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Analyzing the Institutionalization of Free and Open Source Software Adoption in Tanzanian Higher Education Institutions

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Abstract

Free and open-source software (FOSS) are viable alternatives to pricey proprietary software due to their low total cost of ownership (TCO). They are predicted to have a bright future because of their advanced technologies in service delivery. Despite the availability of FOSS adoption studies, public discourse as well as information and communication technology (ICT) policies, FOSS applications are inadequately adopted in Tanzanian Higher Education Institutions (HEIs) due to lack of institutionalization. This finding poses a need for examining the institutionalization status. Institutionalization occurs when FOSS adoption and use becomes a standard practice. This study analyses the institutionalization of FOSS adoption by examining the national and selected universities' ICT policies and observing the evolution of public discourse towards FOSS by examining multiple articles. The study adopted a systematic literature review and was guided by an analytical framework that triangulated new institutional theory, the underlying concept of organizing vision, and rhetorical diffusion theory. The findings show that, although there are sporadic use of FOSS in some Tanzanian HEIs, FOSS adoption is generally not institutionalized. As a result, the study recommends adjustments in preparation of ICT policies, making adoption of FOSS part of organizational strategic plans for them to enjoy decision-makers' support.

1. Introduction

Several scholars support the argument that Free and open-source software (FOSS) applications have a low Total Cost of Ownership (TCO) when compared with their counterparts' proprietary software [1-5]. As a result, their popularity has grown in multiple developing-country industries, including education, because they may bridge the digital divide gap caused by a lack of funds [5]. In

addition, FOSS provides sophisticated learning and teaching technologies that were previously unattainable. Some governments in developing countries have gone beyond, instructing their organs to use FOSS applications as productive software [1]. For example, Tanzania has promoted FOSS applications since 2003 by creating advisory national Information and Communication Technologies (ICT) policies that tolerate their implementations.

FOSS applications certify four mandatory user privileges to allow them to be used for any purpose, modified to fit needs, redistributed without authors' consent, and improved depending upon users' demands [6-9]. For these reasons, FOSS applications may be an ideal solution for Tanzanian Higher Education Institutions (HEIs) [10-12]. Thousands of FOSS applications that have the potential to improve the quality of existing educational resources or aid in the development of new courses, such as open educational resources (OER), are freely available in the public domain [13]. However, based on the recommendations made by the OER Action Plan, the smooth adoption of FOSS applications, particularly OER, requires robust implementation of policies and guidance that may address the pre-adoption issues.

To streamline the integration of ICT in HEIs, including OER, the Tanzania Commission for Universities (TCU) has provided guidelines for the delivery and assessment of courses through dual or blended and virtual delivery modes [14]. However, according to Hoosen [15], when reporting the findings from The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Commonwealth of Learning (COL) in the Survey on Governments' Open Educational Resources (OER) Policies, Tanzania and many other African countries have shown less interest in OER policies. Without national policy guidance or framework, these countries have been utilizing OER and other FOSS applications, such as compilers, animation tools, and simulators. This observation does not disregard the reality in several other organizations, such as the Open University of Tanzania (OUT), which has diverse OER policies, approaches, and frameworks.

In the literature, several researchers have predicted the bright future for FOSS and its development methodology [16-18]. They consider FOSS a driving factor behind the democratization of technology and innovation advancement. For example, according to recent estimates, FOSS source codes, including those in HEIs, account for 80%-90% of all cutting-edge software [19]. Contemporary patterns show several HEIs, without their knowledge, use FOSS because some of their software, such as students' records and contents management systems, were built using FOSS source codes. Nevertheless, Spinellis [20] argues that, with today's technological advancements, if most of the code in someone's software is not FOSS, they are spending time and money spinning the wheel.

FOSS applications differ from commercial software's development, commercialization, acceptance, and use [21]. Although FOSS applications may be much better than closed software in terms of security [22], other scholars, such as Hedgebeth [23] and Dasher [24], claim that they still lack security and stability and are unreliable. Their components are unstable, mutable, and changeable. The code, community coordination mechanisms, license, and documentation are shaky [25]. As a result, they generate a profound alteration, to which some natural resistance arises [16]. Current research indicates significant impediments to mainstreaming their implementation [16, 26]. Despite these arguments, FOSS adoption is still a viable alternative in Tanzania HLIs. However, initiatives to adopt them lack clear guidelines [27]

and are still based on team members' ability and the decision-makers' desire to support their implementation strategies [28-31]. Following the benefits of FOSS applications, there is a need to research their adoption and diffusion and study how these processes can be institutionalized [32, 33].

