional objective	ICT indicator
Policies	
Implement ICT Policies In D.U according to the strategic plan	Number of ICT policies
Let the university community know the ICT policies implemented	People percentage who know about the ICT policies
Creating rules that promote ICT use within the University	Number of ICT rules
Providing the community with the rules related to the ICT	People percentage who know about the ICT rules
Creating DU-ICT services catalogue	Number of ICT services
Creating policies that promote university community to use the services provided in the catalogue	Number of ICT services catalogue users
Resources	
Disposing and execute the financial resources to execute de ICT governance	ICT government executed budget percentage
Counting on people trained on ICT governance in the University	Number of people trained on ICT governance
Set clear rules regarding ICT investment and sustainability	Number of ICT investment and resources rules
Developing rules that establish ICT resources availability in university community	Number of ICT resources availability rules
Having available resources for creating and promoting the DU-ICT services catalogue	ICT services catalogue executed budget percentage
Generating personnel with ICT competences that support the services provided in catalogue	Number of support people for DU-ICT services the DU-ICT services catalogue
Curriculum	
Developing micro-curriculums of subjects that integrate ICT resources use	Number of micro-curriculums with ICT resources
Developing subjects that teach topics related to ICT	Number of ICT subjects
Developing rules that promote ICT use in subjects	Number of rules for ICT use in subjects
Promoting the use of ICT tools in subjects development	Number of subjects that use ICT
Developing micro-curriculums that promote the use of ICT services from the DU-ICT services catalogue	Number Of micro-curriculums with ICT services
Promoting the use of ICT services from the DU-ICT services catalogue in subjects	Number of subjects that use ICT services

Table 2: Continue

Dimension/ICT dimensional objective	ICT indicator
Organization	
Aligning the different organizational structures of DU in ICT governance	Organizational structures percentage with ICT governance
Generating people with the skills and competences for using ICT tools	Number of people trained on using ICT
Generating tools that promote the use of ICT within DU organizational structures	Number of rules for ICT use within organizational structures
Promoting the use of ICT tools within DU organizational structures	Number of people that is ICT tools
Having ICT services from the DU-ICT services catalogue within DU organizational structures	Number of services from the DU-ICT services catalogue for organizational structures
Promoting the use of ICT services from the DU-ICT services catalogue integrate DU administrative areas	Number of administrative users of the DU-ICT services on people that catalogue
Teaching	
Developing pedagogical methodologies that make use of ICT	Number of methodologies for using ICT
Promoting the knowledge for teachers to use ICT tools	Number of potential teachers using ICT
Generating tools that promote the use of ICT in teaching processes	Number of rules regarding the use of ICT in teaching processes
Promoting the use of ICT tools in teaching processes	Number of teachers that use ICT tools
Having ICT services available from the DU-ICT services catalogue in processes	Number of services from the DU-ICT services catalogue teaching for teaching
Promoting the use of ICT services from the DU-ICT services catalogue processes	Number of teachers who use the services from the DU in teaching ICT services catalogue
Learning	
Generating available ICT tools for students learning	Number of ICT tools for students
Promoting the knowledge for using ICT tools for students	Number of students with ICT competences
Generating rules that promote ICT tools use for students	Number of ICT use rules for students
Promoting the use of ICT tools in students learning process	Number of students who use ICT tools
Having available ICT services from the DU-ICT services catalogue in students learning process	Number of UD-ICT services for students
Promoting the use of ICT services from the DU-ICT services catalogue in students learning process	Number of students who use DU-ICT services

Table 3: Axis 2 ICT indicators, governance and control of the master plan development

