

Leadership policies and strategies for the integration of ICT in public higher education institutions: case study of Antsiranana (Madagascar)

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Abstract

The study investigates the integration of ICT in public higher education institutions in Antsiranana, Madagascar, focusing on the role of leadership in successfully implementing ICT amidst rapidly evolving technology and teaching methods. It identifies crucial factors like leadership models, infrastructure, and professional development, using a mixed method of quantitative and qualitative data analysis. The findings emphasize the importance of leadership support, resource allocation, and participatory approaches in overcoming challenges in ICT integration. While specific to Antsiranana, the research offers insights for effective ICT policies in higher education, especially in developing countries, and suggests further exploration in this field.

Keywords: ICT Integration; Higher Education; Antsiranana, Madagascar; Leadership Impact; Digital Transformation

1. Introduction

The public higher education institutions in Madagascar have responded to the call of the Ministry of Higher Education by embarking on the reform process through the Bachelor, Master, and Doctorate system. Although this reform offers numerous opportunities, it confronts the institutions with complex challenges. One of the main challenges identified lies in the implementation of the reform, which requires the development of new infrastructures as well as pedagogical and administrative reorganizations within these institutions, including the integration of Information and Communication Technologies (ICT) in teaching. Regarding the integration of ICT, the situation of the public higher education institutions in Antsiranana, in the northern part of Madagascar, where this study was conducted, still face the ongoing challenge of adapting to rapid technological changes, and this path is fraught with various obstacles, despite initiatives led by the leaders of these institutions.

The integration of ICT in higher education institutions in Antsiranana is an ongoing process. Each institution is at a different stage of this transformation. Nevertheless, most of them share a common commitment to adopting cutting-edge technological tools, a willingness to collaborate with partners to strengthen the ICT skills of stakeholders, the determination to reorganize administrative and pedagogical tasks to take advantage of the benefits of ICT, and a continuous commitment to achieving the defined objectives in terms of effective use of ICT in higher education, even if the degree of their commitment differs from one to another.

Over the past decade, we have witnessed an explosive growth in the use of ICT, and its impact on education has become ubiquitous (Adu, E.O & Olatundun, 2013). It is therefore not surprising to find that leaders of higher education institutions in Antsiranana are increasingly interested in integrating ICT into

education, and are investing in it. However, this task cannot be accomplished without specific technical skills and a deep understanding of the advantages and challenges presented by ICT. Consequently, leaders must be able to develop strategies to integrate ICT in a diversified way into the functioning of their institutions. Successful integration of ICT in higher education institutions requires the formulation of effective policies and leadership strategies. These policies and strategies must be designed to meet the challenges and seize the opportunities related to ICT, while taking into account the specificities of higher education institutions.

Despite initiatives to make technology available to learners, several circumstances continue to compromise the effective implementation of ICT in learning environments (Adu, E.O & Olatundun, 2013). Higher education institutions face complex challenges, and the outcomes of ICT integration initiatives often do not match expectations. These unsatisfactory results stem from various factors, including inadequate leadership models, infrastructure constraints, lack of skill reinforcement among teaching staff, low levels of digital literacy among students, financial constraints, as well as cultural factors (Albugami & Ahmed, 2015), which hinder the implementation of ambitious technological projects and persistent gaps in teacher training for optimal use of ICT.

The leadership model of ICT leaders can significantly influence the integration and adoption of ICT in higher education institutions (HABIBALLAH et al., 2021). It also defines the policy of ICT use by leaders in the overall educational strategy of the institution. Therefore, the appropriate leadership model applied within the institution significantly affects the general process of all administrative and academic activities. As Tony Bush (2003) pointed out, the quality of leadership has a considerable impact on teaching and learning outcomes. Moreover, it is the role of institution heads to pave the way for the integration of technology at all stages of education within their institutions by adapting it as an integral part of their work strategy and by advocating its use by becoming role models in the field of technology (Banoğlu, 2011). The studies of Yu & Darrington (2006) support the integration of technology in institutions and estimate that this process begins with the mindset of institution leaders in the first place. It is true that many actors need to be considered to achieve the objectives related to the use of ICT in teaching; however, the main responsibilities for its implementation fall on the leaders of the institutions. Furthermore, these leaders are considered the most important factors influencing the use of technology in institutions. Arooj Ahmed Qureshi (2013) supported this view by highlighting that the key factor in the effective use of ICT in teaching and in the learning process lies in the competence of the institution heads. He raised the responsibilities of these leaders to encourage and share their vision of ICT with their staff at all levels, because according to him, when the head of the institution is enthusiastic and visionary about the use of ICT, the realization of administrative and pedagogical tasks becomes smooth within the said institution. In the case of public higher education institutions in Antsirananana, the leaders are endowed with skills that make them capable of leading the institutions and aligning their vision with the different objectives set. They are not only responsible for financial operations, infrastructure and personnel management, public relations, and the coordination of the teaching program, but in recent years with technological advances in pedagogy, they are also entrusted with other more complex responsibilities as a technology leader, whose main role is to ensure an effective implementation of information and communication technology in the institution. Given all these responsibilities, the leader represents a significant figure for the integration of ICT. In other words, the role assumed and the practices exercised by the leader constitute the most powerful factors in the integration of ICT within the institution. Supported by Hayes (2006), he reported that institution heads are central figures in the integration of ICT and that they facilitate or hinder its implementation phase. After analyzing the situation within these institutions, we found that the challenge lies in the process of implementing ICT initiatives, and that this stems from the leadership model applied by the institution head. Effective leadership practices of the leader are imperative variables for the success of the implementation of ICT, according to Tearle (2003). This means that one of the major factors explaining the ineffective implementation of ICT in the learning environment results from the

lack of clear justification of leadership practices in the incorporation of ICT into the institution. For example, despite adopting ICT in their pedagogical practices, educators have limited knowledge of how to effectively integrate ICT into classroom practices (Al harbi, 2014); they lack capacity building in the use of ICT. In many cases, the adoption of ICT is often carried out without a solid understanding of what the technologies should improve and in the absence of clear guiding values. This vision is supported by Twining (2007), who argues that the lack of a common vision on the value of technological tools in education explains why, despite substantial investments in educational technology, the desired outcomes are not yet achieved. Thus, simply providing institutions with useful technological tools, infrastructure, and ICT resources does not guarantee the success of ICT implementation if the leader does not adopt an appropriate educational policy and a clear strategy in terms of ICT adoption. In a way, this situation can be understandable, because without a clear policy on ICT implementation to support leaders in institutions, it would be difficult for them to ensure the successful integration of ICT. In fact, Madagascar does not yet have a national policy on ICT in higher education. Although the government, represented by the Ministry of Higher Education, is currently working on initiatives for digital development in higher education, many challenges still remain to be addressed for the concerned institutions. Consequently, the leaders of the institutions often work on their own initiative to integrate ICT, due to the lack of clear guidelines and support at the local and national levels.

In their role as leaders in the management and allocation of resources to ICT stakeholders, Flanagan and Jacobsen (2009) explain that it is the responsibility of the institution heads to manage the resources required for the integration of technology. This involves in particular defining budgetary priorities that directly support the objectives of the institution's technological plan. Another factor hindering the successful integration of ICT in public higher education institutions in Antsiranana is related to the inadequacy of technological resources or infrastructures. Many initiatives have been undertaken in terms of acquiring materials and infrastructures in ICT, but this proves to be far from sufficient. If some institutions have invested considerably in this sense with the objective of compensating for their lack of technological infrastructures, others are still far behind, possessing only a few basic minimum ICT tools. Therefore, it is difficult to effectively integrate ICT into teaching and learning activities if the higher education institution in question does not yet have adequate technological infrastructure, particularly a reliable Internet connection, appropriate computer hardware, and software. In other words, the absence or inadequacy of these technical elements explains in part the inefficiency of the successful implementation of ICT in the university context. Thus, teachers and students in these institutions still face difficulties in accessing online resources, in being unable to use specific learning software or participate in distance learning activities due to these technological limitations. Moreover, the lack of adequate professional development opportunities for teachers and ICT leaders also contributes to the failure of effective use of ICT in teaching and learning (Supriadi & Sa'ud, 2017). Training programs and ongoing support are essential to strengthen the ICT skills of educators and leaders. However, the efforts invested in this regard are still very limited or even non-existent in some establishments located in Antsiranana. In addition, the problem of resistance to change in the face of innovation or the use of ICT in the institution, as well as the lack of pedagogical change and the absence of progressive evaluation in terms of ICT initiatives, remain a major challenge and a common problem in most of these institutions. To address these issues, a comprehensive approach is necessary, including the development of leadership, professional development programs, infrastructure improvement, policy development, and consideration of progressive evaluation in terms of ICT. By addressing these challenges, the heads of the respective higher education institutions can create an environment conducive to the effective integration and use of ICT in institutions.

In the context of this study on *leadership policies and strategies for the integration of ICT in public higher education institutions*, seven variables identified as key factors in the process of this integration will define the conceptual model of this research. These factors include the leadership model, infrastructure and resources, professional development, pedagogical change, resistance to change, policy and implementation strategy, as

well as the progressive evaluation of ICT usage. Each of these elements plays a crucial role in how ICT is adopted, integrated, and evaluated within educational institutions (Andriamihavana et al, 2023).