Shaikh [25] acknowledges that, despite substantial goodwill towards FOSS, the implementation trajectories differ widely among nations and organizations. Nevertheless, there are worries about FOSS lifespan, testing, validation, and enterprise viability. However, multiple attributes have changed in the FOSS community. For example, in addition to FOSS transforming from its free software origins to a more mainstream, commercially viable form [34], The FOSS development process has become less bazaar when compared to conventional methods. Its user base has also increased to include Microsoft, Oracle, and IBM, with some taking on restricted leadership roles [16].

Despite a significant rise in FOSS research [35], there is an increasing demand for conceptual studies on the uptake and institutionalization of practices for adopting FOSS applications [16, 25, 32]. According to DiMaggio and Powell [36] and Greenwood et al. [37], a practice or innovation is usually institutionalized when it becomes a norm. This statement is in line with the description of institutionalization by Marsan et al. [16]. In the context of FOSS adoption, institutionalization refers to the extent to which adopting FOSS applications becomes a common practice inside HEIs. Their use is so prevalent that it has become the accepted method. However, relatively few studies have been published on FOSS in organizational settings, including institutionalizing [21]. Theoretically, institutionalization may help address detractors of FOSS movements and challenges and resistances caused by its transformation [16]. It may facilitate the acceptance and utilization of FOSS projects. Usually, integrating FOSS with developing countries' proprietary-dominated public sectors, such as HEIs, should start with fostering the normative institutional element [38].

Adoption is one of the four core processes of innovating FOSS [39]. Others include comprehension, implementation, and assimilation. Ideally, adopting an allegedly institutionalized innovation is not the behavior of a rational actor seeking to maximize their effectiveness and efficiency but rather the behavior of an institutional actor who accepts and follows social norms without questioning or even thinking about them to ensure the legitimacy of their actions [40]. According to this viewpoint, actors may be exposed to institutional effects from their education, professional associations, and even the public debate surrounding the innovation.

This study has adopted the institutional theory [40, 41], the rhetorical theory of diffusion of innovations [42], and the underlying concept of organizing vision [39, 43] to respond to the research question: To what extent has the adoption practices of FOSS applications been institutionalized in Tanzanian HEIs? Unlike prior institutionalization studies, which viewed the adoption of FOSS as projects [21, 35], other "adoption behaviors" were also taken into account in this study by examining institutional and national ICT policies, such as the degree to which organizational members actively participate in FOSS development communities or apply FOSS development processes and how organizational policies support the FOSS adoption.

In addition, this study provides a more in-depth examination of the institutionalization of FOSS applications in specific sectors and geographical areas to advance knowledge. Finally, the study responds to one of the endorsements made by previous studies, such as that of Marsan et al. [16],

by building a broader picture of FOSS institutionalization.

The second section delves into the analytical framework, the third section is allocated to the adopted methodology, the fourth section presents the results, and the fifth section discusses the results. Finally, the sixth section is for the conclusion and the way forward.

2. Analytical Framework

In formulating the strategy for realizing the institutionalization of adopting FOSS applications in Tanzanian HEIs, this article is based on three theories: new institutional theory, organizing vision theory, and rhetorical diffusion theory**.**

2.1 The New Institutional Theory

Although many theories, such as the population ecology of organizations by Hannan and Freeman [44], resource dependency by Salancik and Pfeffer [45], and contingency theory by Lawrence and Lorsch [46], can explain organizational evolution, including HEIs, the new institutional theory by DiMaggio and Powell [36] and Sandhu [47] is more relevant for this article. It considers institutional contexts and holds that competitive pressures and institutional demands force multiple companies to adopt convergent forms. According to Cai et al. [48], "institutional environment" refers to the rules, conventions, understandings, attitudes, and assumptions about what constitutes proper or acceptable organizational forms and behavior. Following institutionalization, an organizational environment tends to take precedence, increasing convergence and conformity [36].

Tolbert and Zucker [40] contended that institutionalization might be a property when determining whether an innovation is institutionalized or a process by which a practice becomes institutionalized. This study considers institutionalization as property. An innovation, for example, adopting FOSS in HEIs, becomes institutionalized when accepted as legitimate in a specific context and the accepted way of thinking and doing [16]. Generally, institutionalization processes or steps are characterized by events [49] such as partial acceptance, rapid diffusion, saturation, and total legitimacy [50]. It also relies on two essential factors: profitability and compatibility [51].