Dimension/ICT dimensional objective	ICT indicators
Policies	
Generating policies that contribute to the governance and control Master plan of I and T	Number of IT governance and control policies
Make the management and control I and T Master plan known by the community	Number of people with knowledge on governance and control university policy
Resources	
Having and executing the economic resources for executing the mechanisms governance and control I and T	Percentage of executed budget for the M and T governance and from the control plan
Having and assigning people with the necessary skills to play roles in I and T master plan areas	Number of people trained on governance and control I and T governance and master plan
Curriculum	
Developing micro-curriculums of subjects on which the impact of I and T master plan is reflected	Number of micro-curriculums impacted by the I and T master plan
Generating subjects that explain the elements the ICT governance and control must have	Number of subjects about ICT governance and control
Organization	
Promoting governance and control I and T master plan within different of universidad distrital	Number of organizational structures with PM I and T structures organizational governance and control
Providing DU university community with tools of governance and the master plan	Number of tools of governance and control from the Y and T control from master plan
Teaching	
Provide DU teachers with access and training of the ICT tools given by T and I master plan	Number of teachers trained governance and control I and T tools the MP
Promoting among DU teachers the use of ICT tools given by the T and I master plan	Number of teachers that use the ICT tools from the I and T MP
Learning	
Giving DU students access and training of the ICT tools given by the T and I master plan	Number of students trained governance and control I and T tools MP
Promoting among DU students the use of ICT tools given by the T and I master plan	Number of students that use the ICT tools from the I and T MP

Table 4: Axis 3 ICT indicators. Missionary and support services through ECOSIIS

Dimension/ICT dimensional objective	ICT indicators
Policies	
Generating policies that contribute to developing and using ECOSIIS system	Number of ECOSIIS policies
Make the university community know about the policies that contribute to developing the use of ECOSIIS system	Number of people who know about ECOSIIS policies

Table 4: Continue

Dimension/ICT dimensional objective	ICT indicators
Generating policies that contribute to developing and using ATENEA system	Number of ATENEA policies
Make the university community know about the policies that contribute to developing and using ATENEA	Number of people who know about ATENEA policy
Generating policies that contribute to developing and using PLANESTIC	Number of PLANESTIC policies
Make the university community know about the policies that contribute to developing and using PLANESTIC	Number of people who know about PLANESTIC policies
Resources	
Having and Executing the economic resources for the execution of ECOSIIS system	ECOSIIS Executed Budget Percentage
Having and Assigning people with the necessary skills to execute ECOSIIS system	Assigned personnel for ECOSIIS
Having and Executing the economic resources for the execution of ATENEA system	Budget percentage for ATENEA
Having and Assigning people with the necessary skills to execute ATENEA system	Personnel assigned for ATENEA
Having and Executing the economic resources for the execution of PLANESTIC	Budget percentage for PLANESTIC
Having and Assigning people with the necessary skills to execute PLANESTIC	Personnel assigned for PLANESTIC
Curriculum	
Developing micro-curriculums in subjects that promote the use of ECOSIIS system	Number of micro-curriculums with ECOSIIS
Developing subjects that explain the concepts of documentary Management	Number of documentary management subjects
Developing micro-curriculums in subjects that promote the use of ATENEA system	Number of micro-curriculums with ATENEA
Generating subjects that explain the concepts of Business Intelligence	Number of business intelligence subjects
Promoting the development of virtual and the technological platform for this purpose	Number of virtual subjects
Developing micro-curriculums of virtual subjects according the University's pedagogic model	Number of virtual subjects Micro-curriculums
Organization	
Promoting the use of ECOSIIS system within organizational structures of DU	Number of organizational structures with ECOSIIS
Promoting the use of ECOSIIS system within the DU community	Number of ECOSIIS users
Promoting the use of ATENEA system within organizational structures of DU	Numero de estructuras organizacionales ATENEA
Promoting the use of ATENEA system within the DU community	Numero de usuarios ATENEA
Generating organizational structures that support PLANESTIC´s operation	Number of PLANESTIC organizational structures
Having and assigning people with the necessary skills to support PLANESTIC's operation	Operation personnel for PLANESTIC
Teaching	
Giving DU teachers access and training to ECOSIIS system	Teachers trained on ECOSIIS
Promoting among DU teachers the use of ECOSIIS system	Number of teachers using ECOSIIS
Giving DU teachers access and training to ATENEA system	Number of teachers with access to ATENEA
Promoting among DU teachers the use of ATENEA system	Number of teachers using ATENEA
Training teachers on teaching process in virtual modality	Number of teachers trained on virtual teaching
Promoting among the teachers the development of teaching processes using virtual platforms	Number of teachers using virtual platforms
Learning	
Giving DU students access and training to ECOSIIS system	Number of students trained on ECOSIIS
Giving DU students access and training to ECOSIIS system	Number of students that use ECOSIIS
Giving DU students access and training to ATENEA system	Number of students trained on ATENEA
Promoting among DU students the use of ATENEA system	Numbers of students that use ATENEA
Training students on learning process in virtual modality	Students trained on virtual learning
Promoting among the students the development of learning processes using virtual platforms	Number of students that use virtual platforms