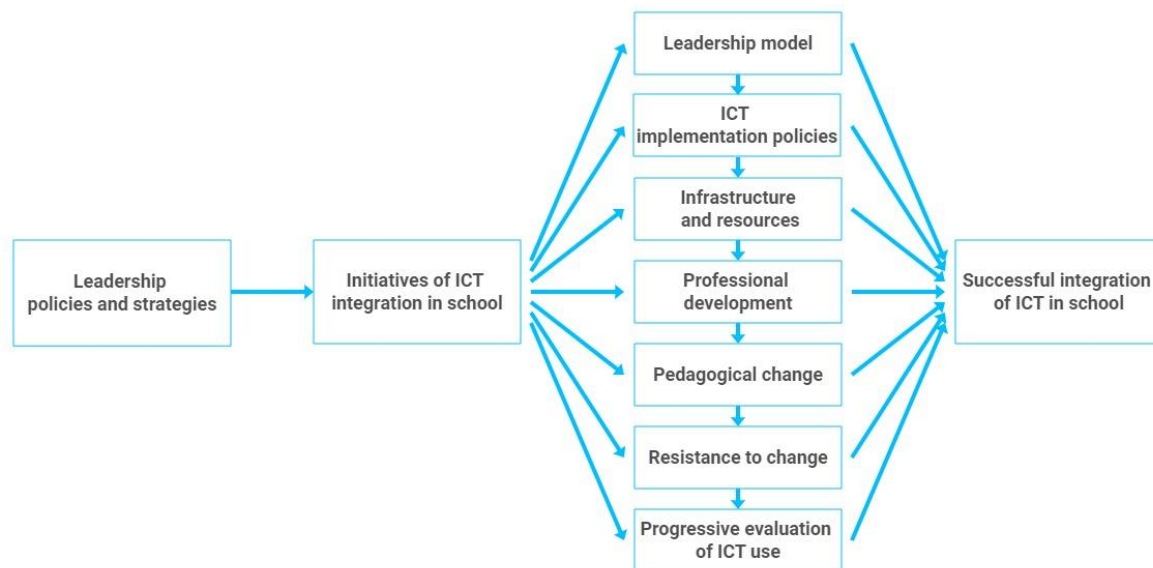


Fig. 1. Conceptual framework

2. Methodology

This study adopted a mixed methodology for a comprehensive understanding of the integration of ICT in higher education institutions in Antsiranana. It combined quantitative and qualitative methods, using both primary sources (surveys and interviews) and secondary data from previous research.

The sample for this study consisted of leaders from nine public higher education institutions in Antsiranana, carefully selected for their expertise and availability. The interviews were scheduled according to the participants' availability, and the data were transcribed for analysis.

The questionnaires included sections to collect personal information, details about the institutions, as well as structured questionnaires (Likert scale) and semi-structured questionnaires to deeply explore the integration of ICT. The qualitative responses were numerically transformed to facilitate statistical analysis, and a simplified coding was applied.

Content analysis was used to reveal the underlying concepts in the data and highlight the relationships between these concepts. Particular attention was paid to the confidentiality of the participants and institutions by using coded designations, such as E-A, E-B, E-C, up to E-I, to anonymously represent the institutions in our study, thus preserving their anonymity while facilitating the organization and analysis of the data.

Overall, this mixed methodology provided a thorough understanding of the integration of ICT in higher education institutions in Antsiranana, while maintaining the ethical principles of confidentiality and integrity of research.

3. Results

3.1. Demographic and Institutional Profile

Table 1. Profile of Leaders and Institutions

Variables \ Institutions	E-A	E-B	E-C	E-D	E-E	E-F	E-G	E-H	E-I
Leader_age_class	<50	<50	<50	<50	50+	<50	<50	<50	<50
Leader_Gender	M	F	M	M	M	F	M	M	M
Institution_Type	Institute	School	School	Institute	Faculty	Faculty	Faculty	School	Faculty
Institution_Creation_Year	1992	1973	1983	2001	1985	1980	2013	2015	2010
Number_Students	970	1175	1410	500	1730	1626	1748	364	1200
Number_Permanent_Teachers	40	37	24	1	40	19	18	5	10
Number_Adjunct_Teachers	50+	50+	50+	50+	50+	50+	50+	50+	50+

The diversity in terms of the leaders' age, gender, type of institution, year of establishment, size of the student population, and the number of permanent and adjunct teachers, highlights the multiple facets that characterize these institutions and that can influence their approach to education and technology.

3.2. Analysis of Results Related to Structured Questionnaires

The table below presents the responses to the structured questions in the form of a Likert scale, where responses are numerically rated from 1 to 5.

Table 2: Summary of Responses to Structured Questions

Variables/Institutions	E-A	E-B	E-C	E-D	E-E	E-F	E-G	E-H	E-I
Leadership model									
Strategic_ICT_Integration	4	4	4	5	3	5	4	4	5
Level_ICT_Integration	4	3	3	3	1	3	3	3	2
Infrastructure and resources									
Availability_Tech_Support	4	4	4	5	4	4	4	4	4
Level_Availability_Tech_Support	3	3	3	4	2	3	3	2	2
Professional development									
ICT_Training	4	4	4	3	3	3	3	4	2
Level_ICT_Training	4	3	4	2	1	2	2	4	2
Pedagogical change									
Pedagogical_ICT_Effectiveness	4	4	4	4	3	4	4	4	3
Level_ICT_Pedagogical_Effectiveness	3	3	3	3	2	3	3	4	2
Collaborative_ICT_learning	4	4	4	4	2	2	4	5	3
Policy and implementation strategy									

ICT_Policies	4	4	4	3	3	4	4	4	3
Administrative_ICT_Use	4	4	4	5	3	5	4	4	2
Level_Admin_ICT_Use	3	3	3	4	1	2	3	3	2
Progressive assessment of ICT use									
ICT_Security	4	4	3	4	3	2	4	3	4
ICT_impact_assessment	2	4	4	2	2	4	2	3	2
General_Rating_ICT_Use	3	3	3	4	2	3	3	3	2

Below is an analysis of the gathered results:

- **Leadership Model**

Strategic Integration of ICT: Scores range from 3 to 5, indicating a generally positive recognition of the strategic importance of ICT. However, some institutions show more moderate levels of strategic integration.

Level of ICT Integration: Scores vary between 1 and 4, suggesting significant differences in the degree of ICT integration within the institutions.

- **Infrastructure and Resources**

Availability of Technical Support: Scores are mostly high (4 or 5), indicating good availability of technical support in most institutions.

Level of Technical Support Availability: With scores ranging from 2 to 4, this shows variability in the quality or accessibility of technical support.

- **Professional Development**

ICT Training: Scores vary from 2 to 4, reflecting diverse levels of ICT training for staff.

Level of ICT Training: Scores, ranging from 1 to 4, indicate gaps in the quality and depth of the ICT training offered.

- **Pedagogical Change**

Effectiveness of ICT in Pedagogy: Most institutions received scores of 3 or 4, showing a positive perception of the effectiveness of ICT in teaching.

Level of Effectiveness of ICT in Pedagogy: Scores, oscillating between 2 and 4, suggest varying degrees of success in the pedagogical application of ICT.

- **Policy and Implementation Strategy**

ICT Policies: With scores mainly around 3 and 4, it appears that most institutions have well-established ICT policies.

Use of ICT in Administration: Scores range from 2 to 5, indicating differences in the effectiveness of using ICT for administrative operations.

- **Progressive Evaluation of ICT Usage**

ICT Security: Scores, ranging from 2 to 4, show that ICT security is a variable concern among institutions.

Evaluation of the Impact of ICT: Scores are quite low (mainly 2 and 4), suggesting that the evaluation of the impact of ICT is an area needing special attention.

These data reveal that, although ICT is generally well integrated into higher education institutions in Antsiranana, there are significant variations in how different aspects of ICT are managed. Areas such as professional development, ICT security, and the evaluation of the impact of ICT appear as zones needing specific attention and improvements. These findings can guide future policies and strategies for better integration of ICT in these institutions.

3.3. Analysis of Results Related to Semi-Structured Questionnaires

The integration of Information and Communication Technologies (ICT) in higher education institutions in Antsiranana represents a crucial aspect of their modernization and the improvement of the quality of education. Based on the responses to semi-structured questionnaires collected from leaders of nine institutions, this analysis sheds light on overall perspectives and reveals specific trends.

At the heart of this integration is the basic ICT infrastructure present in the majority of the institutions, including equipment such as computers, projectors, and internet access. Some institutions go further, boasting more specialized tools like computer labs and virtual learning platforms, demonstrating a deeper commitment to digital technology. However, the increasing ICT needs clash with the reality of often insufficient infrastructure, a challenge partially met through support from external organizations and increased digitization efforts.

Transcending mere hardware installations, institutions adopt varied strategies to encourage ICT adoption among their staff. From continuous training and skill development to incentive policies, the focus is on raising awareness and educating on technology usage. While approaches may vary, with some preferring to leave the choice of technological engagement to individuals, the common goal remains the promotion of an enlightened digital culture.

This culture of digital innovation naturally extends to professional development. Training programs are regularly offered to enhance the digital skills of teachers, although the impact and adoption of these programs vary greatly from one institution to another, suggesting the need for a more coherent strategy to standardize digital expertise.

Efforts to integrate ICT are, however, confronted with significant challenges. Besides technical obstacles, a certain cultural conservatism can hinder the adoption of new practices, with some teachers and administrative staff displaying notable resistance to change. Institutions respond to this challenge through targeted training and policy adaptation to better meet individual needs and preferences.

Beyond these challenges, institutions implement innovative ICT initiatives, such as online registrations and digitization of administrative data, often successful when stakeholder engagement is strong and the necessary technical skills are available internally. These initiatives, tailored to the specific needs of each institution, reflect a willingness to innovate and progress.

