Diffusion Modeling: A Study of the Diffusion of "Jatropha Curcas" Based Diesel Oil (Jacodiesel) in Adamawa State

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Abstract

Diffusion of innovation is a versatile social science theory which typically represents an interface of communication and change. Its goal is to attempt to understand the range of influences to which consumers of new ideas, products, or systems are exposed to at a given point in time in a given social environment. The present study analyzed the communicative influence as they relate to a specific innovation; the *Jatropha Curcas* based diesel oil (Jacodiesel) in the context of a specific social environment. It relied on qualitative methodologies of participant observation and focused on 210 interactions over a period of six weeks in the study area of Yola, Jimeta and Numa. Jacodiesel is one of the products developed under the sustainability programme at the American University of Nigeria. The study was aimed at contributing to the development of a generalized model for predicting the diffusion pathways for AUN's sustainable products, as well as providing a platform for empirical testing of the diffusion paradigm in a local community. The findings from the study affirmed the efficacy of the Diffusion of Innovation in modelling the communication influence of the innovation studied. The diffusion process should cater for the peculiar needs and characteristics of the people it is intended to serve strictly following the diffusion pathways and using adequate change agents. Consequently, the study recommended the use of diffusion networks which integrate interpersonal networks, and multimedia strategies for the

effective diffusion of innovation such as Jacodiesel in Adamawa State and other parts of the country.

Keywords: Sustainability, Diffusion, Innovation, Communicative influence, Multi-media and communication

Introduction

Adamawa state is home to several plants that have been shaped by extreme weather conditions. It is tagged the land of beauty and characterized by several rivers as well as boasts of a rich blend of savannah and desert vegetation. This has helped to define the plants that grow and survive all year round. One of such plants is the *Jatropha Curcas* which the American University of Nigeria (AUN) had identified to be of great economical value beyond its current use of curtailing desertification. This identification led to the Jatropha - Biodiesel project which is part of the several sustainability initiatives of the institution that are born out of "an empirical planning process directed at optimizing resource usage, minimizing environmental impact, curtailing health-reducing pollution and creating sustainable livelihood" (Che et al 2014). The project involved the extraction of diesel oil from the plants for domestic use by the inhabitants to better their economic standing.

Jatropha is a hardy tree shrub capable of growing in unfertile soils, as well as being able to capture atmospheric carbon, one of the main green-house gases that cause global warming. It's potential to be used as biofuel, herbal remedy, fencing, raw materials for the soap industry and carbon sequestration, make it especially interesting in solving some pressing environmental challenges facing the environment. Sensitization efforts had been embarked upon to help cultivate more abandoned land for the production of Jatropha. This is intended to achieve the overall goal of producing the Jacodiesel. Besides, the inhabitants had been encouraged to adopt this cost effective innovation instead of the hitherto unavailable and expensive diesel from the Petrochemical industries. As an innovation, the productive engagement of the stakeholders is important and therefore the need to critically examine the diffusion process in relation to each innovation became a *desideratum*.

The purpose of this study therefore was to determine the communicative processes in the context of the diffusion of Jacodiesel, and, at the same time, explicate the key diffusion concepts based on the classical diffusion parameters of Rogers (1995) as they all relate to the sustainability programme at AUN. Explicating the diffusion concepts in the context of the

present study simply means critically observing adopter categories related to the diffusion pathway, as well as analyzing the perception of potential adopters regarding process based and communication based characteristics of innovation in question. This becomes instructive as a result of the seemingly important issues occasioned by high concentration as well as low concentration in the spread of knowledge

Research questions

The primary research questions of the study were: What is the perception of subjects towards JACODIESEL innovation based on: *Compatibility value; Relative Advantage, Complexity of Use, Trialability and Observability;* How significant is subjects' perception of the communication mediated components leading to *Knowledge, Persuasion, Decision, Implementation and Confirmation;* To what significant extent does communication processes, modes/media influence subjects' perception and adoption or non-adoption of JACODIESEL innovation?

