



Research Paper

# Adoption of Programming Frameworks in Computer Curricula: Higher Learning Institutions in Tanzania.

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**ABSTRACT:** The rapid technological changes have introduced new requirements on education systems all over the world in the past decade; however, the curriculum systems in our country do not match with technological changes and hence create the skills gap between what is taught on the colleges and universities with the market need. This study has addressed the case of adoption of programming languages with their respective frameworks in Tanzania. The study used empirical review techniques to investigate the adoption of emerging programming language's frameworks in Tanzania colleges and universities' curriculum. The study shows that the pace of acquiring these technologies is not promising. The adoption of language frameworks by Tanzania higher learning institutions do not match with current pace in technological changes. The study is suggesting immediate actions to be taken by the regulatory bodies and other stakeholders to bridge current skills gaps between Tanzania academic institutions' curriculum to match with the market need.

**KEYWORDS:** Education Curricula, Curriculum Developments, Programming Frameworks, Technological Changes, Programming Languages.

Received 10 Apr, 2022; Revised 25 Apr, 2022; Accepted 27 Apr, 2022 © The author(s) 2022.

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## I. Introduction

The word curriculum means a course of study or a plan that provides learning opportunities in the form of knowledge, skills, attitudes, and beliefs. Curriculum is a set of desired learning outcomes and the structured set of learning experiences aimed at achieving such outcomes (Kasuga, 2019). A curriculum is 'a well-planned and structured document showing what a learner (student) is expected to learn and achieve in terms of skills, knowledge and understanding and describes all aspects of teaching and learning such as learning strategies, assessment methods and the intended outcomes from learning' (NACTEVET, 2022).

The word framework means a real or conceptual structure intended to serve as the supports for the building of something that expands the structure into something useful. In computer systems, a framework is often a layered structure indicating what kind of programs can or should be built and how they would interrelate which may also include actual programs, specify programming interfaces, or offer programming tools for using the frameworks (Lutkevich, 2022). Frameworks can also be regarded as an object-oriented reuse technique which are very important part of object-oriented developers, and they are not well understood outside object-oriented developers and are often misused (Jonson, 1997). Nowadays all programming languages has its own frameworks. Programming frameworks however, is a guideline used by developers to minimize development time, improve security, and alleviate the overhead associated with common activities performed in web development (Supaartagorn, 2011).

## II. Related Study

In Tanzania the curriculum developments has been overseen by the National Council for Technical and Vocational Education and Training (NACTVET), and Tanzania Commission for Universities (TCU). The Effective regulation and coordination of education and training in the country mandated to these government bodies that ensures the curriculum addresses the needs of the society by controlling the contents and context which plays a central role towards production of skilled, competent and knowledgeable citizens to meet the demands of the country's social and economic development.

According to Kasuga (2019), the developments of curriculum in Tanzania education systems are heavily relied on national policies. Curriculum change or review refers to any alteration in the aspects of a curriculum such as philosophy, values, objectives, organizational structures, and materials, teaching strategies, student experiences, and assessment and learning outcomes (Meena, 2009). Education programmes and policies are inextricably interwoven with each other, so that one cannot productively discuss education programmes in a policy vacuum (Kelly, 2004). In this context any changes in curriculum must be approved by government bodies to ensure its quality and maintain the government interest (Athumani, 2019).

### **2.1. Historical Background of Programming Languages Curriculum**

The curriculum developments and reviews in programming languages related subjects/courses can be traced back before independence in 1950s. In this era the universities curriculum was adopted from national curriculum provided by ministry of education (Kasuga 2019). Several programming languages were emerged as a machine language to address the daily needs such as, Assembly Language, Autocode, FORTRAN, Algol, Cobol, and LISP (HP, 2018). Nowadays the most popular languages are Java, C, C++, Python, C#, R, PHP, JavaScript, Ruby, and Matlab (Cass, and Stephen 2015). However, according to North-Eastern University (2022) the most popular programming languages are: Python, JavaScript, Java, C#, C, C++, Go, R, Swift, and PHP. There are no doubts that there are contradictions on the languages from different sources, however some programming languages such as PHP, Python, Java, and C++ has appeared in common from all sources. These programming languages have come up with their frameworks for better programming environment for distributed systems.

### **2.2 Situation Analysis**

Currently Python is the most widely used programming language by developers (Samira 2022, and Jiangang 2019); however, Java seems to be the most popular taught in colleges and universities in Australia (Mason, Crick, Davenport, Murphy, 2018). The choice of languages by the developers is mainly determined by the employers' preferences (S. Christopher, 2018). Currently the ICT technologies has changed drastically compared to the pace of adoption of these technologies in Tanzania (Harry, 2022). The organisation responsible for computer science curriculum developments (IEEE, and ACM, 2020) suggest the use of latest technologies in curriculum developments in computer related programmes which include: Computer Engineering, Computer Science, Cybersecurity, Information Systems, Information Technology, Software Engineering, and Data science sectors.