Driven by an ambitious vision, these institutions aspire to become fully digital establishments, with objectives aligned with overall digitization, improving access to education, and expanding the range of training offerings. These aspirations fit into an international context focused on greater interactivity and collaboration in education.

In summary, higher education institutions in Antsiranana demonstrate a firm commitment to the ICT integration process, marked by notable progress and promising projects. However, they must overcome significant structural and cultural challenges and contend with heterogeneous levels of ICT adoption. Professional development actions, incentive and support policies, and external support are essential levers for successful integration. To maintain this momentum, a comprehensive strategy that combines infrastructure strengthening, an encouragement policy, and continuous training is indispensable.

4. Discussions

In light of the goal of this study and the formulated research questions, the analysis of the nine public higher education institutions in Antsiranana reveals multiple and nuanced facets of the integration of Information and Communication Technologies (ICT). The accumulated observations offer a comprehensive

view that not only puts current policies and strategies into perspective but also allows for formulating recommendations to strengthen ICT integration effectively and sustainably. To better understand the reality of ICT integration and its current implementation situation in higher education institutions, it is important to trace back to the origin of the reform that brought a shift in Madagascar's education system; which subsequently significantly influenced the roles incumbent on each leader of these public institutions. Due to the contextual diversity prevailing at national, regional, and institutional levels, institutions have adopted a variety of strategies in their efforts to integrate ICT into program design, delivery, and research. This diversity stems from the fact that there is not yet a universal approach in this regard. Indeed, policy approaches vary from one institution to another and even from one department to another within each institution. Consequently, each leader is forced to mobilize their own resources to successfully carry out any ICT-related project.

In 2009, the Ministry of Higher Education and Scientific Research (MESUPRES) in Madagascar decided to reform the higher education system by adopting the LMD (Bachelor-Master-Doctorate) system. This major change in the educational system was encouraged by international organizations such as UNESCO, the European Union, the World Bank, and the University Agency of La Francophonie (AUF). The goal of this reform was to adopt a higher education structure aligned with international standards of the LMD model. Besides the development of new infrastructures and the implementation of pedagogical and administrative reorganization within these institutions, one of the requirements of this system for all Malagasy public higher education institutions is also to integrate ICT into their educational system and institutions. Although it has been demonstrated that the transition to this system offers many benefits, such as learner mobility, optimization of programs according to labor market needs, and improving the competitiveness of Malagasy higher and technical education internationally, many challenges remain for its full implementation in the educational system of our local public institutions in Antsiranana. Consequently, this has raised concerns among the leaders of these institutions, as to adapt to this innovation, they need support in various areas. Reality shows that no action plan, clear strategy, or guidelines to follow were available for the heads of institutions to integrate ICT into their daily practice. Thus, the responsibility fell on each head of institution to develop their own strategies in a context where there was little interaction with ICT. Despite numerous initiatives from the ministry responsible for higher education through the development of digital technology and the use of technologies, it is clear that Madagascar still does not have defined national policies to integrate ICT into higher education (World Bank, 2007). In this perspective, we discuss the importance and functions of national policies in information and communication technologies (ICT) for higher education. Our discussion is inspired by the works of UNESCO (2013), which looks at "the transformation of education: the power of ICT-related policies", as well as the USAID report (2011) on "National ICT education policy". These references serve as a basis for understanding the deficiencies in the strategies adopted by the leaders of higher education institutions in integrating ICT and for envisaging potential improvements. It is important to know that national policies play a leading role in promoting and managing the integration of ICT in higher education. Firstly, they establish a strategic direction by defining a clear vision and specific objectives for the use of ICT in higher education. This vision serves as a roadmap for educational institutions, helping them align their efforts with national priorities in technological education. Moreover, national policies also define financial resources to be allocated to support the integration of ICT. This may include funds for purchasing technological equipment, training teachers, and creating modern digital infrastructures. By providing adequate funding, an environment conducive to the adoption of ICT is created. Moreover, through national policies, a regulatory framework for the use of ICT is also established. They define data security standards, guidelines on the protection of students' and teachers' privacy, as well as rules to ensure ethical and responsible use of technologies. Another essential aspect within the framework of national policies is teacher training. They set

up professional development programs aimed at strengthening teachers' ICT skills. These programs enable teachers to effectively integrate ICT into their pedagogical practices. Moreover, these policies encourage research and the development of new educational technologies by promoting collaboration between higher education institutions, the private sector, and researchers to stimulate technological innovation for learning. Finally, they ensure that the integration of ICT is done equitably. This means they strive to ensure that all students, regardless of their socio-economic background, have equal access to technological resources. This equity of access is essential to avoid any disparity in learning opportunities (UNESCO, 2013; USAID, 2011; Cross & Adam, 2007).

In the absence of national policies clearly defining guidelines for the integration of ICT in higher education, institutional leaders are left without a reference framework to guide their digital development initiatives. This gap has significant repercussions on their responsibilities as primary managers of their institutions, given the many challenges they face. As a result, they are forced to rely on their own initiatives to support such a radical change (Cross & Adam, 2007). Our study has highlighted the consequences of the absence of these policies supposed to guide and frame the leaders of institutions in adopting ICT in education. Results aligned with Karsenti (2009) concluded that among the challenges related to the integration of ICT, particularly the absence or insufficiency of incentive policies to encourage the use of ICT in education is noted.

Not only did the leaders show gaps in terms of knowledge and experience in assessing the ICT situation within their institution, but this experience also revealed that, due to the absence of this reference framework, they struggle to define the true parameters of ICT integration. Although recently, the country has taken notable steps, under the direction of the Ministry of National Education and the Ministry of Higher Education, to adopt an exemplary approach and implement initiatives to integrate ICT into institutions, as we mentioned earlier, there remains a void in terms of a national policy framework defining the role of ICT in higher education. Higher education institutions, therefore, find themselves having to refer to a series of inconsistent and fragmented statements, scattered within several higher education policy documents, in order to make institutional decisions in line with national priorities (Cross & Adam, 2007). For example, evaluating the integration of ICT into an overall strategy assumes that ICT is widely implemented in all pedagogical and administrative aspects of the institution. However, reality shows that this is not the case, and that the adoption of ICT remains partial, or even very limited, if we refer to the basic reference framework. Consequently, our structured questionnaires have led to nuanced results that do not faithfully reflect the real situation in each institution. In the absence of clear guiding policies, heads of institutions certainly have visions and initiatives to introduce ICT, but they struggle to define priorities in terms of acquiring basic technological infrastructure to start this integration process. Thus, they are often led to prioritize other investments in different areas rather than devoting resources to technological development. This situation underscores the crucial importance of national policies and clear guidelines to effectively guide and support the integration of ICT in higher education.

Although much is known about support for innovation, less is known, particularly in developing countries at the national and regional levels, about the specific leadership characteristics necessary for leaders charged with integrating ICT into their institutions (Al Sharija, 2012). Indeed, there is a significant gap in the literature, with international calls to continue research on leadership and the implementation of ICT in higher education (Schiller, 2002) especially in the context of developing countries, as the latter finds itself in a complex sphere where it can no longer escape integrating ICT into its educational environment. There had been no research on the practices of these directors regarding the adoption of ICT in higher education in Madagascar, making this research the first of its kind. Therefore, it was necessary to examine the leadership

practices of institutional directors regarding the integration of ICT. This approach aimed to obtain a clear picture of the current situation and to provide support for improving the transformation processes of the educational system. Within any institution, including those in Antsiranana, the role of the leader is very important. Their leadership sets the standards that are then reflected in the way teachers teach, students learn, and technical and administrative staff (PAT) perform their administrative tasks. Furthermore, the leadership practices of the head of the institution for the integration of ICT determine the success or failure of the process (Al Sharija and Qablan, 2012).

The adoption of ICT in institutions strongly depends on the positive attitude of institutional leaders towards them. International studies suggest that educators' and administrators' reluctance to use modern technologies often stems from their apprehension about computing, a lack of conviction about the usefulness of ICT for education, and a perception of inaccessibility of these tools (Totolo 2011). This dynamic explains why some leaders, like those of institution E-D, do not fully engage in the integration of ICT. Research indicates that directors who perceive technologies as being simple to use and beneficial are more willing to integrate and use them effectively (Totolo 2011; Flanagan and Jacobsen 2003; Schiller 2003; Otto and Albion 2002). As illustrated in the cases of institutions E-A and E-B, as highlighted in (Melpomeni and Konstantinos 2004), confidence in experimenting with new things with adequate training in technology and pedagogy (Bottino 2004), as well as a willingness to take risks (Conlon and Simpson 2003), are also factors that foster the openness of directors to adopting ICT in their institutions, as is the case for E-A, E-B, E-F, and E-C. Conversely, leaders with a lack of ICT competence not only have a negative view of adopting ICT but also fail to see the urgency or necessity of integrating these tools into their educational management; this is particularly true for E-D.