Literature review

The suspicion and skepticism commonly associated with most innovations is a primary obstacle to adoption. Potential adopters maintain the right to know the advantages and disadvantages of new products compared to existing ones. They also want to have adequate information regarding cost – effectiveness, steady source of supply, possible health hazards and so on. Difussionists agree that the extent to which the innovator is willing to engage directly with the implementation process is an effective strategy for dispelling suspicious and skepticism among potential users. In rural communities, Renana, Eitan and Vijay (2010) found that the fears associated with the on-set of profit driven innovations are different from those associated with humanitarian driven innovations. For example, in the case of Jacodiesel, potential adopters naturally possess the quest to know if the innovator/producer would be directly involved in the business of marketing the products through organized outlets as is the case with NNPC down-stream sector. Viewed in the context of diffusion theory, the import of their quest lies in the need for the innovator/producer to spearhead the trialability stage of the innovation.

Social scientists concerned with traditional diffusion modeling concepts have identified the key communicative processes in the diffusion of innovation to include word-of-mouth, social signals and network externalities. Thus over the years, diffusion modeling has developed as a special field of communication that seeks to map out the path for spreading

new ideas and products with a high degree of success or adoption. Spearheading the trialability stage will minimize the diffusion lag commonly occasioned by potential users' wait-and-see syndrome which could be detrimental to adoption. Thus, as a result of the direct relevance of the programme to the community, a unique diffusion model will gradually evolve through the principle of reinvention; which is the necessity for products to be continuously adapted, pushing the rate of adoption rapidly toward the critical mass. The diffusion model in AUN is gradually evolving through a carefully planned and integrated sustainability driven student initiatives (Che et al, 2014). The essential structure of the diffusion model is described in table 1.

Table 1: The structural synopses of diffusion of innovation model

Stages	Diffusion Event
Stage 1: selection of diffusion assistants	Students who are interested in participating in community development projects are guided by diffusionists to formulate concepts related to the innovation. Such concepts include entrepreneurship, business, ethics, corporate social responsibility, communication and community mobilization.
Stage 2: identify the innovation	The diffusionists identify the specific innovation (JACODIESEL) as the platform for reaching out to the community. This stage requires that diffusion agents and assistants are comprehensively briefed on the characteristics of the innovation, the characteristics of potential adopters as well as consumer behavior
Stage 3: collaboration	Undergraduate students (acting as diffusion agents and assistants) begin to identify and collaborate with community leaders and NGOs with a view to developing potentially viable economic scenarios related to the innovation. All scenarios must be adjudged by members of the community to be sustainable livelihoods.
Stage 4: promotion of perceived benefits	Multimedia package including print, electronic and interpersonal contact are developed and used to promote the perceived benefits of the innovation which should include job creation, prosperity, education and enhanced livelihoods.
Stage 5: analysis of diffusion lag	Diffusionists begin to identify and analyze potential sources of diffusion with a view to designing communication strategies to mitigate possible effects.
Stage 6; branding and franchise	Based on the successful outcome in stage 1-5 the innovator/producer creates advertising and PR strategies to brand and legitimize the product as a franchise. Strategies for effective distribution and marketing of the new products are also conceptualized at this stage.
Stage 7: reinvention	Diffussionists and product developers collect and analyze diffusion data to evaluate the overall performance of the innovation in terms of rate of adoption, percentages of adopter categories and consumer feed-back which will serve as input into the reinvention process.

Diffusion of innovation theory, communication and multimedia design

Diffusion of innovation theory emerged as a major communication theory in the 21st century due to its ubiquitous role in an increasingly multidisciplinary world rate. In contemporary world, successful

innovations rely heavily on the, conventional mass media, the new media (multimedia/multi modal platforms) and indigenous/traditional media and channels as well as mediated and non-mediated interpersonal channels. An analysis of the Jacodiesel diffusion stages in relation to mediated events suggests that different stages of implementation would require the use of various channels of communication. It is acknowledged that promoting sustainable diffusion of innovations as well as the acceleration of adoption processes in general is enhanced through careful selection of corresponding mediated events as shown in table 2.