The study has addressed several issues concerning the curriculum developments/reviews from several sources which shows the need to bring awareness on the pace of technological changes to match with taught curriculum in our colleges and universities.

## **III. Research Methodology**

### **3.1 Research Questions**

The study has addressed the following three questions:

- The programming languages mostly preferred by the software developers are the ones preferred by the colleges/university's lecturer in Tanzania?
- The programming languages frameworks mostly used by software developments companies are the ones taught by colleges/universities in Tanzania?
- The curriculum developments or reviews by the colleges/universities match with stakeholder's expectations?
- The questions have shaped the study areas and the research methodologies which has been used to get correct responses.

### **3.2 Study Area and Research Design**

This study was conducted in the Universities and Colleges found in Arusha region, a northern zone of Tanzania. To ensure validity, credibility, and reliability of the study, a systematic procedure was used which involves; formulation of research problems, designing research questions, and reviewing various concepts and theories of curriculum in programming languages and frameworks in both developed and developing countries. The evaluation process of the opportunity and challenges of adoption of languages frameworks in developing countries was performed by using a structured interview and questionnaire to collect data from stake holders which include potential employers, university lecturers, and current university students.

### **3.3 Sampling Techniques and Ethical Considerations**

In Arusha region there are about five universities and nine colleges that offer ICT related subjects namely: Nelson Mandela University, Mount Meru University, Tumaini University Makumira (Tuma), University of Arusha (Ua), ST. Augustine University of Tanzania-Arusha, Forestry Training Institute-

Olmotonyi, Horticultural Research and Training Institute-Tengeru, Kilimanjaro International Institute for Telecommunications Electronics and Computers, Arusha Teachers College, Tanzania Gemological Centre, Institute of Accountancy Arusha (IAA), Jr Institute of Information Technology, Livestock Training Agency Tengeru- Arusha Campus, and Arusha Technical College (NACTEVET, 2022). In this study the data has been collected from three randomly selected universities and seven colleges.

Apart from those universities and colleges there are more than 10 companies in Arusha region that offers more than 51 I.T. related services namely: RelvarTec Inc, Kiliweb Services, Genox Corporation, Arusha Software, Crater IT, Revec CS, ICT-Pros Consultancy Services, Tanzania Web Company Ltd, Soko Technologies, Calpar Global, Red Chapter, Tanzania- Arusha, Kiliative Solutions, Habari Node, Smartnet-Arusha, Computer Springs, AKIDI Technologies, Sharcoctech Solutions, Arusha Website Design, and Tanzania Web Consulting (BRELA, 2022). The data was collected from ten different development companies.

In this study the Colleges`/Universities` prospectus were analysed to decide which university offers I.T. subjects. Also, the study did not mention the universities names and I.T. company names and its profile used for data collection due to various security factors which include loss of privacy and other ethical considerations.

### **3.3.1 Questionnaires Distribution**

This study involves three categories of questionnaires distributed to three different stakeholders in Arusha region. Stakeholders include software developments companies, universities/colleges lecturers, and the students in those colleges/universities. The question for each category were designed to capture knowledge, adoption, importance, and challenges of programming languages frameworks (PLF) in their field.

In this study there are 30 respondents from Software companies found in Arusha which were successfully selected for analysing and evaluating the usage of frameworks in their daily activities.

Also, a total of 100 participated students were selected from I.T related programs/Departments or those who has taken programming related courses in their universities/college`s studies. The questionnaire with irrelevant responses were discarded as a result only 86 questionnaires were taken for data analysis. Higher learning institutions were represented by lecturers and other teaching staff. In this category a total of 50 personnel from 10 different institutions responded of which 48 questionnaires were successfully filtered and two of them were discarded due to inconsistent responses.

## **IV. Results**

The questionnaire was collected from companies and educational institutions and analyzed by using SPSS to provide the way forward on the adoption level of the PLF in Tanzania. The summary of collected questionnaire for students, Lecturers, and Developers is shown on table no 1 below.

SN	Questionnaire Type	Total Responded	Successfully Taken for Analysis
1	Software Developers	30	30
2	Teaching Staff	50	48
3	Students	100	86
	Total	180	164