Firstly, the analysis of results suggests that the existing policies and strategies in these institutions directly influence the capacity to effectively integrate ICT. Through the policies and strategies in the implementation of ICT in the institution, the leaders of the institutions play a crucial role. Many studies support this argument. Al-Harbi (2014) states that despite the adoption of ICT in their pedagogical practices, without defined policies and strategies, leaders have limited knowledge of how to effectively integrate ICT into classroom practices. In other words, the adoption of ICT is often carried out without a solid understanding of what the technologies should improve and in the absence of clear guiding values. As advanced by Cross & Adam (2007), often, ICT is implemented in institutions thinking that it will solve all problems, without taking the time to determine which specific problem they are supposed to solve. In other words, they are often adopted hastily without a clear policy or a thorough analysis of real needs and objectives to be achieved. This can lead to a lack of effectiveness because ICT is not used in a targeted manner to solve specific problems. Moreover, Al Sharija (2012) included the definition of a policy and strategy for adopting ICT as a practice within the competence of leaders. The variability observed between the institutions indicates a need for customized strategies that take into account their unique context. For example, E-A seems to be advancing confidently, thanks to clear policies and well-supported initiatives, while others like E-I are hindered by gaps in the execution and evaluation of their strategies. This underscores the importance of a match between strategic vision and practical implementation.

Regarding the leadership model, institutions with leaders favorable to pedagogical innovation, as observed in some cases, tend to better promote the integration of ICT. Enlightened and committed leadership, which understands and supports technological innovation, is essential. This is particularly true in cases where pedagogical changes and resistance to change are successfully managed by visionary and communicative leaders. Numerous studies support these statements by highlighting the roles of leadership practices of heads of institutions in the successful implementation of ICT in their institutions. Yuen, Law & Wong (2003) assert that the heads of institutions through their leadership model are the main and important actors in the ICT implementation process. Moreover, the results of Labonte (2005) and Yee (1999) confirm these statements by

revealing that effective leadership practices have a positive impact on the environment where ICT is used. This means that when leaders opt for the adoption of appropriate leadership models, they promote a more effective and beneficial use of ICT within their institution. Flanagan & Jacobsen (2003) mentioned that a factor affecting the effective integration of ICT is the lack of qualified leadership. As the use of ICT requires financial, material, and human resources, only a qualified leader can advocate for the allocation of adequate resources for the purchase of equipment, software, and for the maintenance of the technological infrastructure to support these ICT initiatives. These leadership practices also emphasize the definition of a clear vision favorable to technological innovation. Regarding this vision, leadership strategies that have established an effective defined and shared vision conform to the model of effective leadership practices developed by Leithwood et al. (2006), as well as the study by LaBonte (2005). They all emphasized the importance of building a shared vision. Without a clear vision, ICT stakeholders tend to suffer from ambiguity and uncertainty, leading to failure in the introduction of any change in terms of innovation (Al Sharija, 2012). As highlighted by Avolio (1999), the leadership role of a leader in building a shared vision involves creating a sense of common mission; because a shared vision contributes to raising awareness among teachers about the objectives and future directions of the institution, as well as student learning. Such positive leadership practice contributes to reducing resistance to change on the part of the staff (Wedel et al., 2007).

The major challenges encountered relate to issues of resources, resistance to change, and professional development, as highlighted by E-D and E-E. The lack of training and technical support affects the staff's ability to adopt and fully integrate ICT into their pedagogical practices. This reiterates the importance of targeted initiatives for professional development.

Resistance to change, as exposed in the literature review section, has proven to be a major challenge present in all the institutions selected for this study, thus hindering the initiatives of institutional leaders in Antsiranana to integrate ICT into their institutions. It represents a significant challenge for leaders charged with successfully implementing ICT in these institutions. Resistance to change, often due to a rigid institutional culture or a lack of technological skills, remains a notable barrier to innovation. After thoroughly analyzing the use of ICT in these institutions, we have identified the underlying factors to this resistance to change.

Firstly, the leadership model adopted by the head of the institution plays a decisive role in the staff's willingness to engage in the ICT integration process. When an inclusive leadership model is implemented, involving all stakeholders in decisions related to the adoption of ICT, it generally fosters more favorable reactions to the use of ICT within the institution (Al Sharija, 2012; Yee, 1999). On the other hand, when leadership problems persist, they have a significant impact on all administrative and academic activities. In other words, when decisions concerning the adoption of ICT are made centrally, without consultation or involvement of the staff, this can lead to resistance. This lack of participatory leadership often translates into a lack of support for the staff and an absence of conviction about the benefits of using ICT. Tony Bush (2003) highlighted the general consensus that the quality of leadership has a considerable influence on stakeholders' perceptions of ICT use, as well as on the performance of teachers and students. If the staff does not feel supported in the ICT adoption process, they generally exhibit a negative attitude towards this change, often due to fear of an increased workload due to the implementation of ICT or simply because of a natural reluctance to technological change (Bingimlas, 2009). Moreover, if staff members do not clearly see the benefits of ICT in terms of improving teaching, learning, or administrative efficiency, they show no interest in engaging in this process (Al Sharija et al., 2012). Thus, the lack of understanding and support from other heads of institutions has created obstacles to the meaningful use of ICT (Gibson and Albion, 1997; Kearsley, 1998). Moreover, resistance to change also stems from the lack of technical and pedagogical skills among teaching and administrative staff, as well as from the disruption of their established professional routines. Some staff members lack the necessary skills to use ICT effectively, which raises the crucial question of

professional development. This gap in professional development is supported by the findings of Shonta Harrell and Yvette Bynum (2018), who identify the lack of adequate training as one of the main obstacles to the effective integration of ICT in institutions, thus hindering their smooth and effective use. However, it is regrettable that some institutions included in our study do not consider professional development as a priority in the ICT adoption process. Often, their technological planning is limited to the acquisition of hardware and technological resources, neglecting the crucial organizational and cultural changes necessary to support proper use of technology. This observation joins the conclusions of Ismail (2010). Karsenti (2009) also shares this view, stating that insufficient commitment from various stakeholders and educational sector partners hinders the successful integration of ICT in higher education. This circumstance can certainly explain the problem of underutilization of the technological resources that the institution has invested considerably in; as is the case of E-F where it is really highlighted. Moreover, reluctance to adopt these technological resources can be observed among staff members who anticipate potential technical or material problems for which they are not prepared, as highlighted by Almaghlouth (2008). Regarding the challenge of changing routines, both in teaching and administration, it is observed that individuals tend to stick to their usual work and teaching methods, thus, the introduction of ICT into their professional environment can be a source of disruption to their routines. According to the heads of the institutions surveyed, resistance to change in the context of pedagogical change of teachers manifests itself through the refusal to adopt new teaching methods based on ICT by further involving themselves in the use of traditional methods of teaching and learning (Almaghlouth, 2008; Cleary et al., 2008). However, in today's educational context with digital challenges, traditional teaching methods themselves no longer keep up and adapt to the demands of educating generations that must be equipped with the skills and mindset necessary to thrive in the digital age. This explains the need to move to constructivist approaches. Constructivist teaching methods, focused on active engagement, critical thinking, and problem solving, are particularly suited to this digital environment, allowing students to explore, question, and build their understanding, which significantly enriches their learning experiences. Moreover, constructivist methods leverage digital technologies to facilitate personalized learning experiences where teachers can tailor teaching to meet the diverse learning needs and styles of students. Furthermore, constructivist teaching aligns with the principles of student-centered learning. In today's digital age, students have greater control over their learning journey, and constructivist approaches allow them to take charge of their education. The shift from a teacher-centered model to a learner-centered one fosters autonomy and self-directed learning, essential skills for lifelong learning in the digital age (Yee, 1999; Al Sharija, 2012). This underscores the importance of considering teachers' opinions about change and encouraging them to reconsider their teaching methods to meet the objectives set for integrating ICT into education; otherwise, teachers might continue to favor their traditional pedagogical practices. As Bingimlas (2009) points out, resistance to change should not be seen as an intrinsic obstacle, but rather as an indicator that something is not functioning normally. It can be mitigated by adequate technical support and professional development programs, as illustrated in the example of E-B and E-C.

Furthermore, it is concerning to note that in some institutions that have made considerable efforts to invest in technological infrastructure, these ICT resources are underutilized, especially from a pedagogical and administrative perspective. This highlights the need to train and guide staff to maximize the effective use of these technological tools. Professional development in ICT appears to be a common challenge across several institutions. Although they recognize the importance of professional development for successful ICT integration in higher education, these institutions struggle to educate and train their staff on the importance and effective use of ICT. Some institutions, such as E-A, E-B, E-C, and E-F, have implemented training programs to enhance the digital skills of their staff. However, these initiatives are often limited to a small number of people and do not necessarily reach the entire teaching and administrative staff. As Flanagan & Jacobsen (2003) emphasized, the rapid evolution of the education sector with the increasing integration of

ICT into pedagogical and administrative practices spares no ICT stakeholder in the institution. Thus, institutional leaders should consider the needs of all staff when planning a training program for better ICT adoption within the institution, as failure to do so could lead to the failure of all efforts invested in this perspective. Moreover, it is essential to recognize that each teaching and administrative staff member has individual potential that must be activated, otherwise it could hinder all progress. According to Bass (1990), the aspect of "Individual Consideration" is of major importance. Leaders have recognized the importance of individual skill development of their staff, but as they have indicated, this professional development process within their institution is not yet systematically implemented. A concrete example is found at E-I, where the importance of ICT is recognized, but the promotion of professional development in this area seems to encounter difficulties in being implemented in a structured manner. Our study also revealed that a large part of the staff of the institutions does not benefit from adequate support in professional development or clear guidelines on the use of ICT in their profession. These findings are consistent with the results of Alharbi's (2012) study, which also advocates for strengthening support for professional development, particularly focusing on ICT-related skills for the institution's staff. In line with this conclusion, Mohammad et al. (2011) advocated for the continuation of professional development activities aimed at preparing and enhancing the staff's skills so that they can fully take advantage of the integration of ICT and its potential in their professional environment.