Table 2: Diffusion stages and the corresponding mediated events

Diffusion stage	Mediated event	Objective
Knowledge	The **mass media and interpersonal** channels should be employed not only to establish the legitimacy of the innovation in the mind of potential users but also to develop a yearning for change on their part.	Develop a synergy between charge aids and opinion leaders to enhance the credibility of the innovation.
Persuasion	The **design of media** messages is focused on the persuasion of potential adopters. The socio-political, economic and psychological problems militating against adoption are diagnosed.	Developing favorable attitudes in the community toward the product. Building adopter confidence through sustained interpersonal contact.
Decision	The **mass media** are used to promote the benefits of the innovation in a sustained manner, while interpersonal channels are used to monitor opinion leaders, and followers with a view to influencing them positively.	Sustaining persuasive messages to ensure that adoption is permanent and not discontinued.
Implementation	Intensive **use of interpersonal channels** is required to provide credible practical support to adopters. Create effective branding and advertising strategies using radio, TVs, drama.	Provide users motivation, more product information and professional instructional support for effective implementation.
Confirmation	**Interpersonal channels are combined with documentaries and vox pops** are employed to provide an opportunity where first hand users share their experiences for the benefit of the late majority and laggards. The product should also be promoted through social media	Promote self-reliance through the use of the product

From the economic perspective, the diffusion process is conceptualized as product growth or market penetration of new products and services that is driven by social influences as well as functional data analysis (Sood, James and Tellis, 2009). Jacodiesel is viewed as a new product which must find its own market penetration in competition with existing NNPC products which have almost attained 100% penetration in the Nigerian market. The need to combine the popularly used diffusion modelling methods with the Classical Bass Market Penetration model as reviewed by several scholars to strengthen the diffusion of innovation at AUN therefore becomes necessary. The Bass model is valuable as it provides a useful media and economic interface for the analysis of both the communicative influences (social interaction, mass media and advertising) and economic influences (consumer interaction, growth, and market penetration) as they relate to adoption.

Theoretical framework

The main thrust of the Diffusion of Innovation (DoI) theory has remained constant over the last five decades. It is simply a structured social communication process designed to accelerate the adoption of new ideas and products in a given socio cultural milieu. It involves careful analysis of the critical communicative mechanisms for adoption. Rogers Everett (1995) is often credited with the historical development of the diffusion theory due to his seminal works spanning through five decades, focusing on the diffusion paradigm for effective interdisciplinary application in the fields of Communication and multimedia, Education, Agriculture, Sociology, ICT, Marketing, Advertising and Public Relations, and Medicine.

Specifically, DoI theory conceptualizes diffusion as a communication process by which innovations pass through social and interpersonal channels over time. Thus, from the stand point of communication theory, in every successful innovation must run a thread of sustainability, describable on a certain continuum ranging from *high* to *low*. Diffusion modelling is synonymous with the prediction of the spread of innovations from the standpoint of the communicator as well as the adopter (Rishante and Saasongo (2006); Sood, James and Tellis, 2009; Rishante, Obono and Idu, (2010).

For technology based innovations such as "Jacodiesel", diffusion modelling is akin to product growth modeling where the primary purpose

is to guide the innovation in such a manner as to modify it in an on-going fashion to meet the needs of adopters, rather than imposing the prototype design on them. Diffusion of Innovation theory typically describes four critical stages through which an innovation must systematically pass through to gain acceptance. The stages are "knowledge", "persuasion", "decision", "implementation" and "confirmation" (Clarke, 1999). These attributes describe the pathway which must be integrated into diffusion models for optimum adoption. An analysis of the communication and diffusion pathway in the context of Jacodiesel is shown on table 4.

Additionally, DoI theory requires an understanding of the characteristics of an innovation which must be taken into account for effective diffusion modeling. The characteristics of the innovation are its "relative advantage", "compatibility", "complexity" "trialability" and observability (Rogers, 1995). An analysis of the perceived characteristics of the Jacodiesel is shown on table 2.

Methodology

Given the exploratory nature of this study, a qualitative approach was adopted as against a quantitative approach that would simply aggregate figures. The qualitative approach serves the need of the study especially when the respondents are not comfortable with the English language, their educational status and the apathy they are likely to express towards an academic enquiry that involves filling out questionnaire. Primary and secondary data were collected using the participant observational approach commonly employed by communication and diffusion researchers (Wimmer and Dominick, 2000).