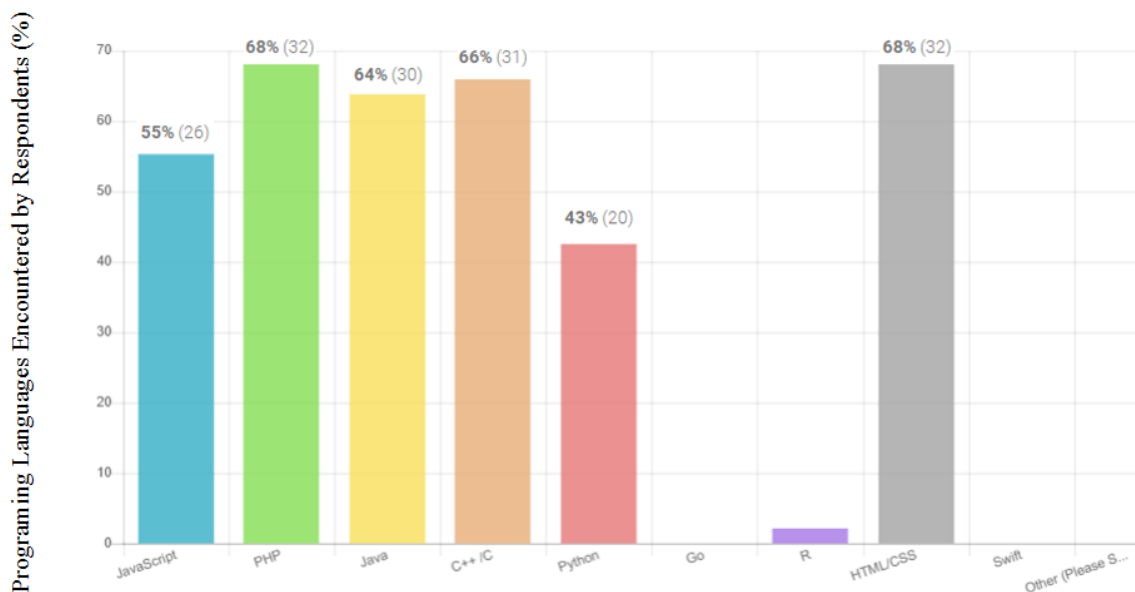
**Table no 1:** Respondents from all Questionnaires

This result includes those responded and those questionnaires which were taken for analysis so as to contribute towards the study.

### **4.1 Results from Lecturers and Other Teaching Staffs**

#### **4.1.1 Languages Commonly Used by Higher Learning Institutions` Teaching Staff**

The results shows that PHP, HTML/CSS, C++/C, and Java are the mostly known languages in colleges/universities found in Tanzania. While Python is not very common among lectures. Other languages such as R, Go, and Swift are not known in Tanzania higher learning institutions.

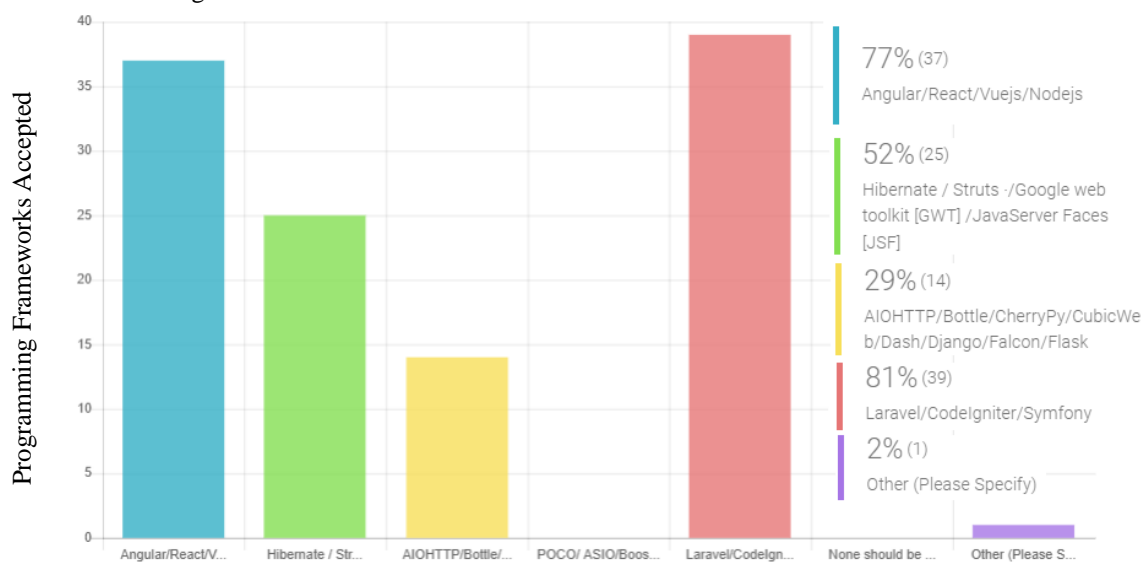


**Figure1:** Staff Preferences (%) Vs Programming Curriculum in Tanzania

This part shows that the languages such as R, Go, Swift, and other languages are not used by the staff for teaching. This suggests that the higher learning institutions in this region do not have enough content regarding those languages. Python also is emerging as a dominant language that has several staff who preferred to use it. Other languages (HTML/CSS, JavaScript, PHP, Java, and C++/C) hold most shares on the number of respondents ready to use in colleges or universities.