2.2 Organizing Vision in FOSS Adoption

Multiple parties play different roles in organizational institutionalization best practices. However, public involvement is highly critical. For example, to understand the FOSS adoption institutionalization, it is critical to examine the public discourse, also called organizing vision (OV). According to Swanson [39], everything publicly said about innovation and its organizational uses is called OV. However, many researchers and practitioners view OV as highly contentious, especially in the FOSS community [16]. Thus, this study contributes knowledge by examining OV in institutionalizing the adoption of FOSS applications in Tanzanian HEIs. Slåtten et al. [52], attest that the OV has multiple facets in literature. It can be considered a perfect and distinctive vision of the future [53], a mental picture of the organization in a potential and ideal future state [54], describes the long-term potential of business technology or corporate culture and suggests a workable strategy for getting there [55], a roadmap for the organization's future rather than a current description [56], a morally satisfying ideological aim that organization members can support [57], and the main principle that directs all organizational activities [58]. According to Marsan et al. [16], OV generally aids in legitimization by employing justification and encourages the mobilization of forces to support manifestation.

Ideally, the institutionalization of innovation, such as the adoption of FOSS applications, is related to the ongoing development of OV [43],

whose 'career' may be plotted by considering the number of articles published every year on the innovation, in our case the adoption of FOSS applications in HEIs. Thus, an OV's career progresses when more articles are published regarding adopting FOSS [43]. It is a sign of the community's growing interest in FOSS adoption and, as a result, an increase in dissemination. Nevertheless, although more research is required to determine OV's contents [59], several factors may affect the shape of the career curve. For example, the intended problem to be addressed, marketing, the degree of conflict or cooperation exercised in a particular community, and the *adoption* and *diffusion* of technology.

Generally, researchers looking to understand the adoption and dissemination of innovation in businesses should pay close attention to the rich concept of OV. As a result, this study asserts that OV will be strongly related to institutionalizing FOSS adoption in Tanzanian HEIs.

2.3 Rhetorical Theory of Diffusion

When the diffusion of a practice dependent on the discursive explanations employed to legitimize is accepted and taken for granted, the activity reaches a condition of institutionalization [42]. The rhetorical diffusion theory explains how the taken-for-granted concept is linked to organizational managerial practices. According to Schutz [60], taken-for-grantedness means "to accept our knowledge of certain states of affairs as unquestionably plausible until further notice."

The rhetorical theory of diffusion addresses some of the challenges imposed by the OV. For example, Swanson and Ramiller [43] and Green [42] contended that it is impossible to determine whether an innovation has been institutionalized simply by noticing a decreased discourse surrounding it. Green [42] proposed the best way of examining institutionalization, which demanded fulfilling two conditions: availability of less public dialogue about innovation and increased or constant adoption. However, what Green [42] proposed still ignores the taken-for-granted attribute.

However, concurrently using the rhetorical diffusion theory with the OV theory may provide a more comprehensive understanding of the institutionalization of FOSS uptake in Tanzanian HEIs. As a result, this study tracked the career of the OV for FOSS while also tracking the status of adoption or dissemination in HEIs. In other words, the study triangulated the OV concept and rhetorical diffusion theory under the leadership of the new institutional theory to investigate the institutionalization of FOSS adoption in HEIs.

3. Methodology

This study is exploratory because it aims to better understand the process of FOSS adoption or deduce what field data may have to say about FOSS institutionalization in Tanzanian HEIs. It begins by reviewing the national ICT policy and the ICT policies from the University of Dar es Salam (UDSM), the University of Dodoma (UDOM), Kilimanjaro Christian Medical College (KCMCo), Kampala International University of Tanzania (KIUT), the College of Business Education (CBE), Mzumbe University, Muhimbili University of Health and Allied Sciences (MUHAS), the Open University of Tanzania (OUT) and the Sokoine University of Agriculture (SUA).

The article has also reviewed the national and institutional ICT policies to understand better additional FOSS adoption behaviors, such as support provided by examined institutions, and to distance the study from previous research. Although Tanzania has thirty-two full-fledged universities, seventeen university colleges, and five campuses, centers, and institutes, according to the Tanzania Commission for Universities [61], the study has purposely selected eight universities due

to their size, ownership, reputation, specialization, and the readily online accessibility of their ICT policies.

In reviewing documents, the study was guided by concepts of "learning-about" by Wang and Ramiller [62], "management fashion theory" by Abrahamson [63], and organizing vision theory by Swanson and Ramiller [43]**,** which are crucial in encouraging innovation acceptance and diffusion processes. Based on the provided guidance and recommendations, the study examined documents intended for practitioners and met the three inclusion criteria of audience, style, and contents proposed by Marsan et al. [16].

In the second phase, the study examined how adopting FOSS applications in Tanzanian HEIs adheres to the recommendations made by Green's [42] rhetorical theory of diffusion. To do this, the researchers conducted a Systematic Literature Review (SLR) using guidelines proposed by Kitchenham and Charters [64]. The SLR automatically searched articles on adopting FOSS in HEIs to establish the OV career. The identified articles from SLR developed a foundation for the public discourse on adopting FOSS in HEIs. These articles were searched from five repositories, including Google Scholar, IEEE Xplore, Science Direct, ACM Digital Library, and Springer Link, using customized search strings created by keywords and synonyms listed in Table 1.