The purposive sampling technique was used on the population of residents in the three strategically located suburbs of Yola, Jimeta and Numan. In each of these towns, a filling station was selected as the base for the participant observation. Through active participation in the research setting over a period of six weeks, the explicit and non-explicit predisposition of potential consumers of Jacodiesel were assessed in the natural settings where the behaviours and phenomena of interest occurred with sufficient frequency to make the observation worthwhile. Diffusion assistants were given a set of questions related to the diffusion of Jacodiesel to stimulate verbal responses from customers while the researchers unobtrusively listened and observed their interactions. Thus, both

assistants and customers constituted the sources of vital information used by the investigator to explain the adoption of Jacodiesel. In all, 210 interactions were conducted at an average of 5 per day. The observations are ranked as **high** when it scored between 81 – 100%; **medium** when it is 60 – 80% and when it is below 60%, it is ranked **low**. The observation schedule was designed and validated along Rogers (2005) and Clarke (1999) parameters.

Results and discussion

The Yola community where the Jacodiesel was pilot tested is a homogeneous society where people generally respect social status. The present study has shown that in such societies, the spread of diffusion is rapidly driven by group identity despite the security challenges which engulfed the North-East Sub-region of Nigeria due to the *Boko Haram* insurgency. The conduct of the field work in the present study supports the claim that diffusion work is of least danger when compared to other work such as aid worker in insurgent areas; thus diffusion could serve as means of counterinsurgency as well as minimize the incidence of "bunkarisation". "Bunkarisation" is defined as the phenomenon whereby aid workers, journalists and diffusionists operating in hostile crises zones in developing countries are forced to detach themselves from the community and attempting to manage their activities from a safe distance using intermediaries and media technology (Duffield, 2014).

On the contrary, the present study has shown that communities have friendly disposition towards diffusion work. This favourable atmosphere has given rise to an effective diffusion methodology involving direct engagement for the purpose of rigorously planting and monitoring the diffusion processes for all sustainable products in the region. Presently, the AUN environment also engenders positive innovative behaviour at the individual level with undergraduate students participating actively as diffusion assistants in community development projects.

An analysis of the perceived characteristics of Jacodiesel as well as the internalized communication and diffusion pathway is shown in tables 3 and 4.

Table 3: An analysis of perceived characteristics (Adapted from Rogers (2005) of Jacodiesel

		Perceptions		
Characteristics	**Operational definition**	**High** 81-100	**Medium** 60-80	**Low** Below 60%
Relative advantage	The extent to which individuals agree that the quality of Jacodiesel would be equal or superior to existing product.	0	X	0
Compatibility	The extent to which potential users agree that Jacodiesel is valuable and meets their needs	X	0	0
Complexity/simplicity	The extent to which users agree that Jacodiesel could be easily adopted and used	X	0	0
Trialability	The extent of readiness on the part of users to try Jacodiesel almost immediately it is available	X	0	0
Observability	The extent to which users anticipate positive results after the first trial	0	X	0

An analysis of perceived characteristics of the innovation with respect to jacodiesel

The table above suggests a high perceptual frame in line with the thrust of the research question on the perception of the respondents towards Jacodiesel innovation. Based on the perceived characteristics of the innovation process, respondents were observed and their perception

ranked along the continuum of low, medium and high. Taking each of the characteristics one by one, the study recorded a median perception mark for the extent to which individuals agree that the quality of the innovation would be equal or surpass the existing product. The relative advantage was not well diffused to the beneficiaries and this is not unconnected with the manner in which communications are designed and managed. This equally indicates that a strong point of actually getting people along with the innovation is that the relative benefit of the innovation in relation to the existing usage must be clearly explained within the context of the recipient usage and not in exclusion to some external parameters. Consequently, within the frame of this study, Jacodiesel, the diffusion agent properly undermined the need to educate them on the attendant advantages that include steady fuel in case of scarcity, saving extra cash that would have gone to the purchase of diesel and the likes.