#### 4.1.2 Programming Frameworks Accepted by Lecturers

In this question, the teaching staff were asked on which programming languages framework deemed necessary to adopt based on the knowledge of perceived benefits of such particular language. Their responses are summarized on figure2 below.



**Figure2:** Programming Frameworks Preferred by Teaching Staff Vs Various Frameworks

The graph on figure2 shows that Laravel/CodeIgniter/Symfony and Angular/Reactjs or Vuejs or Nodejs are the mostly preferred frameworks by teaching staff. Also, PHP, JavaScript, and C++/C are commonly used programming languages in their colleges or universities.

### 4.1.3 Willingness to Start New Programming Frameworks by Lecturer

The lecturers were asked the extent of their willingness to commit and devote their time and efforts for new curriculum that will encompasses the programming frameworks in their teaching process. The figure3 below shows their responses with respect to how quick the are ready to perform their curriculum review.

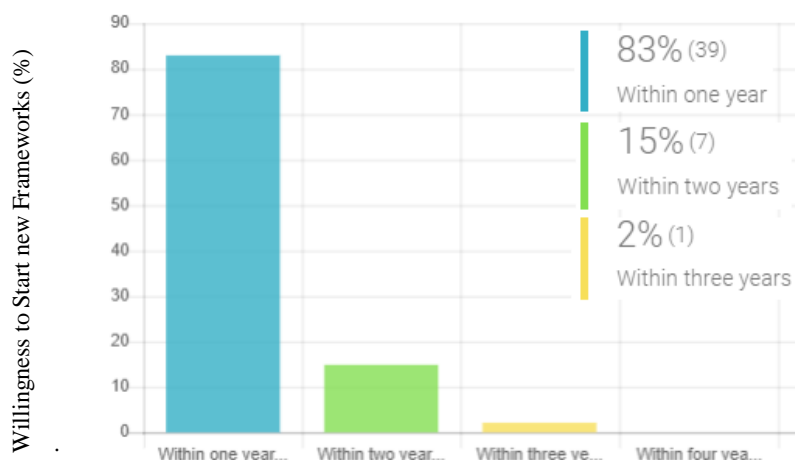


Figure3: Teaching Staffs` Willingness to Start New frameworks in Their Institutions Vs Duration in Years.

It is clear that the lectures are eager to start new programming frameworks immediately as shown on figure3 above. The graph shows 83% of respondents are willing to facilitate the launching of new programming frameworks in their institutions.

## 4.2 Results from Students

There are 100 students responded the questionnaire related to the preferences on programming languages and frameworks in general. The following are the responses on various questions.

### 4.2.1 Programming Languages known by Students

This question was designed to capture the preferences or knowledges concerning the languages common for students. This may not imply the languages that they have learnt before, but however it may include any idea of perceived usefulness or perceived easy to use of such language were presented in this section.