The goal of professional development, as supported by Kolmos, Rump, Ingemarsson, Laloux, and Vinther (2001), as well as Pesavento, Bator, and Ross (1994), has a triple dimension. Firstly, it aims to provide basic knowledge for the improvement of the institution, thus promoting the growth of the institution, whether as a whole entity or at the individual level of the staff. Secondly, it contributes to creating a conducive atmosphere, facilitating effective interaction among staff members. Thirdly, it establishes a common understanding among members of the academic and administrative community regarding educational priorities. The head of the institution, as these authors highlight, must create a favorable climate for professional development at the institutional level to take place successfully. In the absence of a favorable, creative, and positive environment for staff development processes, as Kydd et al. (1997) noted, staff performance can suffer negatively. Moreover, professional development should be accessible to all ICT users in the institution, including staff and teachers, in accordance with the recommendations of these researchers. Therefore, it is a challenge for leaders to offer tailored and flexible professional development opportunities, focused on technology integration and design, rather than on computer applications alone, as it is important to note that a lack of ICT skills can have a significant impact on teaching effectiveness (Flanagan & Jacobsen, 2003). Furthermore, being a qualified leader in ICT also involves the ability to set up training and professional development programs for teachers while trying to identify essential ICT skills, selecting or creating training resources, and organizing effective training sessions. The absence of all these technological competencies in leaders is thus the origin of major obstacles hindering the effective integration of ICT in higher education institutions (Flanagan & Jacobsen, 2003).

Regarding infrastructure and its role in integrating ICT, our study has provided insight into the existing infrastructure within each institution and analyzed its relevance in the ICT adoption process in these institutions. Based on the exploitation of responses to semi-structured questionnaires collected from the leaders of nine institutions, this research sheds light on global perspectives and reveals particular trends regarding ICT in each institution and the leaders who represent them. At the heart of ICT integration in institutions lies the basic ICT infrastructure present in the majority of institutions. The situation of infrastructure and ICT resources in these institutions presents a varied range of realities. Overall, even though there is a great disparity between these institutions regarding the quality and quantity of their ICT resources, they all show a degree of commitment towards adopting ICT, with investments in equipment such as computers, video projectors in the case of all institutions, but online platforms and computer labs are assigned

to only some of them; this is an essential prerequisite for successfully integrating ICT into higher education. Some institutions go beyond others, showcasing more specialized tools that demonstrate a deeper commitment to digital technology, thus showing a willingness to modernize their teaching and learning methods. Indeed, as discussed in Karsenti and Ngamo (2009), the existence of minimal infrastructure in educational institutions constitutes prerequisites for the successful implementation of ICT in higher education. In fact, as we addressed in the literature review section, three factors define the prerequisites for integrating ICT into higher education, such as the presence of basic infrastructure in educational institutions, the availability of technical and professional support, and the possession of adequate financial means (Karsenti and Ngamo, 2009; Bhuasiri et al., 2012; Jouko Sarvi & Hitendra Pillay, 2015). Numerous studies have highlighted the crucial role of infrastructure and resources in information and communication technologies (ICT) in their integration into higher education. As mentioned in (Russel et al., 2003; UNESCO, 2002; Karsenti and Ngamo, 2009; Karsenti, 2009), these technological infrastructures play an essential role in facilitating access to ICT for the entire educational community, thus ensuring that students and staff have the necessary means to use them practically. This reality is observable in the educational institutions in Antsiranana, where the use of ICT is gradually developing. To this end, they have invested in equipment such as computers, video projectors, online platforms, and computer labs. Furthermore, these infrastructures and resources effectively support online learning, enabling institutions to offer online courses, provide digital educational resources, and facilitate communication between teachers and students, thus offering learning flexibility. However, it is important to note that, although some initiatives have been undertaken in our institutions, their implementation remains limited to some of them, such as the cases of E-A, E-B, E-C, and E-F.

These initiatives notably include the use of online learning platforms and learning management systems, although their use remains partial, being attributed to a limited number of teachers. Regarding E-A and E-B, they stand out as being at the forefront in this integration initiative, characterized by quality teaching in the field of ICT and a clear mission to train future users of these technologies. Administratively, technological infrastructures simplify the management of institutions, from managing student registrations and records to accounting and human resources. The heads of institutions favoring ICT tools, who actively participated in our survey, also confirmed these essential contributions of ICT infrastructure within their institutions. However, it is equally essential to recognize that this adoption of ICT within these institutions is uneven and that the quality and quantity of resources vary considerably from one institution to another. As an illustration, some institutions, such as E-B and E-C, have well-developed infrastructures, while others, such as E-H, face rudimentary and insufficient resources. The head of institution E-E even stated that the technological infrastructure available in his institution is not suitable for the use of technology in pedagogy and administration. He expressed his opinion that, at the moment, his institution continues to face Internet connection problems and with the current infrastructure, it is difficult for them to achieve technological advances. Moreover, the environment surrounding the use of these technological infrastructures is still fraught with many challenges. The major challenges against these initiatives of the leaders of the institutions in Antsiranana related to these technological infrastructures are summarized as the obsolescence of technological resources (Abdul Razzak, 2013), a slow internet connection, limited availability of digital educational resources and content (Karsenti, 2009; Al Sharija, 2012; Albugami and Ahmed, 2015), a limited number of computer labs, recurrent computer breakdowns, the slowness of ICT systems, and the limited availability of educational software (Öznacar and Dericioğlu, 2017).

The complex challenges related to technological infrastructure explain the current situation of higher education institutions in Antsiranana. Despite their efforts to acquire infrastructure and technological resources, which are the first prerequisite for integrating ICT, most of these institutions still have a long way to go to meet the necessary conditions for a successful adoption of ICT within their institutions. Furthermore,

the leaders of higher education institutions, as one of the main actors in the implementation of ICT in education, play a major role in defining the necessary technological infrastructure. To do this, they require basic ICT skills, as it is their responsibility to provide stakeholders with the necessary resources they need for the use of ICT.

In addition to the problems related to technological infrastructure, a common obstacle to the successful integration of ICT in these institutions is insufficient funding. All leaders reported a lack of financial resources, which limits their ability to invest more in technological infrastructure and keep it up to date. This creates a gap between the ambitions for ICT integration and the reality of available resources. Much research (Öznacar and Dericioğlu, 2017; Yee, 1999; Al Sharija, 2012; Shonta Harrell and Yvette Bynum, 2018; Karsenti, 2009; Flanagan & Jacobsen, 2003) has come to the same conclusion about the lack of financial resources hindering the adoption and upgrading of technological infrastructure. The significant inadequacy of technological infrastructure in these institutions, as unanimously expressed by the leaders, remains a major problem. This situation mainly stems from the blatant lack of economic resources available for investing in these infrastructures. However, the leaders noted that efforts have been made to bring the technological infrastructure and the necessary technical configuration of the institution to an acceptable level. To this end, the heads of institutions try to gather the necessary funding using student registration fees collected, with the help of local organizations, as well as through donations. However, the general opinion among them is that the government, represented by the Ministry of Higher Education, does not provide the necessary financial support to solve this problem. This insufficiency translates into a lack of funding in operating budgets, thus leading to a deficit of appropriate infrastructure and equipment. For some institution heads, this reflects a lack of effort on the part of the competent authorities to support the introduction of these technological advances in the educational field. They feel that these educational institutions are seriously underfunded to effectively integrate ICT. Al Sharija (2012) also found in his studies that the lack of appropriate funding proved to be a major hindrance, hampering not only the acquisition of the necessary technological infrastructure but also the successful implementation of ICT within higher education institutions. Pelgrum's (2001) study conducted in 26 countries attributed the problem of lack of technological equipment resulting from the funding deficit as one of the major obstacles deterring education practitioners from using ICT. Furthermore, Paterson (2007) noted that the costs associated with ICT in developing countries were directly related to limited budgets and financial allocations (p. 98). The institution heads, participants in our study, clearly emphasized that the state has not provided significant financial support to address this inadequacy in terms of technological infrastructure. Consequently, they have been forced to mobilize their own resources by gathering student registration fees in order to introduce the use of technology in their institutions, and to align with technological evolutions in education.

Regarding the assessment of the impact of ICT, it is evident that only a few institutions have actually engaged in a thorough assessment of the use of ICT in order to measure and understand their effect on the educational experience. Although these institutions are not necessarily at the forefront of all ICT integration initiatives compared to others, they stand out for their continuous efforts to systematically assess these initiatives. In contrast, other institution leaders admitted in interviews that they had not paid sufficient attention to this aspect of ICT adoption. In other words, they revealed that there had been no assessment of the impact of their ICT integration initiatives within their institution. All this explains why the integration of ICT has not yet reached the desired level and remains to this day a major challenge. The importance of a progressive assessment of the use of ICT within an institution has been widely discussed in the literature review section. Without a systematic and ongoing evaluation process, ICT integration efforts may lack direction, effectiveness, and the ability to exploit their potential to improve education. In other words, This lack of evaluation leads to inefficient use of resources and does not allow for properly measuring the benefits or shortcomings of this technological initiative. Numerous studies attest to the usefulness of establishing a

continuous evaluation system for all efforts to implement ICT in higher education institutions. Hakami et al. (2013) support this view by stating that the lack of progressive evaluation explains the inefficiency of ICT integration in institutions. This signals the relevance of ongoing evaluation to determine the effectiveness of any ICT reform initiative. In the absence of such an evaluation, as in the case mentioned of Saudi Arabia by Hakami et al. (2013), educational institutions may continue on a path that proves costly in terms of resources and investments without reaping the desired educational benefits. Progressive evaluation is essential to ensure that the integration of ICT in higher education is aligned with the needs of students, effective from a pedagogical point of view, and able to adapt to an educational environment in the digital era. This ensures that resources are used optimally and that the benefits of ICT are fully exploited.