However, for the other issue of the extent to which users anticipate positive results after the first trial, the score was equally medium which tallies with the rating for relative advantage. A high rating for relative advantage would have equally generated a corresponding high rating for extent of observability. The issues of compatibility, complexity/simplicity and trialability all recorded high perceptions. Consequently, the study can assert that the perception of the respondents towards Jacodiesel is high.

Table 4: Internalized communication and diffusion pathways adapted from Clarke (1999)

Operational definition	**High** 81-100	**Medium** 60-70	**Low** Below 60%
The extent to which people know about the existence and performance of Jacodiesel	X		
The extent to which people are favorably disposed toward Jacodiesel	X		
The probability of a strong commitment to its adoption to contain diffusion lag		X	
Practically putting the new product to use			X
Affirmation of commitment by potential users to sustain the use of the new product provided the quality is maintained	X		

Internalized Communication and Diffusion Pathways with respect to Jacodiesel

The significance of the subjects' perception of the communication mediated components leading through the pathways is not as strong as intended. The diffusion pathways have been argued to provide component steps towards adequate diffusion of the innovation. For instance, the extent to which people had requisite knowledge about the performance and existence of Jacodiesel is rated high to the extent that not all the diffusion characteristics were made known to them. High perceptual frame was equally recorded for the extent to which they are favourably disposed to be persuaded as well as affirmation of commitment or confirmation by potential users to sustain the use of the new product provided the quality is maintained.

However, the respondents' perception on decision taking and implementation had some snags. Perception on the probability of a strong commitment to its adoption to contain diffusion lag is rated medium. This is not surprising as the extent of attention to effectively attend to the diffusion characteristics is maintained which will help mitigate and narrow the diffusion lag. Diffusion lag can cause huge knowledge gap and render the development communication initiative ineffectual. Again, the responses were low on perception as it affects putting the new innovation to use. This is despite their intention to allow for trialabilty.

Reasons that could account for some of the snags in the diffusion pathways as perceived by the respondents will include the kind of innovation and the need that the innovation will serve for the people. Borrowing from the work from Rogers (2005) and the distribution of how people adapt to innovation, we will discover that with a product such as Jacodiesel, there is likely to be very little percentage for early innovators and more percentage of laggards. Early and late majority will equally experience significant percentile representations in relation to early adopters. Innovation in terms of food, clothing and ready source of income to boost the revenue profile of the people in the studied area is most likely to generate a high perceptual rate of 'decision' and 'implementation'.

For the last research question on the extent of communication processes, modes/media influence perception and adoption or non-adoption of the Jacodiesel innovation, the table below presents an analysis.

Table 5: An analysis of media platforms of innovation diffusion with respect to Jacodiesel

Operational definition	High 81-100	Medium 60-70	Low Below 60%
The extent to which people favorably disposed to knowing and acting on the existence and performance of Jacodiesel through Radio, Television, Newspapers, Magazines, Films/ Cinema	0	X	0
The extent to which people are favorably disposed to knowing and acting toward Jacodiesel innovation through Phones, internet, iPad, iPod, androids, branded apps	X	0	0
The extent to which people favorably disposed to knowing and acting on the existence and performance of Jacodiesel through idiophones, membranophones, Aerophones, Chordophones, symbolographic platforms of communications in communities.	X	0	0
The extent to which people favorably disposed to knowing and acting on the existence and performance of Jacodiesel through age grade for, gender groupings, religious groups, economic associations, etc	X	0	0

Statistically using the communication modes categorization above of mass media, new media, traditional media and interpersonal channels which were all documented in Rogers (2005) as effective media for innovation diffusing, one can conclude that communication when effectively used, can significantly influence the diffusion process. Based on the characteristic of the population of the study, the mass media is perceived as having medium ratings for the diffusion of Jacodiesel innovation. While one will contend that radio would have a high perceptual frame, the fact that it was grouped along the orders of television and newspaper will help reduce the impact factor of the perceptual responses. For the other categorizations, the perceptual responses are 'high' suggesting that the communication modes agree with the needs of the people in question. The extensive use of mobile internet and other forms of mobile media has equally meant that people are having access to the

deployment of new media irrespective of place and economic status. A scholar once posit that information posted on social websites have the capacity to reach a large number of persons at the same time and create even greater dysfunctions than the conventional mass media citing the Arab uprising and terror plots as instances (Dominick, 2012).