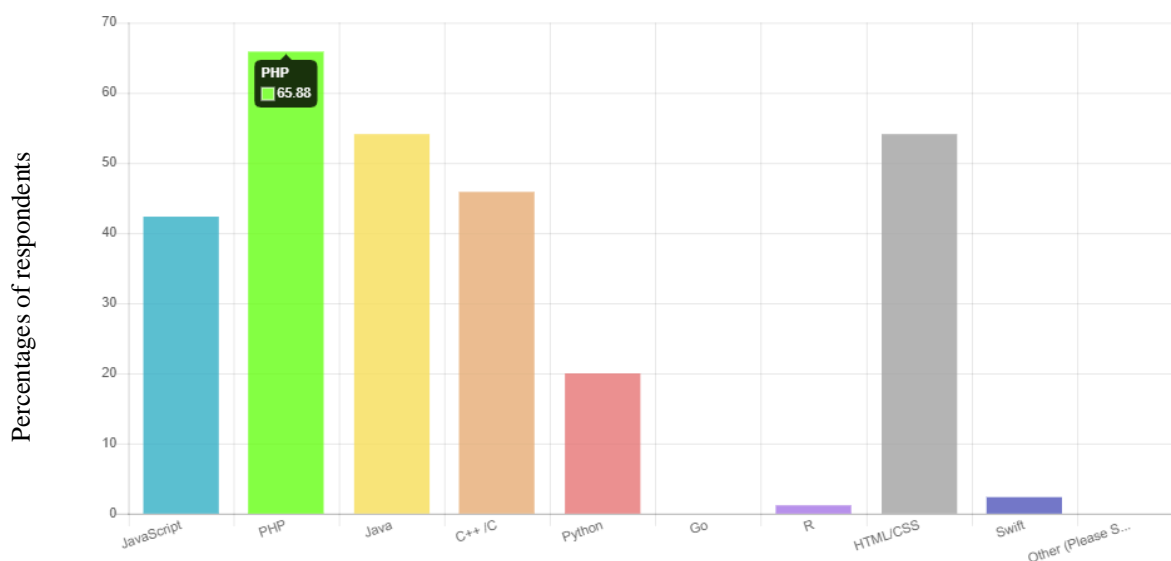
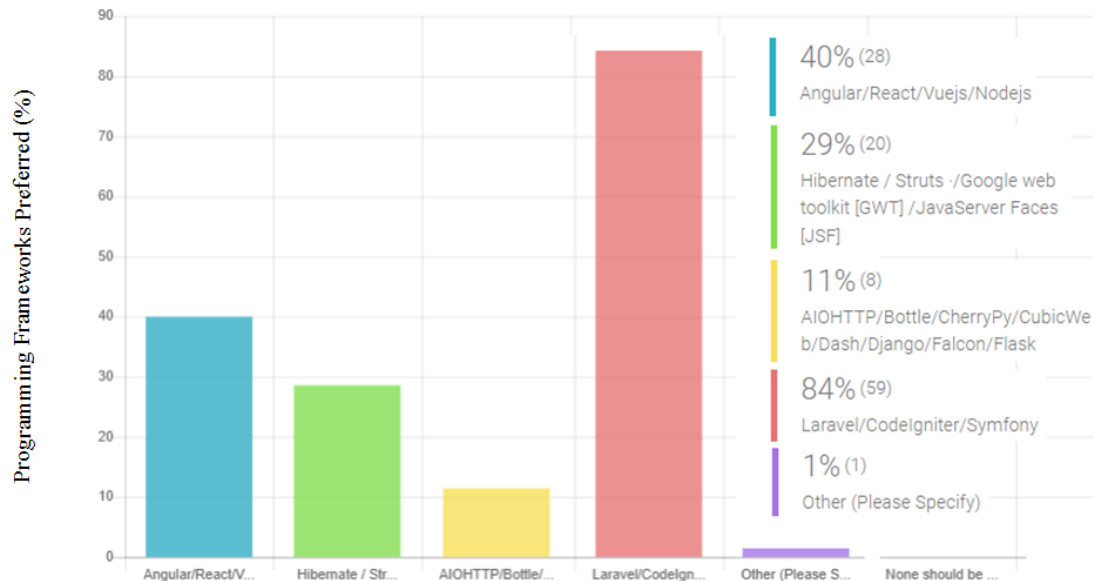


Figure4: Programming Languages Mostly Preferred by Students

The knowledge of students towards choice of language mostly determined by the courses offered by their institution. The graph shows that PHP, HTML/CSS and Java are the leading languages in most institutions in Tanzania. In centrally of the most research Python is not popular in Tanzania higher learning institutions.

**4.2.2 Programming Frameworks preferred by Students**

This section measures the choice of language framework selected by the students. The intension is to capture the general views on the language framework preferred by these students. Their choice will be motivated by way they have encountered the similar scenario concerning frameworks before this study. Also, other sources of information such as social media, internet search engine, and modules learnt from previous studies. This choice doesn't implies the extent of usage of such framework but rather it is about familiarity concerning the topic.



**Figure5:** Programming Frameworks Preferred by Students Against Frameworks

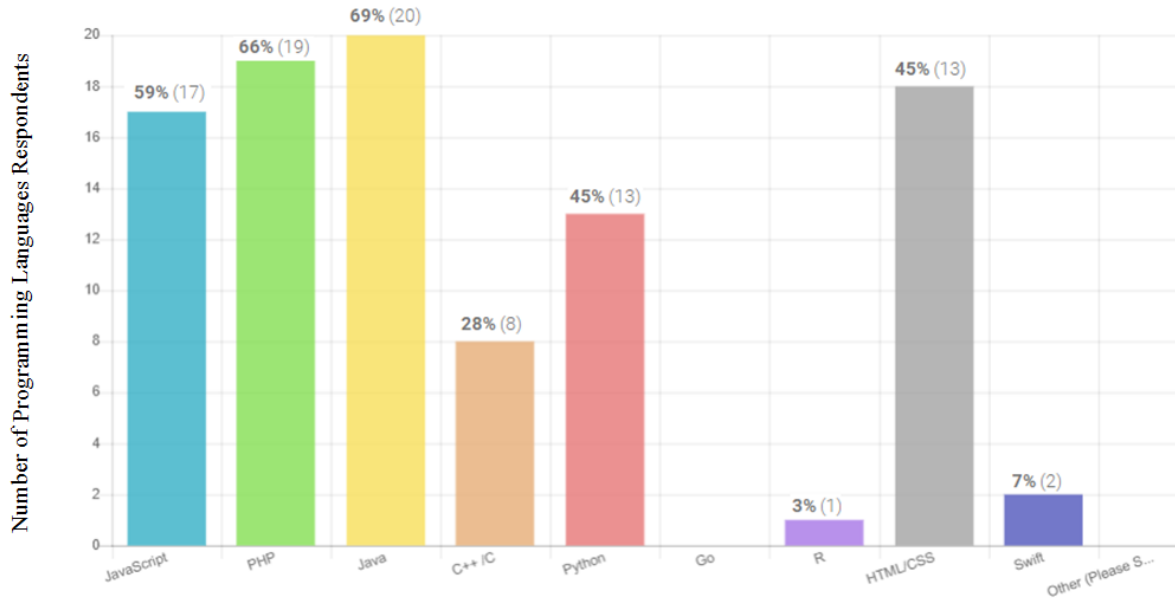
Most programming languages framework is not popular among students' environments which makes most of them to rely on their little knowledge to make decision. In this regard PHP related frameworks seems to dominate this part of which 84% have selected Laravel, CodeIgniter, and Symfony frameworks.