Table 1. Keywords and synonyms.

Keyword	Synonyms
Free and open-source software	FOSS, OSS, FLOSS, Open source software
Adoption	Uptake, acceptance, diffusion.
Higher Education Institutions	HEIs, University, College
Tanzania	URT

For the inclusion/exclusion criteria, all peer-reviewed journals in English published by reputable publishers between 2003 and September 2023 were included in the study. The year 2003 was chosen as the starting point since the United Republic of Tanzania began encouraging the use of FOSS in various areas. The search strategy for the articles to be included adopted steps proposed by Namayala et al. [3], and the quality of included articles was determined by the recommendations posed by Page et al. [65], Critical Appraisal Skills Programme [66], and Shea et al. [67]. See Table 2 for the contextualized search strings.

Table 2. Customized search strings per repository.

Repository	Search String
Google Scholar (GS)	("Free and Open Source software" OR FOSS OR OSS OR FLOSS OR "Open source software") AND (Adoption OR Uptake OR acceptance OR diffusion) AND ("Higher Learning Institutions" OR HEIs OR University OR College) AND "Tanzania"
IEEE Xplore (IEEE)	("Free and Open Source software" OR FOSS OR OSS OR FLOSS OR "Open source software") AND (Adoption OR Uptake OR acceptance OR diffusion) AND ("Higher Learning Institutions" OR HEIs OR University OR College) AND ("Tanzania" OR URT)
Science Direct (SD)	("Free and Open Source Software" OR "Open Source Software" OR OSS OR FOSS) AND "adoption" and ("Higher Education institutions" OR "Higher Learning Institutions") AND "Tanzania"
ACM Digital Library (ACM)	[**All**: (allfield:(] **OR** [[[**All**: "free and open source software"] **OR** [**All**: "open source software"] **OR** [**All**: oss] **OR** [**All**: foss]] **AND** [**All**: "adoption"] **AND** [[**All**: "higher learning institution"] **OR** [[**All**: "higher education institutions)"]

	AND [**All**: "Tanzania"]]]] **AND** [**E-Publication Date**: (01/01/2003 **TO** 12/31/2024)]
Springer Link (SL)	"Free and Open Source Software" AND "Tanzania" AND "adoption"

We performed an initial search in July 2023 and repeated similar searches in August 2023 using the same search strings to validate the initial search. All articles found were listed and filtered in two steps: in the first step, articles were chosen based on the authors' consensus after reading the articles' titles, keywords, and abstracts; in the second and final phase, the articles included were chosen based on author consensus after reading the articles chosen in the first step. After removing duplicates, twenty-nine articles were identified as containing enough information regarding adopting the FOSS applications in Tanzania HEIs (see Figure 1 for the selection process).

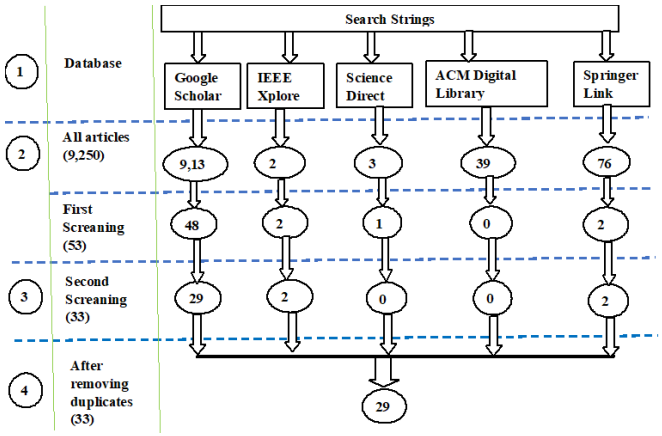

Figure 1. Articles' selection process.

We plotted the OV's career curve by determining the number of articles published about FOSS adoption annually from 2003 to 2023. We discovered that the career of FOSS's OV has fluctuated since it peaked for the first time in 2012. This result makes 2012 a critical year in our study because it represents the career's peak in community interest in the FOSS adoption in HEIs. We also discovered the causes for the community's high interest in 2012 by examining the OV's content and whether these reasons were positive or negative. This discovery enabled us to deduce the reasons for the OV's subsequent fluctuating points in the FOSS adoption career in Tanzanian HEIs.

