

Encounters in Sustainable New Product Design and Development by Zimbabwean Design, Technology, and Engineering University Students

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Abstract: The drive of this paper is to explore the obstacles faced in new innovative product development design by Zimbabwean university learners in a bid to attain the United Nations (UN) Sustainable Development Goal (SDG) 12 “**Responsible production and consumption**” and the education 5.0 pillar “**Innovation**”. However, there is little progress toward the attainment of these related goals by students in the Zimbabwean university landscape and is fuelled by a lack of guidance and assistance from various stakeholders in the accomplishment of this objective. The study mainly concentrated on the encounters faced by university learners’ prior development of products that solve better the existing and emerging societal problems and at the same time fulfilling the UN sustainable development goal (SDG 12) “Responsible consumption and production” and Education 5.0 pillar “Innovation”. Open-ended questionnaire was used in this study to solicit in-depth data on the challenges university students encounter in new product development. Findings from the study indicated that Zimbabwean university learners are constrained by multiple challenges emanating from lack of monetary support from the Ministry of Higher and Tertiary Education, Innovation, Science and Technology (MHTEIST) and at the micro level either institutional level or agential conditions surrounding learning in the various universities of the country. These challenges include a shortage of resources, poor infrastructure, high student-lecturer ratios, lack of in-service training and staff development programs for lectures, and ineffective curriculum implementation among others.

Keywords: Product Development, Sustainable Production, Education 5.0, Sustainable Development Goal (SDG12).

I. Introduction

According to Kitamura & Hoshii, (2015) sustainable development is observed, as a necessary direction for the universities at large to traffic to wards for the attainment of a sustainable future. Nevertheless, they additionally hinted that educating for sustainability in new product development in Zimbabwean universities is by no means stress-free hence all interested parties should make substantial determination towards its attainment through the production of competent university learners and graduate designers. Little or limited literature is available on what the Zimbabwean government is doing to regulate and improve quality in new product design and development by university students. The main challenges plaguing the production of competent designers include limited resources, lack of experience, human capacity developments, lack of trained personnel, lagging in technological advancement, and lack of access to the right people and networks to help them with new innovative product development design. Universities in the country as institutions of higher learning have the overall mandate to steer economic development and competitiveness in addressing societal challenges through new innovative product manufacture of which Zimbabwean university lecturers, and learners are lagging behind and also become less competitive in the global market. Despite Zimbabwe’s initiatives to improve the quality of education across all its tertiary institutions, and also the attainment of the Education 5.0 mantra and SDG12, key players either students, and lecturers still lag behind in the development of products as a myriad of challenges still befall them. Embracing fully the Education 5.0 mantra and SDG 12, isa critical stage for equipping Zimbabwean universities lecturers, and students with relevant skills and capacities for long- term solutions in problem solving through new product development despite the multiple challenges they face. Zimbabwean universities as systems therefore, must invest a lot in mitigating challenges related to the attainment of education 5.0 goal and SDG 12 as well as those befalling key players in their efforts to address problems through new innovative product development. Universities and all other relevant stakeholders in the Higher education landscape, are hence forth obligated to meritoriously respond to the needs of adequate resources, training, developed infrastructure, review the university curriculum continuously and so forth as a worthwhile effort to enhance and promote innovative ideas in new product development.

Statement of the problem

The lack of support, resources, time, equipment, and training among Zimbabwean university learners to facilitate the development of sustainable new products is a major challenge that needs to be addressed. There is a need to identify the challenges associated with sustainable innovative new product design and development by Zimbabwean university learners and graduates, in order to develop effective strategies to support their efforts.

Research questions

This study on sustainability through new product development design by Zimbabwean university learners is directed by the subsequent Exploration Interrogations (EI)

EI 1: What challenges do Zimbabwean university students face in the development of new innovative products?

EI 2: How can Zimbabwean university students leverage new product development design and have a competitive advantage in the global market?

EI 3: What strategies can be adopted to ensure the successful development of sustainable innovative new products?