**4.3 Results from Software Developers**

In this category, the questionnaires were distributed to the software developers from several companies found in this region. Their view concerning the most preferred languages, and most preferred frameworks were collected. This part was not necessarily mean that the respondent is using such particular software for developments but rather the general knowledge on the framework. This may imply that, for a given environment the software developer would choose such language or framework to make systems development.

**4.3.1 Programming Languages Preferred by Software Developers**

In this part, the preferred language was asked to reflect on the user intention to use such language for developments. The developer responses are indicated on figure6 below of which the percentages of those responded were drawn against the preferred languages.

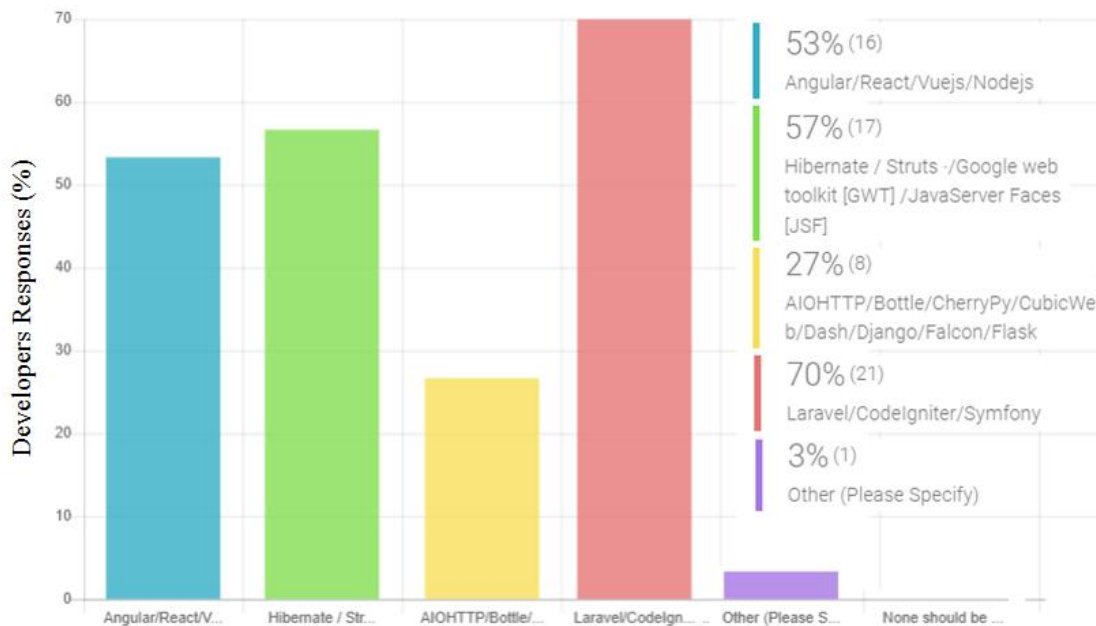


**Figure6:** Software Developers` Preference (%) on Programming Languages

The developers prefer mostly Java, and PHP followed by JavaScript and HTML/CSS while other languages are rarely common among systems developer. The figure6 above shows that Java is the most preferred and Go language is not well known by these programmers.

#### 4.3.2 Programming Frameworks preferred by Developers

The programming framework question from developers is shown on figure7.



**Figure7:** Developers` Preferred Frameworks (in Percentages-% Vs Different Frameworks)

As shown above on figure7, the frameworks for PHP are mostly preferred by the developers while Java, and JavaScript framework followed as the most commonly known as compared to other frameworks. Most developers are not familiar with python's frameworks such as Django or Bottle as there are very few respondents.

## **V. Discussion**

The study has revealed that PHP, HTML/CSS, and Java are the leading languages mostly familiar in higher learning institutions. However, PHP, Python, and Java are the mostly preferred as development tools by the developers. Python is not known to most lecturers, and students but it is preferred by the development companies. Although C++/C programming languages is very common in the colleges/universities curriculum it is not that much preferred by the developers in the market. On the other hand, Laravel and other PHP frameworks is very common in higher learning institutions while Django and other Python's frameworks are not popular among college/universities teaching staff as compared to their usage by the software developers. Also, the frameworks such as Angular, Spring, Hibernate, Full-Stack, and Struts frameworks are preferred by the programmer in the market and not popular among students in their academic studies.