From the standpoint of the rhetorical theory of diffusion, we needed to monitor the extent of FOSS acceptance in Tanzanian HEIs in 2023. As a result, we reviewed papers published in 2023 about adopting FOSS in Tanzanian HEIs. All identified papers were rigorously studied. Finally, with the guidance of the new institutional theory, we used data from these publications and the career of the OV linked with FOSS to evaluate the extent to which FOSS had been institutionalized in Tanzanian HEIs.

4. Results

4.1 The National ICT Policies

The first version of the Tanzanian national ICT policy was released in March 2003. The policy recognized that Tanzania had a digital divide due to low levels of human capital development and local content creation. Existing methods encouraged the haphazard adoption of many systems and standards, resulting in wasteful duplication of effort and waste of scarce resources, primarily due to the loss of possible synergies. The 2003 ICT policy further emphasized that changing ICT strategies to empower different sectors and address the national developmental agenda is mandatory. However, despite FOSS being widely used in developing countries [4, 68], its use in Tanzanian public and private sectors, including the HEIs, has been unsustainable [69]. As a result, Tanzania's private and public sectors have continued to depend on proprietary software. The March 2003 ICT policy was updated in May 2016 to create a revised version due to a change in the ICT landscape and the need to escalate ICT benefits to the nation and its citizens. A second revised national ICT policy

draft was released in August 2023. However, due to the ongoing improvement of the released draft, the discussion of the national ICT policy has been centered on the May 2016 version.

Although this version of ICT policy recognizes several initiatives to promote the adoption of FOSS applications in Tanzania, such as the development of the Jambo Office by the University of Dar es Salaam in collaboration with the Royal Swedish IT Consultancy Company, FOSS project adoption remains low. Many FOSS applications lack the requisite frameworks to become operational, necessitating the implementation of critical activities to promote domestic value-added and local content development in the ICT industry.

4.2 Tanzania Higher Learning Institutions' ICT Policies

The UDSM developed its earliest version of ICT policy by triangulating information from the National ICT policy, the National Development Vision 2025, the Poverty Reduction Strategy Paper (PRSP), the Millennium Development Goals, and the Science and Technology Sub-Master Plan. The UDSM ICT policy promotes more focused and effective management, control, and maintenance (MCM) and the development of strategic applications of ICT resources. This policy focused on ten key ICT areas: (1) Access; (2) Teaching, Learning, Research, and Public Services; (3) ICT Organization and Management; (4) ICT Asset Management, Accountability, and Disposal; and (5) Human Resource Development. (6) Collaboration with government, private sector, and public institutions; (7) Purchase of ICT Products and Services; (8) Administrative Information System Development and Support; (9) ICT Sustainability; and (10) ICT Security. The UDSM ICT policy was revised to the current edition in 2022 and has been operational under the directorate of ICT. However, the UDSM ICT policy is advisory, only tolerating the adoption of FOSS applications rather than emphasizing their adoption. Nevertheless, the policy was inaccessible from the university's website as of August 2023, when this paper was written. Unlike the ICT policies from other examined universities, the reviewed copy of UDSM ICT policy was sourced from a different channel.

Similarly, UDOM released its first edition of the ICT policy in 2011, which has been revised in 2018. The policy sought to provide major ICT issues and a framework for the governance of all ICT-related topics and assist the effective and efficient achievement of UDOM aims and objectives linked to teaching, research, and administrative responsibilities. The UDOM policy was developed to emphasize the importance of ICT as a critical infrastructure for teaching and learning to comply with The National Development Vision 2025 requirements and the seventh objective of its Five-Year Strategic Plan. In addition to being advisory in many ICT-related issues, the UDOM ICT policy does not realize the importance of FOSS applications. FOSS has just been mentioned once in the entire document. Although over 30 percent of applications used at UDOM are FOSS, the university does not have guidelines or a framework for adopting them.

Meanwhile, KCMCo established the first version of the ICT policy in 2016 and revised it in 2022. The formation of this policy was prompted by the enormous potential of ICT for increasing outreach and boosting educational quality. The KCMCo ICT policy, like those from many other HEIs, strives to guide the identification, promotion, and appropriate exploitation of ICT resources and ensure that ICT applications are integrated into the college's planning and operations. However, the KCMCo ICT policy does not acknowledge the presence of FOSS applications, and it has not discussed their benefits and how they can be adopted or adapted.

Likewise, KIUT formulated its first version of ICT policy in 2019, revised in 2021, considering the 2016 national ICT policy and other university-level policies. It is meant to guide the identification, promotion, and appropriate use of ICT to achieve numerous ICT-related improvements, such as infrastructure, operational and management systems, function content, programs, and human resource management. KIUT has created this policy to comply with the Ministry of Education requirements of transforming Tanzania from a knowledge-driven to a digital-driven society, the 2014 Education Training policy, the Tanzania Development Vision 2025, the National Strategy for Growth and Reduction of Poverty (NSGRP), Sustainable Development Goals (SDGs), and Education Development plans. To some extent, the KIUT ICT policy promotes the adoption of FOSS applications. However, it lacks a master plan for adopting the applications.