The surveys conducted on the nine higher education institutions in Antsiranana also reveal a varied commitment to the ICT integration process. This integration, essential for the modernization of teaching, shows different levels of readiness and technological maturity from one institution to another. Examining the three fundamental prerequisites for pedagogical integration of ICT - identified by Karsenti and Ngamo (2009), Bhuasiri et al. (2012), and Jouko Sarvi & Hitendra Pillay (2015) presented in the literature review section - namely, the existence of minimal infrastructure, the availability of technical and professional support, and the possession of adequate financial means, we observe varying degrees of readiness among these institutions. It seems that the higher education institutions in Antsiranana have not completely met the necessary prerequisites for effective integration of ICT. While there are notable advancements in some areas, several key aspects still require substantial improvements to fully meet the essential prerequisites for the integration of ICT. It is crucial for these institutions to continue their efforts to improve their infrastructure, strengthen technical and professional support, and ensure adequate funding to achieve successful integration of ICT in higher education.

To place these institutions in the different phases of ICT integration described by Karsenti (2009), it is observed that most institutions are between Quadrants A and B, where ICT is primarily used to teach basic computer skills or as autonomous learning tools. This result is consistent with what the author discovered, stating that among the different levels of pedagogical integration of ICT, Quadrants A and B are the most common in African countries (Karsenti, 2009). However, some institutions are partially moving towards Quadrants C and D, where ICT becomes integrated pedagogical tools in teaching, and students are encouraged to actively use them in their learning process, as illustrated in the cases of E-A, E-B, E-C, and E-F.

According to UNESCO's (2002) continuum for the integration of ICT in teaching, all higher education institutions in Antsiranana are primarily between the Emergence and Integration phases.

The majority of institutions, including E-B, E-C, E-D, E-F, E-G, E-H, and E-I, are in the Emergence and Application phases. In these phases, ICT begins to be explored and used, but primarily in a limited manner and without fundamental change in teaching methods. These institutions are gradually equipping themselves with basic technology and beginning to integrate ICT in some aspects of teaching and management, but integration remains superficial and has not yet significantly transformed their educational and administrative practices.

E-A, on the other hand, stands out by approaching the Integration phase. This institution shows a more advanced integration of ICT, with technologies well integrated into laboratories, classrooms, and administrative offices, where teachers actively explore innovative strategies to improve their pedagogical practices.

None of the studied institutions seems to have reached the Transformation phase, which represents the complete and routine integration of ICT in all aspects of organization and educational practices.

Thus, while the institutions in Antsiranana are engaged in the ICT integration process, most are still in the early stages of this continuum, with a few exceptions progressing towards more advanced stages.

In relation to the four models of ICT integration defined by Mhlanga (2005), based on Twigg (2003) in section 2.1.3. Model of ICT Integration in Higher Education, the majority of institutions, particularly E-B, E-C, E-D, E-F, E-G, E-H, and E-I, adopt the Supplementary Model. In this framework, they retain their traditional face-to-face teaching methods while integrating ICT as enrichment tools for learning. Technologies are used to complement, not replace, existing pedagogical practices.

Through this synthesis of discussion, it is evident that to achieve successful ICT integration, the nine studied institutions must embrace adaptive leadership strategies, overcome challenges through targeted training and continuous support, and establish effective evaluation mechanisms to guide their progress. Only a holistic and dynamic approach, integrating these elements with a deep understanding of the needs and specific context of each institution, can lead to a successful digital transformation within higher education institutions in Antsiranana. Moreover, it is also noted that the nine higher education institutions in Antsiranana are currently in an initial phase of ICT integration. They are primarily in the stages of Emergence and Application according to the UNESCO continuum, showing nascent integration of ICT without major changes in their teaching or management practices. Following Mhlanga's models based on Twigg, these institutions predominantly adopt a supplementary approach, using ICT to complement traditional methods without completely replacing them. However, gaps persist, particularly in terms of infrastructure, technical and professional support, and funding, requiring increased investment and efforts for a deeper and more effective integration of ICT. These findings are consistent with Karsenti's (2009) observations, which already highlighted the obstacles to the integration of ICT in teaching in Africa, where the challenges to be faced and constraints to be overcome are particularly numerous, exacerbated by a complex combination of geopolitical, socio-economic, and cultural factors, all in a context of increasing and pressing poverty.

5. Conclusions

In the context of the study on the integration of Information and Communication Technologies (ICT) in nine public higher education institutions in Antsiranana, a clear objective emerged: defining appropriate policies and leadership strategies for successful ICT incorporation. Based on the study's objectives and formulated research questions, the analysis of these nine institutions reveals multiple and nuanced facets of ICT integration. Utilizing a mixed-methods approach, this research highlighted the profound diversity of the educational institutions in their ICT integration initiatives, not only in terms of technological resources and infrastructure but also in institutional cultures and policies.

This research was guided by an underlying hypothesis: effective integration of ICT in higher education institutions relies on clear policies, dynamic leadership, sufficient resources, and adept management of resistance to change. The collected data throughout the study confirm this hypothesis, revealing that institutions excelling in these areas demonstrate more seamless and complete integration of ICT.

This study sheds light on the concerning situation of ICT implementation within the public higher education institutions in Antsiranana, a reality much grimmer than what is commonly presented. While these institutions show a certain degree of commitment to the ICT integration process, marked by notable progress and promising projects, they face significant structural and cultural challenges and deal with heterogeneous levels of ICT adoption. Professional development actions, incentive and support policies, and external support are essential levers for successful integration. Our findings also indicate that these institutions primarily need a widespread awareness among their leaders about the precise concepts and essential elements of technological integration. A clear understanding of this notion is crucial, as it could facilitate the ICT implementation process, ensuring it is carried out adequately. In our interviews with these leaders, it became apparent that they do not yet fully grasp the significant link between their role as educational leaders and its influence on the success of ICT integration. Understanding this link more transparently represents a major

obstacle that could be overcome through pedagogical and technological training and the professional development of institution heads (Abdul Razzak, 2013). Moreover, our study highlighted the consequences of the absence of national policies meant to guide and frame institution heads in integrating ICT in higher education. Furthermore, these institutions need technology policies focused on individuals and their attitudes towards ICT integration.

The study's results shed light on the significant influence of current policies and strategies within the concerned institutions. It appeared that when these policies are carefully crafted and effectively implemented, they become a real lever for ICT integration. However, the challenges associated with ICT integration are numerous and vary from one institution to another. Common trends emerge, such as a lack of technological resources and infrastructure, some resistance to change, a deficit in technical skills, and a manifest absence of state subsidies. Institutions that have successfully overcome these obstacles have consistently implemented targeted training programs and initiatives to encourage ICT adoption among their staff.

The study also highlighted the predominant role of leadership models in the ICT integration process. Transformational leadership, in particular, proved to be an undeniable success factor (Al Sharija, 2012). Leaders who embrace this form of leadership foster innovation and shared vision, creating an environment conducive to ICT adoption.

Additionally, the necessity for regular assessment of ICT's impact on the educational experience was also emphasized. High-performing institutions use performance indicators and regularly collect feedback from users to measure the effectiveness of ICT integration and identify areas for improvement.

Therefore, ICT integration appears as a complex process requiring a holistic approach. We can conclude that its success depends on the interplay of several factors: well-defined policies, inspiring leadership, wise resource allocation, commitment to professional development, innovative pedagogy, and effective and empathetic management of change. All these elements, combined with regular evaluations and active sharing of best practices, enable the studied public higher education institutions to maximize the benefits of ICT for enriching both teaching and administrative management.

Furthermore, an invitation to strategic reflection and action from the leaders of higher education institutions is anticipated. The higher education institutions in Antsiranana, equipped with the data and analyses provided, are better prepared to navigate the complex landscape of ICT integration. By adopting the recommendations from this research, they can not only meet the identified challenges but also fully capitalize on the opportunities offered by digital technologies, forging an educational future that meets the demands and expectations of the 21st century.

6. Recommendations

The significance of this research lies in its potential to inform and guide leaders in developing effective policies and leadership strategies for the implementation of ICT in higher education institutions. By identifying challenges and factors influencing the success of ICT integration, this study can also aid higher education institution leaders in creating an environment conducive to successful ICT usage. It can enlighten policymakers and educational practitioners by providing recommendations based on specific case studies to enhance ICT integration in higher education institutions.

In light of these findings, implications and recommendations are formulated for the leaders of public higher education institutions in Antsiranana regarding successful ICT integration within their institutions. Considering the unique dynamics of each institution, adopting these recommendations could lead to significant changes and substantially improve ICT integration in their respective environments.

6.1. Leadership and Institutional Policies

In the context of ICT integration in higher education, the role of institutional leaders is a determining factor. Leaders are encouraged to embody transformational leadership, characterized by its ability to establish a shared vision, inspire, and motivate the entire educational community. This leadership style goes beyond daily management; it is about transforming values, beliefs, and attitudes towards ICT to create a sustainable culture of innovation.

A transformational leader in a higher education institution in Antsiranana might, for example, initiate pilot projects of massive open online courses (MOOCs) to test the effectiveness of new teaching methods and knowledge dissemination. They would actively encourage teaching staff to integrate digital tools into their pedagogy and recognize their efforts and successes in this area, thus fostering an environment where experimentation and adoption of ICT are valued.