There are languages seem to lose its market share but still heavily popular in the higher learning institutions. Also, there are other languages and frameworks emerged and preferred by the developers are not adopted by the colleges/university's curriculum. The study shows that the level of adoption of programming frameworks by the college/universities in this region do not match with the pace of technological changes in the market. There are several factors which affect the adoption of programming languages frameworks include political factors, government policies, eager to change, fears to change, perceived usefulness of such framework.

The adoption of any technology is determined by the users' perceptions towards the significance of such acquired knowledge. There are several theories which suggest the best way to adopt new technology. According to Tamilmani et al (2020), adoption and use of Information Systems /Information Technology (IS/IT) has been determined by several models/theories such as: Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), theory of planned behavior (TPB), Consumer Acceptance and Use of IT theory, Diffusion of Innovation (DoI) theory, and Model of Personal Computer Utilization (MPCU)

### **5.1 Technology Acceptance Model**

According to Doraszelski (2004) firms do not necessarily wait for a future technological breakthrough, but instead have an incentive to delay the adoption of a new technology until it is sufficiently advanced. According to Jensen (1984) Models of uncertain profitability argue that a firm has an incentive to delay adoption because it can gather information as time passes, and thus perhaps avoid adopting an unprofitable technology. Consequently, the adoption decision depends critically on how fast and by how much the firm expects that technology will advance over time (Doraszelski, 2004). The Tanzania Colleges/Universities has the time to delay to cope with technological changes but the time shouldn't be too long to remain behind the market need.

### **5.2 Consumer Acceptance and Use of Information Technology**

According to Venkatesh (2012) the technological acceptance depends on age, gender, and user experiences; Experience will moderate the effect of behavioral intention on use, such that the effect will be stronger for consumers with less experience. However, the perceived technological uncertainty which refers to an individual's perception that he or she is unable to accurately predict or completely understand some aspect of the technological environment hinders the acceptance and use of any technology (Song, Michael, and Mitzi M. Montoya-Weiss, 2001).

Based on this concept the government should make efforts for our universities lectures to have enough industrial experiences to make changes according to the pace of technological changes. The study investigated that the current curriculum in these universities/colleges do not match with the pace of technological changes. The government should enforce emergency policies to tackle the problem so that the Tanzania graduates gains latest technologies.

## **VI. Conclusion and Recommendations**

The results and discussion clearly show that the pace of technological adoption of new technologies do not match with technological changes in Tanzania. Also, none of the Adoption Models that have been discussed earlier has shown any time frame necessary to adopt new technologies due to various factors including uncertainty of the benefits of new technology, users experience, individual perceptions to accept new technologies, fears to adopt unprofitable technology, and lack of accurately predict the future benefits of such technology.

The study recommends the government to put extra effort to mitigate technological changes by facilitating seminars, and conferences that will bring awareness on the current technological advancement which will be useful for curriculum developments. Also, the colleges/universities should emphasize on industrial training of their staff to induce the current market need to their lectures by supporting them to conduct industrial practical training from various companies that employ their graduates to gain industrial experiences. The students should use latest technology to grab the opportunity to learn any extra knowledge that will be useful to



compete in the market.