Nevertheless, CBE has gone the extra mile and established the ICT policy and ICT guidelines in 2018. The ICT guidelines guide the handling and utilization of ICT facilities. It is the derivative of the CBE ICT policy and the national ICT policy. In contrast, the ICT policy is the derivative of ICT best practices and the national ICT policy 2016 edition. The CBE ICT policy sought to increase access to ICT in teaching, learning, research, and consultation. It is the product of input from various stakeholders, and it was approved by both Campus Workers' Councils and the College Master Workers' Council before ratification by the college governing body. Although the CBE ICT policy has acknowledged FOSS as an institutional opportunity and provides a guideline that FOSS shall be preferred, promoted, and used in the college, it still lacks a detailed framework for adapting, adopting, and installing FOSS applications.

Likewise, Mzumbe University developed its ICT policy as a framework for leadership and coordinating ICT management and utilization. It considers the institution's strategic goals to ensure the smooth functioning and running of ICT and ICT services-enabled functions. The ICT policy at Mzumbe University was drawn from the national ICT policy and includes the university's overall vision, goal, and objectives, as well as policy problems concerning ICT infrastructure, information systems, user skill development, and sustainability. However, the policy is silent about FOSS applications and the strategies to adopt or adapt them.

Moreover, MUHAS developed its first ICT policy in 2004 and revised it in 2017 to provide the highest-level ICT directive to address the challenges of deploying ICT infrastructure, systems, and services to achieve its core functions. MUHAS believes using ICT provides opportunities to cope with the challenges of training increased numbers of health professionals. The revised MUHAS ICT policy acknowledges and promotes the adoption or adaptations of FOSS applications by indicating that they ensure cost-effectiveness and sustainability of the Information Management System (IMS) and guarantee their survival in poor funding. However, the policy does not indicate the adoption, adaptation framework, or guidelines. The context for this policy is derived from the national ICT policy and other existing policies and strategies at MUHAS, such as the MUHAS Five Years Rolling Strategic Plan 2015/16 to 2019/20, the MUHAS Ten Years Corporate Strategic Plan 2014/2015 to 2023/24, the Intellectual Property Policy and Procedures (2011), the Library Policy and Procedures (2013), the Research Policy and Procedures (2011), and the Institutional Repository Policy (2012).

In addition, the first version of the ICT policy for OUT was formed in 2004. Various policy amendments were implemented due to growing ICT use and numerous technical advancements,

and the current ICT policy, which comprises seventeen key areas, was developed in 2014. This policy supports the adoption and use of ICT at the university. It also suggests best practices to assist the university in determining its medium- to long-term strategic ICT objectives and solutions for achieving them. The OUT policy promotes and acknowledges the adaption and adoption of several FOSS applications. However, it lacks guidelines and a master plan for adopting FOSS projects. It has laid the foundation for developing this framework in the future.

Finally, by involving several stakeholders, SUA established its first ICT policy and guidelines in 2002 to ensure that ICT applications are integrated into the planning and implementation of university functions to guide the identification, promotion, and responsible use of ICT. In March 2014, the policy changed to account for many technological, institutional, and structural developments affecting ICT development internationally, nationally, and inside the university. The updated policy is consistent with the national ICT policy and Corporate Strategic Plan (2011-2020), which pushes for using ICT to improve efficiency, cost-effectiveness, and competitiveness. Although the SUA ICT policy acknowledges strategizing on adopting and using FOSS applications, guidelines on how to turn strategy into reality are missing.

4.3 Changes and the Current Situation of the OV's Career in HEIs for FOSS

The career for the FOSS adoption in Tanzania HEIs has fluctuated since we started the career analysis in 2003. It reached its highest peak in 2012 and started fluctuating again to a lower point in 2022 (Figure 2).

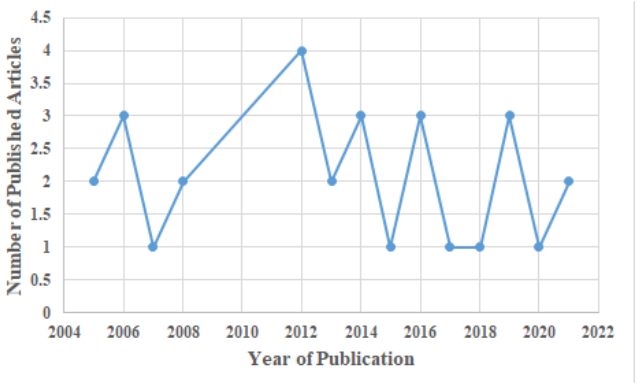

Figure 2. Career of the HEIs FOSS adoption's OV.