Establishing clear institutional policies and specific strategic plans for ICT is a critical step to guide and support their integration. These policies define expectations, responsibilities, and standards, which is particularly important to ensure equity, access, and the quality of education. Regulatory frameworks should address issues such as data use ethics (privacy protection and informed consent), cybersecurity (protection against data breaches), intellectual property (copyrights and sharing of educational resources), and quality standards for digital teaching.

For instance, a policy might mandate that all digital course materials be accessible according to international standards, ensuring that students with disabilities can also benefit from online resources. Another policy could require that data generated by online learning platforms be analyzed to continuously improve learning paths while strictly respecting the confidentiality of student information.

Training leaders on emerging technologies, change management, and digital strategy is crucial to ensure that ICT integration is led by individuals who are not only competent but also visionary. This involves continuous training, seminars, conferences, and workshops focused on the latest trends in educational technology, digital strategic planning, and adaptive leadership skills.

In practice, this could mean that leaders of institutions in Antsiranana participate in international higher education leadership networks, where they can learn from global best practices and adapt them to their local context. Mentorship programs could also be established, where experienced leaders in educational ICT mentor new leaders, sharing their expertise and experiences.

In summary, these three pillars - transformational leadership, development of clear policies, and leadership training - form the foundation on which an institution can build successful and sustainable ICT integration, tailored to its specific needs and cultural and economic context.

6.2. Resource Allocation

For the successful integration of ICT in higher education institutions in Antsiranana, targeted strategic investments are imperative. This means reallocating existing budgets to prioritize technological needs, such as acquiring state-of-the-art hardware and software, upgrading network infrastructures for reliable high-speed access, and building or renovating classrooms into smart and interactive learning environments.

For instance, a portion of the budget could be allocated for installing interactive whiteboards and in-class response systems, enabling a more dynamic and engaging learning experience. Similarly, funds could be used to equip libraries with accessible digital resources, such as academic databases and e-books, ensuring that students and teachers have access to the latest research and information in their respective fields.

Strategic partnerships with external entities like technology companies, non-governmental organizations, and government agencies can play a key role in enhancing the ICT capabilities of institutions. These collaborations can range from co-funding ICT projects to creating professional training programs and applied research. By forming such partnerships, institutions can benefit from the expertise and resources of various sectors, greatly facilitating and enriching the integration of ICT.

For example, a partnership with a tech company could enable an institution to provide its students with advanced software and online learning platforms at a reduced cost or even for free. Similarly, working with NGOs focused on education could help develop training programs for teachers, preparing them to effectively use ICT in their teaching practices. These partnerships could also create opportunities for students to engage in practical internships, better preparing them for the workforce in an increasingly digitized economy.

In conclusion, a strategic approach in resource allocation and forming partnerships is essential to ensure that higher education institutions in Antsiranana can not only adopt ICT but also integrate it innovatively and sustainably into their teaching and research. These joint efforts will help establish a technologically advanced and interconnected educational ecosystem, benefiting both students and the academic community as a whole.

6.3. Professional Development

In the context of higher education institutions in Antsiranana, professional development plays a crucial role in ensuring that teaching and administrative staff keep pace with rapid advancements in ICT. Continuous training programs should be established, offering a variety of learning modalities tailored to individual needs. This could include practical workshops on new software tools, seminars on best practices in online teaching, and online courses on digital pedagogy. These trainings could be delivered in partnership with ICT experts and recognized institutions, thus ensuring the quality and relevance of the skills acquired.

For example, a workshop could be organized to train teachers on integrating computer simulations into their science classes, making learning more interactive and engaging for students. An online course could be offered to familiarize staff with Learning Management Systems (LMS), which have become a crucial element of modern higher education.

To complement these training programs, incentive systems can be put in place to encourage and recognize staff efforts in learning and applying ICT. This could take the form of monetary rewards, promotions, public recognition, or opportunities for advanced professional development. These incentives would not only motivate staff to train in ICT but also value and celebrate those who effectively integrate these tools into their work.

Imagine, for example, creating an annual Digital Pedagogical Innovation Award, given to a teacher or team who has implemented an innovative approach to using ICT in the classroom. This could not only inspire the winners but also encourage their colleagues to explore and adopt new technologies.

In summary, establishing robust ongoing training programs, combined with well-thought-out incentives, creates an environment where staff are motivated and equipped to navigate the constantly evolving digital landscape. This investment in human capital will translate into better ICT integration and, consequently, an enhanced educational experience for students in Antsiranana.

6.4. Pedagogical Change

Pedagogical innovation is the cornerstone of successful ICT integration in higher education. In Antsiranana, this would involve revising and modernizing curriculums so that ICT are not just additional tools but integral components of learning. This integration would prioritize active and interactive learning methods, placing the student at the center of the educational process and promoting the development of practical skills

and critical thinking. For example, the use of simulation software could transform physics classes into interactive virtual experiences, allowing students to visualize and manipulate otherwise abstract concepts.

The widespread adoption of hybrid learning models fits into a modern vision of education. These models combine the benefits of face-to-face teaching, such as direct interaction and peer support, with those of online teaching, such as flexibility and access to a multitude of digital resources. For example, an institution might offer classes for group discussions and practical activities, while theoretical lectures would be available online, allowing students to follow them at their own pace. This would make learning more accessible and could improve student engagement, especially for those balancing studies with other responsibilities.

To further illustrate, take the example of a biology course. Laboratory sessions would be conducted in person to allow students to benefit from practical experience, while lectures would be accessible online as interactive videos and podcasts. Students could thus review theoretical concepts at their own pace before applying this knowledge in a practical lab context.

Introducing these pedagogical changes will require thoughtful reflection and meticulous planning to ensure they meet the needs of students and educational staff. However, these initiatives could significantly enrich the educational experience in Antsiranana, preparing students to succeed in an increasingly digital and interconnected world.

6.5. Change Management

Managing resistance is a crucial aspect of the change process, especially when it comes to adopting new technologies. Establishing programs to manage this resistance is essential for a successful transition to ICT integration. This requires transparent communication and the creation of channels for open dialogue. For example, forums and workshops could be organized to allow teachers and staff to express their concerns and discuss the potential benefits of ICT in their professional practice. It would also be wise to include concrete examples showing how ICT have improved teaching and learning in other institutions, to demonstrate their effectiveness and reassure staff about their added value.

Creating digital transition teams is a proven strategy in many organizations. These teams would be responsible for digital project management and would oversee the implementation of ICT initiatives. They would ensure the coherence of the implementation of new technologies and provide ongoing monitoring. For illustration, a transition team could oversee updating the institution's network infrastructure, ensuring that deadlines are met and that new installations meet user needs. Additionally, they could organize training sessions for staff and students, ensuring that everyone is comfortable with the new systems and tools.

In practice, a digital transition team might launch a pilot project in a department, such as the introduction of interactive whiteboards. This initiative would be regularly evaluated, collecting feedback from teachers and students, to adjust and improve the process before extending it to other departments.

For successful change management, it is essential to recognize the contributions of all actors and to value their participation in this process. Ultimately, these joint efforts could transform higher education institutions in Antsiranana into dynamic and cutting-edge learning environments, where ICT are not only integrated but fully exploited to enrich the educational experience.

6.6. Continuous Evaluation and Improvement

To ensure that ICT integration achieves its objectives and to identify areas requiring improvements, institutions should establish regular evaluation mechanisms. This could involve using analytical tools to track student progress, surveys to gather user impressions and suggestions, and establishing clear performance indicators. For example, online surveys could be conducted at the end of each semester, allowing students and

staff to evaluate the effectiveness of the ICT tools made available to them. Performance indicators could include measures such as engagement rates in online courses, frequency of use of digital resources, and student satisfaction.

Creating forums and networks for sharing best practices is a powerful way to accelerate ICT adoption and continuously improve its use. By establishing communities of practice, higher education institutions can become spaces where knowledge flows freely and innovations are rapidly disseminated. For example, teachers who have successfully integrated ICT tools into their teaching could present their methods during regular webinars or educational conferences, inspiring their colleagues to explore new approaches. Online platforms could be set up to allow staff members to share resources, discuss specific challenges, and develop collaborative solutions.

In practice, the institution could launch an internet portal where case studies and tutorials on educational technologies are made available. Teachers could post videos showing how they use ICT to enhance learning and encourage student participation.

By adopting an iterative approach and focusing on continuous evaluation and improvement, higher education institutions in Antsiranana can not only maintain alignment of their practices with current standards but also become leaders in the field of technologically advanced education. This will create an environment where ICT are not just a teaching tool but a central pillar of the educational experience, preparing students to succeed in an increasingly digitized world.

