BOOK CHAPTER │ RE & Engineering Design
dx.doi.org/10.22624/AIMS/REBK2022-P13

Requirement Engineering in the Design of Cassava Shredding Machine

Ugwuanyi Uchenna Barnabas[1], Adeniyi John Ayodele[2] & Aballa A. Nkechi[3]
[1, 2, 3] Federal College of Dental Technology & Therapy
Enugu, Enugu State, Nigeria
Emails: ugwuanyiuchenna17@gmail.com, gajilo2013@gmail.com,
aballaagathankechi@fedcodtten.edu.ng
https://scholar.google.com/citations?hl=en&authuser=2&user=NdEv5M4AAAAJ

ABSTRACT

The study aimed at providing insight of technological development in the design of shredding machine for cassava. Cassava processing has been localized and mechanized. But one form of cassava processing, cassava shredding, has not received appropriate technological attention, hence, has been operated manually. The methodology applied was a survey research, involving in-depth , semi structured interview of key components the value chain on four domains: knowledge, problem solving quality output and job attitude, including 42 desired and distractive factors of stakeholders perceived by requirement engineering and 38 desired and distractive factors of requirement engineering perceived by stakeholders. The responses were coded and analyzed by software. The result through effective interaction indices indicated low perception of requirement engineering on stakeholders, especially production engineers and design engineers on development of cassava shredding machine. Lack of technical knowledge has hampered problem solving, in developing mechanism that shred cassava, to produce quality shreds, with throughput efficiency.

Keywords: Requirement Engineering, Cassava, Machine, Shredding, Indigenous Designs

Introduction

Sustainable development goal (SDG) number 2 emphasizes zero hunger (UN, 2020). Africa is an agrarian continent, rich in food production but lack the technology to preserve produce and mitigate hunger. An estimated 1 in every 4 people in sub-Saharan Africa is malnourished (FAO, 2018). During the COVID-19 Pandemic, the education sector saw a rapid uptake and deployment of several Learning Management Systems (LMS). Thousands of funds have been invested by higher

Yet, a third of the food produced for human consumption every year gets lost or wasted, and forty percent of these losses happen at post-harvest and processing levels in Africa. The losses can be traced back to challenges with harvesting techniques, and storage and cooling facilities. According to the Food and Agricultural Organization of the United Nations (FAO), in sub-Saharan Africa, perishable products, estimated to be about 25-30 percent for animal products and 40-50 percent for roots, tubers, fruits and vegetables are lost (FAO, 2019). Cassava, Manihot Esculenta Crantz and Manihot uitilissima pohl is one of the tubers mostly affected. In some areas in Africa, it constitute over 50% of the daily diets of the people; contributing significantly to the diets of over 800million people with per capita consumption averaging 102 Kg/yr(Kintché, Hauser, Mahungu, Ndonda, Lukombo, & Nhamo, 2017).

Cassava undergoes post- harvest physiological deterioration (PPD) once the tubers are separated from the main plant. Cassava are extremely perishable when harvested and begins to deteriorate within 40-48hrs (Jarvis, Ramirez-Villegas, Campo & Navarro-Racines, 2012). Mechanical damage during harvesting and handling stage also renders it unsuitable for long-term storage. In addition, cassava roots contain 80% carbohydrate on a dry weight(DW) basis of which 80% is starch and small quantities of sucrose, glucose, fructose and Maltose(Fermont, van Asten,Tittonell, van Wijk,& Giller,2009), but also contains potentially toxic level of cynogenic glucosides, made up of Linamarrin(95% cyanogens content and 5% Lotaustralin (Shackelford, Steward,German, Sait & Benton,2015).

The toxic and anti- nutritional substances interfere with digestion and uptake of nutrient; which lead to serious health disorder especially bitter cassava that FAO identified as having cyanide level exceeding FAO recommended 10mg/kgDW (FAO, 2019). Therefore, processing of cassava into a more suitable form becomes imperative.

Traditional methods of processing cassava include: fermentation, grating, drying, milling, pounding, boiling, pressing, soaking or seeping, steaming, peeling, slicing and shredding. Globally, some of these methods form process model, that varies across countries, to produce tapioca; known as Sagu, Mandioca(Brazil), Sagudana, Shabudama(Asia), Krupuk(Indonesia), Kerepek, Pedas(Malaysia), Kheer(India) among others (Reynolds, Waddington, Anderson, Chew, True, & Cullen, 2015). In Nigeria, steaming, shredding/slicing and fermentation for 24hours produce tapioca; which in eastern part of Nigeria, is known as Abacha, Ighu or Nsisa, a popular local delicacy. There are two profiles of abacha in Nigeria: shreds and slices and predominantly processed manually.