As discovered by several other scholars, such as Marsan et al.[16], Swanson and Ramiller [43], and Wang [59], this study has confirmed several factors amounting to the peaking and downfall of OV's career in Tanzanian HEIs. These factors include technological breakthroughs, professional events, clashes, adoption dropouts, collaboration, institutional issues, FOSS commercial potential, competition from proprietary software, and demystification attempts. Marsan et al . [16] reported that adoption, abandonment, and diffusion are commonly discussed factors affecting the OV's career in FOSS in the professional press. Thus, this study has triangulated them to explain the 2012 OV's career peaking. However, although adoption is one of the primary indications, it is insufficient to explain the institutionalization of innovation in companies due to institutionalization not being linear [70].

The study could not find evidence supporting the peaking of OV's career in FOSS adoption in Tanzanian education in 2012. Nevertheless, it is also still uncertain why the fluctuations of the OV's career are due to other years of analysis. Although the literature lacks the motives, authors have speculated that there has been successful adoption/diffusion rather than abandonment in the peaking, unlike in the low OV careers. However, other factors, such as technological breakthroughs, professional events, clashes, collaboration,

institutional issues, FOSS commercial potential, competition from proprietary software, and demystification attempts, are critical to OV's career's peaking and fluctuations.

4.4 Adoption Status of FOSS in Higher Education Institutions

The findings show that the diffusion of FOSS applications in HEIs has increased. This finding confirms the results of Marsan et al. [16]. Some commonly adopted FOSS applications in Tanzanian HEIs include Dspace for institutional repositories, Moodle for learning and contents management, and Koha for library management information systems. Systems development tools such as Git, Eclipse, NetBeans, and Vim are also prevalent. In web development, applications such as WAMP, which represents Windows, Apache, MySQL, and PHP, and LAMP, which represents Linux, Apache, MySQL, and PHP, are commonly adopted. Nonetheless, Python and Java have long been popular programming languages. However, several HEIs in Tanzania are still in the infant stage of adopting and adapting FOSS applications [13], [71].

Furthermore, FOSS application uptake is not uniform across HEIs. It depends on the enthusiasm of decision-makers, technical competency, and exposure of the implementing team. With the current practices, adopting FOSS applications in HEIs is not given the deserved value. Decision-makers still support financially proprietary applications readily available in the FOSS community. As a result, it imposes challenges and difficulties in implementing FOSS applications and causes the abandoning of adoption initiatives. Nevertheless, several other FOSS applications in HEI are occasionally uninstalled or replaced with proprietary due to technical challenges.

4.5 Institutionalizing FOSS Adoption in Higher Education Institutions

Based on the findings from the review of national and selected HEI's ICT policies and the completed documentary review, the public discourse on FOSS adoption in higher learning institutions has been positive. However, it is not uniform to predict the downfall in the OV career. Although positive discourses have encouraged the adoption of FOSS applications in HEIs, the process has been inconsistent, with different types of FOSS not spreading at the same status. For example, the diffusion of server-based programs like Linux and mail servers was far greater than that of desktop-based apps like Open Office.

Nevertheless, the strategic plans and ICT policies of multiple HEIs do not provide deserved privileges to the FOSS adoptions. As a result, despite FOSS applications offering low TCO, adopting FOSS applications in Tanzanian HEIs is not a norm but rather a preference of decision-makers. More needs to be accomplished before indicators for institutionalization can start manifesting. Thus, the institutionalization of FOSS adoption in Tanzanian HEIs is still at the infant stage. This observation confirms the findings of Marsan et al. [16], who also advocated a more granular examination of the institutionalization of FOSS applications in specific industries and locations.

5. Discussions of the Results

This study uses an OV analysis and adoption status indicators as a proxy to explore the degree of institutionalization of FOSS adoption in Tanzanian HEIs. The findings show that the process of adopting FOSS applications in Tanzanian HEIs has been increasing, and there has been a community discourse on the adoption/diffusion of FOSS. The OV career of the FOSS adoption peaked and fluctuated in some situations. Several HEIs have established ICT policies and guidelines that strive

for better adoption, adaptation, and implementation of FOSS projects. However, these policies are not timely reviewed and are just advisory, putting less emphasis and guidelines on adopting FOSS projects. The available knowledge and other research evidence do not warrant FOSS adoption to become institutionalized. For example, although the adoption is increasing, the public discourse on FOSS adoption has oscillated instead of declining. Thus, the institutionalization of FOSS adoption in HEIs is partially achieved.