Theoretical Framework

This study to unearth the challenges militating against and opportunities brought to the innovative development of new products by university learners and graduates is informed and guided by the ideas of Boughey (2012) and his social Realist Theory of structure. Critical realist theory as viewed by Buzani (2014) consents that there is a genuineness autonomous of our illustration of it but concedes that our awareness of reality is business to all kinds of historical and other inspirations. The Social realist theory conferring to Buzani (2014) encompasses of three settings of structure, culture, and agency which are overlaid on each other, and these structures constrain or permit the actions of the agent. The structural setting according to (Buzani, 2014) embraces roles, organizations, institutional structures, systems, policies, committees, substructures, and positional levels within the organization. The structure includes the material conditions that would motivate action (Buzani, 2014), while culture mainly focuses on the way of life of a specific group of people which encompasses behaviour, beliefs, values, customs, relationships, and special symbols.

II. Literature review

The concept of sustainability through new innovation product development design has been gaining traction in recent years, as universities and businesses alike seek to develop products that are both environmentally friendly and economically viable (Bettis & Hitt, 2015). As such, this literature review will explore the challenges associated with sustainability through new product innovation development design by Zimbabwean university students.

According to Chisimba (2018), one of the challenges associated with sustainability through new product innovation development design by Zimbabwean universities students is the lack of access to resources and funding. Zimbabwe is a developing country with limited resources and limited access to funding for research and development. This limits the ability of universities and students to develop new innovative products that are both sustainable and economically viable (Dube, 2019). Furthermore, the lack of access to resources and funding limits the ability of universities and students to access the latest technologies and materials needed for new innovative product development.

The second challenge associated with sustainability through new product innovation design and development by Zimbabwean university students is the lack of knowledge and expertise. Zimbabwean universities and students lack the necessary knowledge and expertise to develop sustainable new innovative products (Gambare, 2016). This is due to the lack of access to resources and funding, as well as the limited access to the latest technologies and materials needed for new innovative product design and development.

The third challenge associated with sustainability through new product development design by Zimbabwean university students is the lack of support from the government (UNESCO, 2017). The government of Zimbabwe has not provided adequate support for universities and graduates to develop sustainable innovative new products. This lack of support has hindered the ability of universities and their students to develop sustainable new products that solve societal demands.

Despite the challenges associated with sustainability through new product development design and development by Zimbabwean university students, there are also opportunities. One such opportunity is the potential for universities and graduates to collaborate with international partners to access resources and funding (Materu, 2007). This could enable universities and their students to access the latest technologies and materials needed for innovative new product design and development. Additionally, university students could collaborate with the government to receive support for their research and development efforts.

Sustainability through new product development design by Zimbabwean university learners presents both challenges and opportunities. The lack of access to resources and funding, the lack of awareness and proficiency, and the lack of support from the government are all challenges that must be addressed. However, there are also opportunities for universities and graduates to collaborate with international partners and the government to access resources and funding, and to receive support for their research and development efforts.

Although Zimbabwean higher education institutions pursue to be the upbringing grounds for the trained students and graduates, whom the country essentially needs for innovative new product development and subsequent attainment of the Education 5.0 goal and the United Nations Sustainable Development Goal SDG12, they are overwhelmed by grave shortage of lecturing staff resulting in high student ratios, poor infrastructure development, shortage of financial and material resources, lack of staff development programs and in-service programs among the rest. The condition is further grave by veneration to the scarcity of more high-ranking qualified lecturing staff with effective technical skills in new innovative product development. Higher education establishments in virtually all African nations are fundamentally incapable to preserve experienced lecturing staff and research academics inclusive (Materu, 2007). Universities also face an acute shortage of technical, administrative and management staff to spearhead product development projects by students from local universities. The situation is impacting not only on higher education establishments in the country but also largely impact on additional echelons of education amenities, well-being upkeep systems and general fiscal accomplishments. Scarcity of university departments lecturing personnel and other workforce is more augmented by government constraint on employment either job freeze, mass exodus of staff for greener pastures, retirements and retrenchments. Pitiable authority, administration and control aggravate the encounters confronted by higher education establishments in Zimbabwe, (Palmer 2015), Administration incompetence groove threatens resources away from the ultimate objectives of swelling access, excellence, and significance and delicately blows out human and financial resources.