Study Background

AgriPack is a leading agricultural machinery production enterprise in Nigeria, with interest on researching, designing and production of processing machines for root and tubers. The company is organized functionally into five departments: Marketing and Sales, Designing, Accounting, Production and Administration. To improve its competitiveness, it adopted a strategy of introducing more new products into the market to achieve higher customer satisfaction. Four components of supply chain has been identified: Production Engineer (PE), Design engineers (DE), operator (O), farmer (F) and consumers (C).

Methods

The type of research adopted for the study was quantitative, using survey research method. Cross –sectional survey research involving face-to-face in-depth semi-structured interview methodology adapted from the "echo" method was applied. Convenience sampling of thirty two (32) participants was selected across all components of chain.

Figure 1: Study Participants

Interviews ranging from two to three hours were recorded and transcribed for coding. Responses were coded collaboratively by the research team members through an iterative process of coding, discussion, and recoding using the QSR N6 qualitative data analysis software. QSR International Pty Ltd. QSR N6. (2002).

The coding focused on identifying the major categories of desired and distractive factors mentioned by interviewees for each role. From these factors categories, we were able to identify specific patterns of interactions within each working relationship and to evaluate the effectiveness of each working relationship from the perspective of both parties involved.

The two-way interaction involved the requirement engineering (RE) desired and distractive factors as perceived by other stakeholders and stakeholders desired and distractive factors as perceived by requirement engineering. The factors were established from four domains: quality output, knowledge, and problem solving and job attitude. (Safayeni, Duimering, Zheng, Derbentseva, Poile, & Ran, 2008).

Results

Figure 2 shows the summary of desired and distractive factors of RE as perceived by other stakeholders. In total, 42 desired and distractive requirements were identified and percentage of response, computed as relative importance. RE identify problem solving as most important and quality output as least important. Knowledge and job attitude were of equal importance. The difference between the percentage of desired and distractive factor in a category gives an indication of the relative effectiveness of RE's performance in that category. RE's major strength were problem solving, knowledge and job attitude. Their major weakness was quality output.

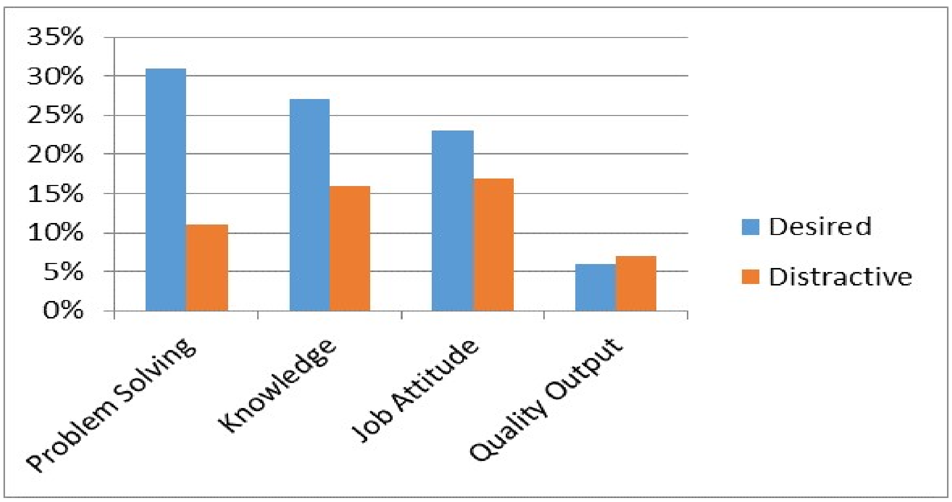

Figure 2: RE desired and distractive factors as perceived by other stakeholders

Figure 3 shows the summary of desired and distractive factors as perceived by RE. 38 factors were identified. Problem solving was considered most important and quality output least. Knowledge ranked second order of importance. Quality output recorded the weakest factor.