Table 5: Axis 4 ICT indicators. IT services management

Dimension/ICT dimensional objective	ICT indicators
Policies	
Generating policies that contribute to developing and using the ICTIMS system	Number of ICTIMS policies
Make the university community know about the policies that contribute to developing and using the ICTIMS system	Number of people who know about the ICTIMS policies
Generating policies that contribute to developing the technological dominance of institutional architecture	Number of TEDO policies
Make known the policies that contribute to developing the technological dominance of institutional architecture	Number of people who know about the TEDO policies
Generating policies that contribute to developing and using the Institutional Model for Software development	Number of IMSD policies
Make known the polices that contribute to developing and using the institutional model for software development	Number of people who know about the IMSD policy
Generating policies that contribute to developing and strengthening RITA network	Number of RITA network policies
Make known the policies that contribute to developing and strengthening RITA network	Number of people who know about the RITA network policy
Generating policies that contribute to developing and strengthening the information security management system	Number of DU-secure policies

Table 5: Continue

Dimension/ICT dimensional objective	ICT indicators
Make known the policies that contribute to developing and strengthening the information security management system	Number of people who know about the DU-Secure policies
Generating policies that contribute to developing and strengthening the DU data network	Number of DUNET policies
Make known the policies that contribute to developing and strengthening the DU data network	Number of people who know about the DUNET network policies
Resources	
Having and executing the economic resources for the ICTIMS system execution	ICTIMS executed budget percentage
Having and assigning people with the necessary skills to execute the ICTIMS system	Amount of personnel assigned to ICTIMS
Having and executing the economic resources for executing the Project technological dominance of the institutional architecture	TEDO executed budget percentage
Having and assigning people with the necessary skills to execute the project technological dominance of institutional architecture	Amount of personnel assigned to TEDO
Having and executing the economic resources for executing the institutional model for software development	IMSD executed budget percentage
Having and assigning people with the necessary skills to execute the institutional model for software development	Amount of personnel assigned to IMSD
Having and executing the economic resources for executing the RITA network project	RITA network executed budget percentage
Having and assigning people with the necessary skills to execute the RITA network project	Amount of personnel assigned to DU RITA network
Having and executing the economic resources for executing the DU Secure project	DU-Secure executed budget percentage UD-Secure
Having and assigning people with the necessary skills to execute the UD-Secure project	Amount of personnel assigned to UD-Secure project
Having and executing the economic resources for executing the DU Data network	DUNET network executed budget percentage
Having and assigning people with the necessary skills to execute the DU data network project	Amount of personnel assigned to DUNET network
Curriculum	
Promoting the support in subjects development through ICTIMS system	Number of subjects with ICTIMS
Generating subjects that explain the concepts of IT management	Number of IT management subjects
Promoting the support in subjects development through technological dominance of institutional architecture	Number of subjects benefited from TEDO
Generating Subjects that explain the concepts of enterprise architecture	Number of enterprise architecture subjects
Promoting the support in subject's development using the IMSD model	Number of subjects with IMSD
Generating subjects that explain the concepts of software development models	Number of software development subjects
Promoting the support in subjects development through RITA network	Number of subjects that use RITA network
Generating subjects that explain the concepts of high performance networks	Number of high performance networks subjects
Promoting the support in subjects development through DU secure project	Number of DU-Secure subjects
Generating subjects that explain the concepts IT security	Number of IT security subjects
Promoting the support in subjects development through the DU data network	Number of subjects benefited from DUNET network
Creating subjects that explain the concepts of LAN networks	Number of LAN networks subjects
Organization	
Designing and commissioning the sub-systems that make up ICTIMS within the organizational structures of DU	Number of working ICTIMS sub-systems
Promoting the use of ICTIMS system within DU's community	Number of ICTIMS users
Integrating the organizational structures to the technological dominance of institutional architecture	Number of organizational structures in TEDO
Having and assigning people with the necessary skills to support the operation of the technological dominance of institutional architecture	Amount of personnel assigned to TEDO
Promoting the use of the IMSD model within DU's organizational structures	Number of organizational structures using IMSD
Having and assigning people with the necessary skills to support the operation and update of institutional model for developing software	Amount of personnel assigned to IMSD
Promoting the use of RITA network within DU's organizational structures	Number of organizational structures using RITA network
Promoting the use of RITA network within DU's community	Number of RITA network users in DU
Developing information security tools according to the organizational structures needs	Number of information security tools for organizational structures
Training university community on information security	Number of people trained on information security
Improve DU's data network within its organizational structures	DUNET network average delay
Improve the satisfaction level about DU's Data network functioning in the administrative area of DU	Satisfaction level of DUNET users
Teaching	
Promoting the use of ICTIMS system within the pedagogic methodologies of DU	Number of pedagogic methodologies using ICTIMS
Promoting the use of ICTIMS system within the teachers group for their teaching processes	Number of teachers using SIGTIC
Contributing to the teaching processes in subjects through technological Dominance of institutional architecture	Impact level of TEDO in teachers
Contributing to the teaching processes of teachers through technological Dominance of institutional architecture	Number of teachers benefited from TEDO
Developing software using the IMSD model as teaching tools in subjects	Amount of software developed by IMSD
Promoting the use of teaching software developed by the IMSD in teachers of DU	Number of teachers using IMSD software
Promoting the courses developed by RITA network among DU officials	Number of officials that have taken the course with RITA network
Promoting the use of RITA network in DU teachers	Number of teachers in RITA network