III. Methodology

The need to depict challenges encountered during new innovative product development by university students in the Zimbabwean higher education landscape prompted the researchers to employ an open-ended questionnaire method in the collection of data. Participants of the study included the departmental education administrators, lecturers, and students of a selected university in Zimbabwe. Participants were drawn from Design Technology education departments, administrators, lecturers, and students from the selected university. Eight students, four lecturers, and two departmental administrators were purposefully selected as participants in the study. Google form questionnaires were sent to participants telemetrically through WhatsApp and email for completion and eventual return. The research approach was utilised to gain an in-depth understanding of the challenges impeding new product development by students at the university level. First, the questionnaire was pilot-tested later administered to four lecturers, two administrators, and eight students from the selected Zimbabwean University. The results of the study were analysed and presented verbatim by use of pseudo names.

IV. Findings

The qualitative exploration of data was done based on the questionnaire responses by eight students, four lecturers, and two administrators as participants of the study from a selected Zimbabwean University. The main emerging factors from the data analysis were limited resources, lack of financial support from the government, lack of time due to use of modules, lack of one-student lecturer interaction due to overloaded classes, and lack of in-service training, collaboration and workshops. Evidence from the questionnaire data indicated that Zimbabwean universities have the latent ability to offer high-quality production skills to the students provided the encounters met are mitigated. Proper migratory strategies will enable students in universities across Zimbabwe to record notable progress in developing new innovative products that best address societal demands. Improving widespread attainment of the United Nations SDG 12 Goal, Responsible Consumption, and production as well as the Education 5.0 pillar, innovation should be the top priority in the Higher and Tertiary Education landscape in the country. An in-depth exploration of participant questionnaire responses showed that the truth is, no new products are being invented by students in Zimbabwean Universities since they are impeded by a lack of both financial and material resources.

Universities country-wide have inadequate resources as implements for new product development. Lack of resources therefore largely impedes new product development by university students in the country. Administrator 1

University in the country are incapacitated to provide adequately ICT resources, reliable devices and software, equipment, tools, and technologies that are needed for production of quality, suitable products desired by the society. Inconsistent access to these essential resources across universities of the country is the major constraint for notable progress towards attainment of the United Nations SDG 12, and Education 5.0 pillars by universities and key players notably students. The government and respective learning

institutions must, therefore, adequately supply learners with the essential resources, including competent personnel especially for Design Technology disciplines.

Little or no support is given to university students by the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development limited access to resources and funding for research and development therefore, largely affects students' efforts towards production of goods and services that address needs of the people at the same time attaining Education 5.0 and SDG 12. In support of this view, students lament that:

Lack of resources is a major constraint hindering us from developing new innovative products aimed at solving existing and emerging societal problems in our areas of specialisation. Resources in short supply included among others computer design software, computer hardware, capital to purchase the material resources, and so forth. Student 3.

Another student responded and shared that:

The university, government, and charity organisations could intervene in one way or the other by providing these high-cost resources to university students and graduates to capacitate us in the production of artifacts that solve existing and emerging societal problems in a unique and interesting manner. Student 5

No workshops, in-service training, and collaborative activities are planned and provided to students and lecturers to equip them with the requisite knowledge and skills needed for sustainable production of goods and services that address the current needs of the people. Universities lack technical expertise and experience in sustainability new product design and development, hence a serious need to invest more in these workshops, in-service training, and collaborative activities as they have the power to transform universities into product design and development environments. The most common reason for the lack of product development in the universities is the inadequate provision of collaboration, professional development, and training. In light of this view, one lecturer responded and opined:

The university curriculum does not adequately prepare and equip students with the relevant skills to produce innovative products that address societal needs. Lecturers identified a lack of skills on their side as a contributory factor as they are not trained to integrate design software in the production of artifacts. Lecturer 4.

Another lecture responded calls for the need to equip staff with current and emerging technical skills by echoing that:

The university has to plan and budget for in-service training and professional development programs for their staff. In-service training and professional development programs in Auto Cad integration for examples are largely and unanimously called for. Lecturer 2

Lectures and university in the country however, could not afford going for in-service training and staff development programs in their deficit skills areas due numerous challenges befalling them. One of the challenges they face is the high cost of training in a dwindling economy. In support of this view, Sithole, and Hahlani, (2022) aver that, one current problem is the cost of training, teachers who have an opportunity to staff develop themselves through acquiring University degrees have a chance of acquiring the knowhow to use Auto-CAD but the cost of going for further training is high, especially during difficulty economic times the country is going through at the moment.