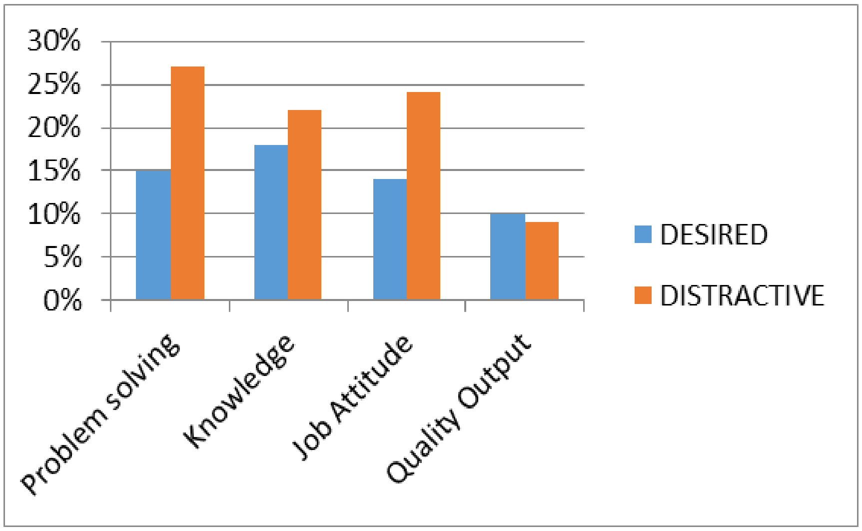

Figure 3: Stakeholders desired and distractive factors as perceived by RE

One striking difference between Figure 2 and Figure 3 was asymmetry in perceptions between RE and stakeholders. Requirements engineering (RE) was perceived by others as strong in all categories except for a slight weakness in quality output, whereas RE viewed other roles as weak in all categories except quality output. It is suggestive that the disparity arose partly due to other stakeholders generate uncertainty for RE through ambiguous requirements as well as its ability to manage this uncertainty.

Effectiveness of Interactions. The ratio of the number of desired to distractive factors provides an indication of the relative interaction effectiveness between the designers and farmers. The value chain mean was estimated 0.78, computed as the ratio of the total number of desired to distractive factors. The outflow and inflow is shown on Table 1 on the next page.

Table 1: Interaction Effectiveness Ratio between RE and other stakeholders.

Outflow	Interaction Effectiveness Ratio	In flow	Interaction Effectiveness Ratio
RE→ DE	1.89	DE → RE	0.67
RE→ PE	1.45	PE→ RE	0.58
RE→ F	1.56	F→ RE	0.72
RE→ O	0.51	O→ RE	0.45
RE→ C	1.26	C→ RE	0.56

The range of interaction effectiveness ratio from 0.45 to 1.89, reflects variability in the relationships between RE and other stakeholders in the value chain. Both outflow and inflow between RE and quality output (O) is relatively weak, indicating least effective relationship.

Conclusion

40-50 percent of cassava could be saved from post- harvest physiological deterioration (PPD) through processing. While other methods have been mechanized, appropriate mechanism that shreds cassava just like manual operation has not been developed. Thus, development of mechanized of cassava shredder has remained in infancy, making the demand for cassava shreds unmet.

References

1. FAO. (2019). Curbing Losses in the food value chain in Africa. Retrieved from https://techcabal.com/2019/04/29/curbing-losses-in-the-food-value-chain-in-africa on 25/03/2023.
2. FAO. (2018). FAOSTAT Database. Rome: Food and Agriculture Organization of the United Nations (FAO). http://www.fao.org/faostat/.
3. Fermont, A.M., van Asten, P.J.A., Tittonell, P., van Wijk, M.T., and Giller, K.E. (2009). Closing the cassava yield gap: an analysis from smallholder farms in East Africa. Field Crops Res. (112) pp24–36.

4. Jarvis, A., Ramirez-Villegas, J., Campo, B.V.H., Navarro-Racines, C. (2012). Is cassava the answer to African climate change adaptation? Tropical Plant Biology. (5) pp9–29.
5. Kintché, K., Hauser, S., Mahungu, N.M., Ndonda, A., Lukombo, S., Nhamo, N. (2017). Cassava yield loss in farmer fields was mainly caused by low soil fertility and suboptimal management practices in two provinces of the Democratic Republic of Congo. Eur J Agron. 2017(89) pp 7–23.
6. QSR International Pty Ltd. QSR N6. (2002)
7. Reynolds, T.W., Waddington, S.R., Anderson, C.L., Chew, A., True, Z., and Cullen, A. (2015). Environmental impacts and constraints associated with the production of major food crops in Sub-Saharan Africa and South Asia. Food Secure. (7) pp795–822.
8. Robertson, S. (2002). Learning from other disciplines. IEEE Software. Vol.22 (3) pp. 54–56.
9. Safayeni, F., Duimering, R., Zheng, K., Derbentseva, N., Poile, C., and Ran, B. (2008). Requirements Engineeering in New Product Development. Journ. Communications of the ACM. DOI: 10.1145/1325555.1325570.
10. Shackelford, G.E., Steward, P.R., German, R.N., Sait, S.M., and Benton, T.G. (2015). Conservation planning in agricultural landscapes: hotspots of conflict between agriculture and nature. Divers Distrib. (21) pp357–67.
11. UN. (2017). World Population Prospects: The 2017 Revision, Key Findings and Advance Tables. New York: Department of Economic and Social Affairs (DESA) of the United Nations (UN), Population Division.
12. UN. (2020). Take Action for the Sustainable Development Goals. Retrieved fromhttps://www.un.org/sustainabledevelopment/sustainable-developmentgoals/on