Table 5: Continue

Dimension/ICT dimensional objective	ICT indicators
Eliminating the number of successful attacks to information security subjects	Number of successful attacks to subjects
Eliminating the number of sucessful attacks to information security of teachers	Number of successful computer attacks to teachers
Improve the DU Data Network efficiency in DU subjects	DUNET network average delay in computer labs
Improving the DU teachers satisfaction level about the DU data network operation	Teachers satisfaction level about DUNET
Learning	
Promoting the use of ICTIMS system within the learning process in DU subjects	Number of ICTIMS tools for learning processes
Promoting the use of ICTIMS system in students for their learning processes	Number of students using ICTIMS
Contributing to the processes learning in subjects through technological dominance of institutional architecture	TEDO impact level in students
Contributing to the learning process of students through technological dominance of institutional architecture	Number of students benefited from TEDO
Developing software using the IMSD model as learning tools in DU students learning	Amount of IMSD software for learning processes
Promoting the use of learning software developed by IMSD model in DU students	Number of students using IMSD software
Promoting the use of RITA network in learning processes	DU traffic generated on RITA network
Promoting the use of RITA network in DU students	Number of DU students on the RITA network
Eliminating the number of successful IT attacks to information security related to the teaching processes	Percentage of successful IT attacks to teaching processes
Eliminating the number of successful IT attacks to information security of students	Percentage of successful IT attacks to students information
Improving the DU Data Network Efficiency in DU academic areas	Average DUNET delay in academic buildings
Improve the satisfaction level of DU data network operation in DU students	Satisfaction level of students about DUNET network

RESULTS AND DISCUSSION

Finally, the ICT impact indicators of the strategic axis 4 IT services management is presented. This is the strongest axis from the four reviewed so far and the reason is that this axis is made up by six strategic projects (IT Institutional Management System-ICTIMS, TEDO-institutional architecture technological dominance, IMSD-institutional Model for Software Development, RITA network, DU secure. Information security system, DU data network. The ICT dimensional indicators are presented on Table 5.

CONCLUSION

It is important to understand that ICT are a very useful means to attaining the corporate goals but they are not considered an end themselves; therefore, it's necessary to measure the ICT impact based on the indicators that reflect their contribution on attaining corporate goals.

When designing indicators for higher education institutions, it is necessary to consider certain dimensions or perspectives that don't have any relevance on other economic sectors, this is because this areas belong to the group of missionary resources and activities from the educational sector such as curriculum, teaching and learning. Therefore, when analyzing ICT impact it turns necessary their analysis and impact separately using the indicators tool.

The process for creating ICT impact indicators cannot be considered a lineal-unidirectional process, because the process contains many replenished links that evidenced in validation stages which can present changes that are necessary for their settlement; in order to ensure that the design and later construction and implementation of the indicators get to obtain the information desired and this way, improve the decision making process of the bodies and people that play this role within the organization.

ACKNOWLEDGEMENT

Researchers wish to thank Universidad Distrital Francisco Jose de Caldas for the supporting during the course of this research project.

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