Traditional media will always hold sway, but there should be a conscious synergizing with new media to ensure greater efficiency especially with the kind of empathy and aliterate lives of youths today. For Jacodiesel, the repertoires of media platforms for innovation diffusion are rich and helped in the overall diffusion objectives.

Conclusion

The raw data for communication process is information. As a basic human survival skill, communication not only projects but impacts and reflects all aspects of human development (Akpan, 2004). This study has so far shown the efficacy of diffusion of Information model in framing the communication influence that results in peoples: 1) decision to know of Jacodiesel initiative; 2) acceptance to create a communication climate favorable to accepting and positively considering the patronage of the innovation and; 3) projective commitment to patronize the use of the innovation, subject to the promise of consistent quality maintenance.

Respondents, however, *lagged* on their readiness to put the innovative product to use. Their reasons in this circumstance, may not be unconnected with their perceived 'median' perception of the *relative advantage* and *observability* value of the innovation , even in the face of a 'high' level of perception of the *compatibility, complexity/simplicity* and *trialability* value of the innovation. In sum, it is safe to conclude that Diffusion of Innovation model efficacy in framing and tracking the communicative influence of Jacodiesel innovation is significantly compelling and valued.

Thus, if the diffusion of innovation model has helped the cause of development and change through appropriate communication, and the Jatropha Curcas is a success, then there is the need to replicate the ideas to all so as to entrench sustainable development. The basis for replication is however founded on the prioritizing of the communication matter to reflect the very exigencies of the peoples' environment as well as their succinct

needs. Anything short of these will result in knowledge gap and negatively impact the development processes the whole design is intended to facilitate.

Recommendations

1. Communication patterns in Adamawa State are becoming increasingly dynamic as a result of the rapid growth in the use of mobile phones, social media and on-line communication. This dynamism is likely to have profound influences on individual adoption decision making.
2. There is need to sustain and integrate diffusion interactions with the internal dynamics of the market through what has been described by diffusionists as 'amplified word of mouth" in which the speed of diffusion of new products such as Jacodiesel can be increased. It is expected that the new products, word of mouth or face to face communication will become more influential overtime than the mass media. Subsequently, interpersonal communication network should be combined with multimedia packages for effective advertising of the new product.
3. A system of active partnership with marketers needs to be developed with sustainability experts at AUN acting as product developers on a permanent and on-going basis. Such application of participative action research has been used in the field of ICT for effective modification of products based on face to face user inputs which are continuously taken into account by developers to ensure steady evolution. It should be noted that diffusion of innovation is a dynamic process which must continue throughout the life of a product.
4. Once Jacodiesel goes on large scale stream, the determination of the cumulative adoption rates of the product will require more systematic diffusion modeling. The systematic remodelling recommended by Sood, James and Tellis (2009) enables the innovator to accurately predict the success of the innovation based on:
    a) Critically defining the population of adopters
    b) Critically defining the time of adoption for each member
    c) Critically defining the total time period to be covered for the deployment of the product for optimum market penetration.

5. In a rival diffusion and sustainability theory, Eyong and Foy (2006) strongly advocate the 'revitalization of the traditional coping strategies for sustainable development in Africa". This paradigm suggests that sustainable development efforts in African communities such as Adamawa State should cater to the environmental good of the community which embodies their culture. This is to say that sustainability projects should be conceived to be substantially pro-poor in content.
6. Universities should integrate a development focus into their academic programmes, and encourage students to pursue "service learning" and participate in direct community development projects. A model could be the AUN students 'service learning" programme that is expedited but gradually, the expansion effort in scope and intensity almost paralleling the Madagascar Sustainable Development Project model (Happy Africa Foundation: *www.happyafricafoundation.org*). This type of model is designed to enable participants such as "service learning students" to get more deeply involved with community projects using the ethno methodological approach.

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