Administrators, lectures, and students shared the same sentiments and they had this to say:

New product development by students and graduates from our universities is hampered by lack of suitable infrastructure and technologies. Infrastructure and machinery are old and dilapidated. Universities have an uphill task of acquiring new and current machinery and technologies to aid product development. There is also an urgent call for the construction of innovation hubs as infrastructure suitable new product development and exhibition of manufactured products. Administrator 2

In support of the above views by respondents, Ojo (2018) perceived that the challenges of insufficient infrastructural amenities are additional chief constrain to the development of products and services by Zimbabwean university learners. John, (2016) also pronounced that infrastructure amenities and technical progressions in our universities are not in order and most of them are dilapidated and even outdated. All the essential requirements for the production of usable products and services are in deficit which poses a hindrance to the attainment of the United Nations SDG 12 and Education 5.0 mantra by universities and their students. The collapse of infrastructure amenities in Zimbabwean universities is disgusting and runs short of a conducive learning environment for innovative new product development by students. University students are learning in old and dilapidated infrastructures and in light of this challenge, participants concur that:

*Student lecturer ratio is sometimes too high and impacts negatively on quality teaching and learning since monitoring and supervision of student of individual student designs by a lecturer is minimised in these large classes. Due to minimum supervision, as students, we produce low-quality products that are not user-friendly. **Student 1***

In view of the participant response above, Gambare, (2016) notes that the quality of teaching and learning in Zimbabwean universities is poor and cannot guarantee new product development and attainment of UN SDG 12 and the Education 5.0 mantra. Ojo (2018) also submitted that student enrolment grows with the national population, and more staff are not recruited to match the rate of growth of student enrolment. This is a result of the massification of university education in the country hence leading to an unmanageable student-lecturer ratio and low student-lecturer interaction in the supervision of design projects. Accordingly, the quality of artifacts produced dwindles since the rise in learner uptake does not obtain a matching escalation in human resources inputs, but rather conflicts with dilapidating infrastructure and material resources.

Poor planning is one of the key encounters threatening Zimbabwean Universities towards attaining SDG 12 and education 5.0. Many Zimbabwean Universities do not have working strategies that foster student development of new products and subsequent attainment of SDG 12 and Education 5.0. Universities therefore, should craft working missions, visions, and goals geared towards the attainment of Education 5.0 and SDG 12 and eventually instil new product development skills in student learners. As such, they are seen enrolling large student numbers in Design Technology and engineering disciplines not considering human and material resources at their disposal. In light of this challenge, participants have this to say:

There is a massification of education in Zimbabwean public universities that manifests in massive student enrolment across all faculty departments. A large student population in university classes results in an acute shortage of resources and reduces student-lecturer interaction during practical. This eventually impacts students' innovative capacities in product development. **Lecturer 2**

Low research output for academics and learners in the Zimbabwean universities' landscape is predominantly low due to lack of sponsorship in that regard and this negatively impacts on the accomplishment of the UN SDG 12 and education 5,0 pillars, witnessed by low or no new product innovations by both students and lecturing staff. The Zimbabwean Universities' research income per academic and research staff, research income per institutional income, papers per research income is one of the poorest in the world (Ojo, 2018) and this is due to the poor attitude of governments towards research and inadequate funding of research programs. Gambare, (2016) also pointed out that research programs in Zimbabwean Universities have not been given enough priorities it deserves. Zimbabwean Universities are therefore challenged to fund and engage in intensive research programs to identify needy areas and henceforth provide working solutions to the problems through new product design and development. Due to poor funding, student designers are discouraged from embarking on product design and development research. In view of this view, a student participant has this to say:

As a university student, I find it not all that easy to engage in research and come up with a new innovative product that addresses societal needs due to lack of finance and even sponsorship. **Student 7**

Participants of the study also cited pressure and limited time as another factor hindering the development of new products in the university as they concur that:

Universities in the country adopted modularization system of learning in the traditional learning semester is divided into two sessions. This entails reduced time and pressure on coursework and exam preparation. This sees further reduction of focus on new product development by most if not all students. **Student 6**