Under the guidance of the new institutional theory, this study has triangulated the OV theory and the rhetorical theory of diffusion in the theoretical framework to provide a successful methodology for studying the FOSS adoption institutionalization in Tanzanian HEIs and complement the weaknesses of individual theories. For example, because of its emphasis on taken-for-granted, the rhetorical theory of diffusion complements the weaknesses of the OV theory. By applying both theories, researchers are better positioned to associate the descending phase in an OV's career with either the institutionalization or the abandonment of the FOSS adoption. FOSS applications address numerous dimensions of Tanzanian HEIs and support diverse software application demands in multiple organizations [10], [34]. However, studies that compare the extent of institutionalization of a particular FOSS application with its proprietary counterpart are missing. This conclusion confirms the discussion made by Marsan [16]. Future studies may address this dimension.

Currently, most FOSS research in HEIs has concentrated on factors influencing the uptake of FOSS applications, and only limited studies focus on institutionalizing the adoption of FOSS in organizational contexts. However, they only consider single-dimensional views of FOSS adoptions, contradicting recommendations made by Aksulu and Wade [35]. Because FOSS is evolving in its acquisition and use [21], multiple dimensions must be analyzed to draw a relevant picture of its institutionalization.

Findings from this study have broader implications and significance because they yield insightful and meaningful data for practice and research that may enhance the quality of delivered education in Tanzanian HEIs. They provide a systematic response to whether adopting FOSS is institutionalized and indicate that, despite public discourse, professional articles, and initiatives to create ICT policies, the institutionalization of FOSS adoption has not matured. Thus, additional measures are encouraged to improve the situation. Practitioners, researchers, and other stakeholders may benefit from the findings by knowing the ideal route and necessary resources to improve the situation, which is hard to establish with current knowledge. Ignoring studies for institutionalizing the adoption of FOSS applications in HEIs may jeopardize the quality of delivered education and other strategies. According to Hedgebeth [23], it may cause a total collapse of several institutes, particularly small and medium-sized ones. Marsan et al. [16] further argued that results from efforts to institutionalize FOSS, including adoption, may not be ignored because of the growing challenges posed by many established proprietary software.

Our findings are accompanied by several limitations that may jeopardize their generalizability. One such limitation is using a large amount of qualitative data, which may pose specific challenges, according to DeLuca et al. [72]. Nonetheless, the study has only examined different versions of Tanzania national ICT policy, policies of only eight selected HEIs, and professional papers in English extracted from five databases, which might not be adequate. According to Marsan [16], the OV for FOSS adoption extends far beyond sampled articles and may include additional

essential sources such as public discourse at professional conferences or on television programs and written discourse available in books on the Internet. As a result, future studies on the public debate on FOSS adoption must incorporate a broader range of sources. However, to reduce bias from sampled publications, the study used the best practices that Kitchenhaum [64] recommended to conduct the SLR.

6. Conclusion

Following the benefits of FOSS in HEIs and the persistent low pace of adoption, particularly on desktop-based FOSS applications, FOSS's adoption and institutionalization remain exciting topics for further research. However, studying institutionalization is a very contentious endeavor since it delves into organizational undertakings. In addition to new institutional theory, this study used an analytical framework triangulating the rhetorical theory of innovation diffusion and the OV concept to better understand the institutionalization of FOSS adoption in Tanzanian HEIs to overcome known challenges. Although findings show noteworthy initiatives to institutionalize back-end FOSS software and some front-end applications in Tanzanian HEIs, the progress does not match the actual demand and benefits of adoption of FOSS within institutions. Thus, there is a need for more research on new techniques for institutionalizing FOSS adoption in Tanzanian HEIs to accelerate the process. In this endeavor, future researchers should explore institutionalization while considering multidimensional views of FOSS adoptions.

The study analyzed other adoption behaviors by examining governmental and corporate ICT policies to distance itself from earlier studies. The findings show that, although visited HEIs have ICT policies in place, these policies are inadequately updated and have been developed without guidelines or a framework on how the FOSS adoption must be completed for desirable results. Nevertheless, most encountered policies are advisory and only tolerate FOSS applications instead of emphasizing adoption and implementations.

In this respect, this study recommends considerable adjustments in policy preparation to account for instructions on achieving the intended aim. Implementing these policies must also enjoy full support from decision-makers and organizational strategic plans. For example, the decision-makers and other executives may be advised to stop funding proprietary projects if counterpart FOSS applications are readily available. Nevertheless, FOSS must be given deserved weight in policy preparation, and guidelines on adopting FOSS should be available.

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