## References

- [1]. A. Kelly, *The Curriculum, Theory and Practice*, 5th Ed, SAGE Publications London-Thousand Oaks, New Delhi, 2004.
- [2]. B. Lutkevich, *The Framework*, Online Technical Definitions, Available Online at <https://whatis.techtarget.com/definition/framework>, 2022.
- [3]. BRELA, List of Companies, Business Registrations and Licensing Agency (BRELA), Available at <https://www.brela.go.tz/>
- [4]. C. I. V. Lopes, D: *A LANGUAGE FRAMEWORK FOR DISTRIBUTED PROGRAMMING*, Ph.D. dissertation, Faculty of the Graduate School, College of Computer Science, Northeastern University, USA, 1997.
- [5]. C. Supaartagorn, PHP Framework for Database Management Based on MVC Pattern, AIRCC's International Journal of Computer Science and Information Technology, Vol 3, Issue 2, pp 251-258, 2011.
- [6]. Cass, Stephen. "The 2015 top ten programming languages." *IEEE Spectrum*, July 20 (2015).
- [7]. Fronchetti, Felipe & Ritschel, Nico & Holmes, Reid & Li, Linxi & Soto, Mauricio & Jetley, Raoul & Wiese, Igor & Shepherd, David. (2022). Language impact on productivity for industrial end users: A case study from Programmable Logic Controllers. *Journal of Computer Languages*. 69. 101087. [10.1016/j.cola.2021.101087](https://doi.org/10.1016/j.cola.2021.101087).
- [8]. G. Samira, "Top Popular Python Libraries in Research." *Authorea Preprints* (2022).
- [9]. Hao, Jiangang, and Tin Kam Ho. "Machine learning made easy: a review of scikit-learn package in python programming language." *Journal of Educational and Behavioral Statistics* 44.3 (2019): 348-361.
- [10]. Hare, Harry. "Survey of ICT and Education in Africa: Tanzania Country Report", 2022.
- [11]. Hassan, Muhammad, S. S. A. S. Kazmi, and Siti FalindahPadlee. "Technology acceptance model (TAM) and dynamics of online purchase adaptability." *International Journal of Recent Technology and Engineering* 8.1 (2019): 390-402.
- [12]. HP, *Computer History: A Timeline of Computer Programming Languages*, Available at <https://www.hp.com/us-en/shop/tech-takes/computer-history-programming-languages#:~:text=1883%3A%20The%20first%20programming%20language,just%20numerical%20values%20of%20things,2018>.
- [13]. IEEE, ACM. *A Computing Curricula Series Report, Computing Curricula 2020, CC2020, Paradigms for Global Computing Education*, 2020.
- [14]. J. Athuman, *Education Pogrammes and Curriculum Reforms in Tanzania: A comparative Review of Education for Self Reliance and Poverty Reduction (PR) Programmes*, *International Journal of Science and Research (IJSR)*, Vol 8 Issue 9, 2019
- [15]. Jensen, R., 1982. Adoption and diffusion of an innovation of uncertain profitability. *Journal of Economic Theory* 27, 182–192.
- [16]. Mason, R., Crick, T., Davenport, J. H., & Murphy, E. (2018, February). Language choice in introductory programming courses at Australasian and UK universities. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education* (pp. 852-857).
- [17]. NACTEVET, *Curriculum Development Procedures*, The National Council for Technical and Vocational Education and Training (NACTVET), Available at <https://www.nacte.go.tz/index.php/curriculum/curriculum-development-procedure/>, 2022.
- [18]. P. Maggi and R. Sisto, "A Grid-Powered Framework to Support Courses on Distributed Programming," in *IEEE Transactions on Education*, vol. 50, no. 1, pp. 27-33, Feb. 2007, doi: 10.1109/TE.2006.879806.
- [19]. R. E. Johnson, *Communications of the ACM* Vol 40, Issue 10, Oct. 1997 pp 39–42, <https://doi.org/10.1145/262793.262799>, 1997.
- [20]. Scaffidi, Christopher. "A survey of employers' needs for technical and soft skills among new graduates." *International Journal of Computer Science, Engineering and Information Technology* 8.5/6 (2018): 11-21.
- [21]. Schreiner, Wolfgang. (2021). *Programming Languages*. [10.1007/978-3-030-80507-4\\_7](https://doi.org/10.1007/978-3-030-80507-4_7).
- [22]. Song, Michael, and Mitzi M. Montoya-Weiss. "The Effect of Perceived Technological Uncertainty on Japanese New Product Development." *The Academy of Management Journal*, vol. 44, no. 1, Academy of Management, 2001, pp. 61–80, <https://doi.org/10.2307/3069337>.
- [23]. Song, Michael, and Mitzi M. Montoya-Weiss. "The Effect of Perceived Technological Uncertainty on Japanese New Product Development." *The Academy of Management Journal*, vol. 44, no. 1, Academy of Management, 2001, pp. 61–80, <https://doi.org/10.2307/3069337>.
- [24]. Sugandini, Dyah, et al. "The role of uncertainty, perceived ease of use, and perceived usefulness towards the technology adoption." *International Journal of Civil Engineering and Technology (IJCIET)* 9.4 (2018): 660-669.
- [25]. Tamilmami, Kuttimani, Nripendra P. Rana, and Yogesh K. Dwivedi. "Consumer acceptance and use of information technology: A meta-analytic evaluation of UTAUT2." *Information Systems Frontiers* 23.4 (2021): 987-1005.
- [26]. Taylor, David, et al. "A Review of the use of the Health Belief Model (HBM), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB) and the Trans-Theoretical Model (TTM) to study and predict health related behaviour change." London, UK: National Institute for Health and Clinical Excellence (2006): 1-215.
- [27]. U. Doraszelski, Innovations, improvements, and the optimal adoption of new technologies, *Journal of Economic Dynamics and Control*, Volume 28, Issue 7, 2004, Pages 1461-1480, ISSN 0165-1889.
- [28]. Venkatesh, V., & Davis, F. (2000). Theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, 46(2), 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
- [29]. Venkatesh, Viswanath, James YL Thong, and Xin Xu. "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology." *MIS quarterly* (2012): 157-178.
- [30]. W. Kasuga, *The Influence of Politics in Curriculum change and Innovation in Tanzania*, *European Journal of Educational Studies*, Vol 5, Issue 12, 2019.