V. Discussion of findings

The study explored sustainability in new product development by university students, specifically looking at the challenges that hinder university students in their efforts to address existing and emerging societal problems at home and abroad through new product development. The study reveals that university students are constrained to respond positively to demands of one of the important pillars of education 5.0 mantra "innovation" and the sustainable development goal SDG 12 "sustainable production and responsible consumption". Results of the study indicate that there is little evidence of new product development by university students in the country due to a handful of impediments that befall them. In fact, the results of the study reveal significantly low levels of motivation and mere ignorance in new product design and manufacture by universities and students. Mostly, the government is failing to adequately fund the universities with adequate grants for the construction of innovation hubs and lecture rooms and even provide for ICT resources, relevant equipment and materials for new product development. Lack of these essentials, hamper students from developing new innovative products that address societal needs. Thus, participants indicated that, their

innovative potential is obstructed by lack of suitable infrastructure and technologies. They indicated that infrastructure and machinery in the universities are now old and dilapidated and very much unsuitable for the 21st era.

Sustainable development of innovative products by university students is also largely determined by the potential of the lecturers to impart and instil the rightful skills to the would be designers. However, study results indicated that, universities are incapacitated to equip students with relevant skills that enable them meet the United Nations Sustainable Development Goal (SDG12) which focus on responsible consumption and production and the Education 5.0 pillars particularly innovation. Hahlani et al. (2022), aver that, lecturer qualification is a central and key factor for fidelity implementation of the new emerging innovation changes in the university setting. However, the results of this study therefore indicate that, lecturers lack the skills to produce innovative designs and hence could not implement the curricula with fidelity.

Drawing from the views of study participants, the production of innovative new products by university students requires a substantial amount of input. Findings of the current study, indicate; that universities are starved of the requisite resources ideal for subsequent manufacture of new innovative products. In this regard, participants concurred that; Universities of the country have crippled resources as inputs to facilitate students' new innovative product design and development. Lack of resources is therefore largely a serious drawback for effective implementation of the Design curricula across universities of the country since it impedes new product development by students and lecturers. Hahlani et al. (2022), indicated that, the high cost of acquiring these essential resources is the main obstacle faced by universities. To alleviate this problem of the high cost of resources, government, ministry, and charity organisations intervene in one way or the other in the provision of the needed resources.

Of note in this study is the massification of university education as evidenced by excessive student enrolment. Participants of the study reiterate that, the massification of university education sees universities with congested classrooms. Higher enrolment figures in the classrooms results in increased pressure on little, crippled resources provided by the government and universities. It is worth noting that reduce resource has a bearing on sustainable design and production of new innovative products. Massification of university education and increased student enrolment, also escalates student lecturer ratios hence reducing one on one lecturer student supervision and this impacts on the quality of goods produced by students if they are any. To mitigate this challenge, universities has to formulate and adhere to policies that regulate student enrolment.

Another important issue observed by participants, as affecting sustainability in new product design and development includes among others lack in-service training, workshops, and collaborative activities for both students and lecturers in the higher education landscape. Participants of the study thus lament that, universities across the country are not adequately providing for workshops, in-service training and collaborative activities for both students and lecturers. Responsible universities and government, must therefore, plan and adequately budget for these staff and student developmental programs which allow for the exchange and transfer of knowledge within human resources. Having in-service training, collaborative activities, and workshops in place, will go a long way in promoting new innovative ideas that address societal problems in an interesting unique way by students' designers in the university setting.

On the other hand, the findings of the study indicate that; there has recently been a paradigm shift from semester operations to the use of modules of the education system across all universities of the country. Unlike semester operations, participants lament that the use of modules reduces contact teaching and learning time. Reduced contact time, therefore, adversely impacts student time to research and experiment with new product design and development. To militate the issue of time, curriculum planners must reconsider the semester operations of the university education system.

From the sentiments of the study respondents' sustainability in new product design and development by university students' is constrained by:

- Lack of resources.
- Poor infrastructure and old machinery.
- High student lecturer ratios due to massification of university education.
- Lack of skills.
- Lack of support from government and universities.
- Low collaborative activities, workshops, and in-service training.
- Adoption of modularisation learning which brought about reduced contact time.
- Lack of enforcement of curricula innovations.