References

- Abdul Razzak, N., 2013. Challenges facing school leadership in promoting ICT integration in instruction in the public schools of Bahrain. Education and Information Technologies. The Official Journal of the IFIP Technical Committee on Education.
- Adu, E. O., Olatundun, S. A., 2013. The Use and Management of ICT in Schools: Strategies for School Leaders. European Journal of Computer Science and Information Technology (EJCSIT), 1(2), pp. 10-16.
- Al Sharija, M., 2012. Leadership Practices of Kuwaiti Secondary School Principals for Embedding ICT. Ph.D. thesis, Queensland University of Technology, Brisbane, Australia.
- Albugami, S., Ahmed, V., 2015. Success factors for ICT implementation in Saudi secondary schools: From the perspective of ICT directors, head teachers, teachers, and students. International Journal of Education and Development using ICT, 11, pp. 36-54.
- Al-Harbi, H., 2014. Towards successful implementation of ICT in education. In The 2014 WEI International Academic Conference Proceedings, Vienna, Austria: The West East Institute, pp. 33-46.
- Almaghlouth, O., 2008. Saudi secondary school science teachers' perceptions of the use of ICT tools to support teaching and learning. Master of Science thesis, The University of Waikato.
- Alsharija, Mohammed, Qablan, Ahmad, 2012. Leadership Strategies for Integration of ICT in Kuwait Schools: Perceptions, Practices and Possibilities. Public Policy and Administration Research, 2, pp. 18-28.
- Andriamihavana, I. C. E., Tsiavia, N., Andriamaniry, N., 2023. Context of ICT Integration in Public Higher Education Institutions in Antsiranana (Madagascar). International Journal of Research Publication. IJRP 2023, 139(1), 94-102; doi:10.47119/IJRP10013911220235797.
- Arooj Ahmed Qureshi, 2013. Impact of Leadership on Meaningful Use of ICT. In Third World Conference on Learning, Teaching and Educational Leadership - WCLTA 2012.
- Avolio, B. J., 1999. Full leadership development: Building the vital forces in organizations. Thousand Oaks, CA: Sage Publications.
- B.Öznacar, S. Dericioğlu, 2017. The Role of School Administrators in the Use of Technology. EURASIA Journal of Mathematics Science and Technology Education, 13(1), pp. 253-268.
- Banoglu, K., 2011. School principals' technology leadership competency and technology coordinatorship. Educational Sciences: Theory & Practice, 11(1), pp. 208-213.
- Bass, B. M., 1990. From transactional to transformational leadership: Learning to share the vision. Organizational Dynamics, 18(3), pp. 19-31.
- Bhuasiri, W., Xaymoungkhoun, O., Zo, H., Rho, J. J., Ciganek, A. P., 2012. Critical success factors for e-learning in developing countries: A comparative analysis between ICT experts and faculty. Computers & Education, 58(2), pp. 843-855.
- Bingimlas, K. A., 2009. Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. Eurasia Journal of Mathematics, Science & Technology Education, 5(3), pp. 235-245.

- Bottino, R. M., 2004. The evolution of ICT-based learning environments: Which perspectives for the school of the future? *British Journal of Educational Technology*, 35, pp. 553–567.
- Cleary et al., 2008. L'intégration des TIC dans l'enseignement secondaire.
- Conlon, T., Simpson, M., 2003. Silicon Valley versus Silicon Glen: The impact of computers upon teaching and learning: a comparative study. *British Journal of Educational Technology*, 34, pp. 137–150.
- Cross, M., Adam, F., 2007. ICT Policies and Strategies in Higher Education in South Africa. *Higher Education Policy*, 20(1), pp. 73-95.
- Gibson, I. W., Albion, P. R., 1997. Information and communications technology literacy through hypermedia cases: A searchable database of theory and practice for individual or group use in pre-service teacher education.
- Habiballah, S., Bibu, N., Danaiaata, D., 2021. Educational leadership and ICT implementation in the Israeli Arab sector – Towards a model of hybrid leadership. *Review of International Comparative Management*, 22(1), pp. 74-86.
- Hakami, A. A., Hussin, A. R. B. C., Dahlan, H. M., 2013. Critical success factors necessary for curriculum integration of computer-based testing into Saudi secondary schools. *Journal of Information Systems Research and Innovation (JISRI)*, 4(3), pp. 22-30.
- Hayes, D., 2006. Making all the flashy stuff work: the role of the principal in ICT integration. *Cambridge Journal of Education*, 36(4), pp. 565-578.
- Ismail, M. Z., 2010. Teachers' Perception of Principal Leadership Styles and How They Impact Teacher Job Satisfaction. Ph.D. Thesis, Colorado State University.
- Karsenti, T., Tchameni Ngamo, S., 2009. Qu'est-ce que l'intégration pédagogique des TIC? In: Karsenti, T. (Ed.), *Intégration pédagogique des TIC: Stratégies d'action et pistes de réflexion*. CRDI, Ottawa, ON, pp. 57-75.
- Kearsley, G., 1998. Educational technology: A critique. *Educational Technology*, 38(2), pp. 47-51.
- Kolmos, A., Rump, C., Ingemarsson, I., Laloux, A., Vinther, O., 2001. Organization of staff development - strategies and experiences. *European Journal of Engineering Education*, 26(4), pp. 329-342.
- Kydd, L., Crawford, M., Riches, C. (Eds.), 1997. *Professional development for educational management*. Open University Press, Buckingham, Bristol.
- LaBonte, R., 2005. Leadership and educational technologies: Leading the charge for e-learning in British Columbia schools. Doctoral dissertation, University of British Columbia.
- Leithwood, K., Jantzi, D., 2006. Transformational school leadership for large-scale reform: Effects on students, teachers, and their classroom practices. *School Effectiveness and School Improvement*, 17(2), pp. 201-227.
- Flanagan, L., Jacobsen, M., 2003. Technology leadership for the twenty-first century principal. *Journal of Educational Administration*, 41(2), pp. 124-142.
- Melpomeni, T., Konstantinos, V., 2004. The prospect of integrating ICT into the education of young children: The views of Greek early childhood teachers. *European Journal of Teacher Education*, 27(1), pp. 29–45.
- Mhlana, E., 2005. University support for lifelong learning: A case for E-learning at the University of the Witwatersrand.
- Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (MESupReS), 2013a. *Decret MESupReS en vue de la mise en place du système LMD*.
- Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (MESupReS), 2013b. *Perspective 2013. Refondation: Garant du développement et de la réussite de l'Enseignement Supérieur et de la Recherche Scientifique*.
- Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (MESupReS), 2013c. *La stratégie nationale de la recherche scientifique à Madagascar*.
- Mohammad, H., Mansour, N., Wegerif, R., 2011. Kuwait's Future Schools Teachers' Perspective on ICT integration in classroom practice.
- Otto, T., Albion, P., 2002. Understanding the role of school leaders in realizing the potential of ICTs in education. *Technology and Teacher Education Annual*, 1, pp. 506-510.
- Paterson, A., 2007. Costs of information and communication technology in developing country school systems: The experience of Botswana, Namibia, and Seychelles. *International Journal of Education and Development using ICT*, 3(4).
- Patton, M. Q., 1990. *Qualitative Evaluation and Research Methods*. Sage Publications.
- Pelgrum, W.J., 2001. Obstacles to the Integration of ICT in Education: Results from a Worldwide Educational Assessment. *Computers & Education*, 37, pp. 163-178.
- Pesavento, L. C., Bator, M. G., Ross, J.-E., 2001. Staff development practices: Is your organization "learning" in the 21st century? *Parks & Recreation*, 36(6), pp. 24-30.
- Sarvi, Jouko, Pillay, Hitendra, 2015. *Innovations in knowledge and learning for competitive higher education in Asia and the Pacific*. Asian Development Bank, Philippines.
- Schiller, J., 2002. Interventions by school leaders in effective implementation of information and communications technology: Perceptions of Australian principals. *Technology, Pedagogy and Education*, 11(3), pp. 289-301.
- Isaacs, S., 2007. *Survey of ICT and Education in Africa: Mauritius Country Report*. World Bank Publications - Reports 10705, The World Bank Group.
- Harrell, S., Bynum, Y., 2018. *Factors Affecting Technology Integration in the Classroom*.
- Supriadi, D., Sa'ud, U. S., 2017. The effectiveness of implementing information and communication technology on student academic services (a case study in Bandung Institute of Technology for the 2015-2016 period). *International Journal of Education*, 9(2), pp. 139-149.
- Tearle, P., 2003. ICT implementation: What makes the difference? *British Journal of Educational Technology*, 34(5), pp. 567-583.

- Bush, T., 2007. Educational leadership and management: theory, policy, and practice. *South African Journal of Education*, 27(3), pp. 391–406.
- Totolo, A., 2011. Adoption and use of computer technology among school principals in Botswana secondary schools. *The International Information & Library Review*, 43, pp. 70–78.
- Twigg, C.A., 2003. Improving Learning and Reducing Costs: New Models for Online Learning. *EDUCAUSE Review Article*.
- Twining, P., 2007. Discussing ICT, aspirations and targets for education: International perspectives. *International Journal of Knowledge and Learning*, 3(2-3), pp. 154-170.
- UNESCO, 2013. *Transforming Education: The Power of ICT Policies*. Paris, France.
- UNESCO, 2022. *Guidelines for ICT in education policies and masterplans*. Paris, France.
- UNESCO, 2002. *Guidelines for ICT in education policies and master plans*. United Nations Educational, Scientific and Cultural Organization.
- USAID, 2011. *Politique Nationale de l'éducation en matière de TIC*.
- Wedel, R., Kalischuk, R. G., Patterson, E., Brown, S., 2007. Turning vision into reality: Successful integration of primary healthcare in Taber, Canada. *Healthcare Policy*, 3(1), pp. 80-95.
- Yee, D. L., 1999. *Leading, learning, and thinking with information and communication technology (ICT): Images of principals' ICT leadership*. (Ph.D. thesis). University of Calgary, Canada. Retrieved from ProQuest Dissertations & Theses (PQDT).
- Yu, C., Durrington, V.A., 2006. Technology standards for school administrators: An analysis of practicing and aspiring administrators perceived ability to performance standards. *NASSP Bulletin*, 90, pp. 301-317.
- Yuen, Law, Wong, 2003. ICT implementation and school leadership: Case studies of ICT integration in teaching and learning. *Journal of Educational Administration*, 41(2), pp. 158-170.