VI. Conclusion

The fact remains that the university education system is possibly the only institution that can provide opportunities for nurturing relevant human resource skills for subsequent development of innovative product designs that will eventually address various needs of societies far and wide. It is however worrisome to note that Universities across the country are not faithfully fulfilling their mandate of addressing societal needs through new product development since they are plagued with a myriad of challenges. In order for the Zimbabwean universities to fairly implement the Education 5.0 mantra and attain the SDG 12, there must be an intensive intervention by the responsible government, ZIMCHE, and the parent ministry, as they must be ready to address the issue of the inadequate resources, university and student collaborative activities, research, student lecturer ratios, student recruitment, facilitation of workshops and in-service training for both staff and students. It is also recommended that the government should adequately budget for university education funding. This will capacitate universities to sufficiently provide for modern and conducive infrastructures, ICT resources, equipment, and material resources, fund research activities, workshops, in-service training and collaborative activities. As such, sustainability through new product development design by Zimbabwean universities learners and graduates presents both challenges and opportunities. The lack of access to resources and funding, and the lack of support from the government are all challenges that must be addressed. However, there are also opportunities for universities students and graduates to collaborate with international students and partners and the government to access resources and funding, and to receive support for their research and innovative product development efforts.

VII. Recommendations

Given the above-mentioned encounters, there is still the potential for revival in sustainable new product development and attainment of UN SDG 12 and education 5.0 pillars by students and staff of Zimbabwean universities if the right measures are put in place. The measures listed below are suggestions as the way forward:

- For Zimbabwean universities to attain their mandate, of developing capable student designers, their curricula must be reviewed to embrace the education 5.0 and the SDG 12 United Nations Goal. Curriculum review is paramount in the Universities of the country to foster new product development by students and graduates as it will bring about a paradigm shift from theoretical to practical oriented learning.
- The Universities, Zimbabwe Council of Higher Education (ZIMCHE) and the parent ministry must put measures in place to ensure that there is quality teaching and learning geared towards education 5.0 and sustainable development goal 12. They have to set and enforce benchmarks for universities to achieve towards addressing challenges impacting the society today and in future through new product and service development. ZIMCHE and the parent ministry must compel universities to offer Design and Technology disciplines that equip clients with requisite product development skills, though, Hahlani, Bhukuvhani, and Sithole, (2022), noted that, since the inception of the Design Technology university curriculum in 2015, only one institution of Higher learning introduced the Design Technology curricula for learners throughout the country's universities. This is evident of little or no serious follow up and enforcement on curriculum implementation by mandated bodies hence innovation of products and services in universities remains critically insignificant.
- The provision of adequate funding is also pivotal in guarantying innovative productive skills by University students. Dube, (2018) recommended that funds allocated to education must be raised to a minimum of 15 percent of total expenditure at the federal level. Adequate funding for university education ensures sufficient and timeous provision of material resources, equipment, software, internet among others for research, design, production of prototypes, pilot testing and eventual manufacture real artifacts for public consumption. Poor funding is therefore, one of the greatest factor impacting negatively on innovative product development by university students.
- Another strategy to foster new product development design and manufacture by students at universities is to invest much in student research activities. The universities, government and charity organizations are supposed to fund student research by providing grants, equipment, ICT gadgets, the internet and any other material resources. Moreover, ZIMCHE and the parent Ministry are supposed to come up with research policies that guide university student research activities toward the production of artefacts are capable capable of addressing societal needs. There should be a deliberate attempt to make research and development the centre of public university education activities (Dube, 2018), and it is important to make research the hub of university education considering the problems Zimbabwean societies and the general populace now face. Supported research activities for university students and graduates accord them the opportunity and power to come up with new ideas and products that address human needs.
- Massification of the Zimbabwean university education has been noted as one major impediment in new product development as it results in overcrowded lecture rooms with higher student-lecturer ratios. This eventually exerts pressure

on resources and student lecturer attention. To avert this, it is recommended that universities and ZIMCHE and Parent ministry come up with policies that regulate student enrolment in the country's universities.

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