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Functioning of an Android app "TNAU Paddy Expert System" and its User's Feedback Sentiment Analysis

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ABSTRACT

TNAU paddy expert system app is a system that links people and institutions to promote mutual learning and utilize agriculture-related technologies, knowledge and information. The present study expounded the functions of an android app "TNAU paddy expert system", also it was intended to find out the nature of feedbacks provided by the TNAU paddy expert system app users and to foster the application more for effective usage through the feedbacks provided by the users. The feedback and ratings were collected from the TNAU Paddy expert system app (both in English and Tamil version) page in the open-source platform viz., Google play store, a total of 63 reviews and 109 users' ratings were collected from the application interface present in the Google play store to find out the nature of feedback and the level of satisfaction of the users. Sentiment analysis was carried out with the help of 'MS Excel 365' and 'azure machine learning' softwares. Then the data was also subjected to factor analysis with the help of Statistical Package for Social Sciences (SPSS) 16.0, to find out the major opinions that were expressed by the TNAU Paddy expert system app users. TNAU Paddy expert system app was the application of scientific research which imparts the scientifically proven paddy technologies and agricultural practices for the betterment of the farming community, that aids farmers to make right decisions at the needed time and through crop doctor component it helps them by protecting their crop and reducing the time and cost.

Key words: *TNAU Paddy Expert System; Android app; m-Agri application; Crop doctor; feedback sentimental analysis; Machine learning; User satisfaction (USAT) index.*

Information Communication Technologies (ICT's) have become the essential tool for agricultural, educational and socio-economic development in the current century (*Brown, 2002; Kozma, 2002; Goodison T, 2003; Kangro , 2004; Hennessy, 2005; Kennedy, 2008; Bank, 2011); Aravindh Kumar and Karthikeyan, 2019; and Malik, 2021*). FAO in 2019 brought out, though the rapid diffusion of ICT created new opportunities for agricultural stakeholders to improve their knowledge (*Asongu, 2015)* and livelihoods (*Aker & Mibiti, 2010*), agricultural stakeholders conflicting perceptions (*Fuess, 2011*) and lack of capacity (*Newburry, 2014*) in using ICT in extension programmes turned out to be a robust barrier. According to Forbes, every day 2.5 quintillion bytes of data had been consumed by the world population (*Marr, 2018*), internet usage had become an integral part of daily life. Day after day in the field of agriculture, intensity of knowledge keeps on increasing and the farmers were becoming knowledge thirsty, they look for new agricultural information in every aspect, today a farmer has to take various decisions on a regular basis to make their livelihood sustained. Farmer need a supporting hand and an expert help for taking those management decisions regarding weather, soil, nursery, plant protection, plant production, weed, marketing, finance/loan and government subsidies. An expert system is defined as "a computer program designed to model the problem-solving ability of a human expert" (*Durkin, 1994*). An Expert System

(ES), also called a Knowledge Based System (KBS), is a computer program designed to simulate the problem-solving behavior of an expert in a narrow domain or discipline. Expert System was the product of ICT, uses a hierarchical classification and a mix of the text description; photographs and artistic pictures. The system involves two main sub tasks, namely diagnosis and management. The system designed and developed using visual basic as front-end and Microsoft Access as back-end software (*Vinod Kumar, 2008*). Agricultural Expert system was a human-computer intervention that majorly used to provide agricultural information and diagnostic solutions to the problems that ordinarily needs human intelligence. Present generation converts the web-based programmes in the form of mobile applications, because this era of information technology handed over a pocket dynamo called smart phones to everyone which became an inseparable associate organ of human. TNAU paddy expert system app is a system that links people and institutions to promote mutual learning and utilize agriculture-related technologies, knowledge and information. It had the capability to extract intelligence and support users to make evidence-based decisions firmly grounded on real-time, with reliable data and effective analytics. A user after getting experience, analyze and understand about the product or service, provide information about that product or service is known as Feedback (*Hattie, 2007; Hattie, 2009; Hattie, 2019; Thirakunkovit S, 2019; Wisniewski B, 2020; and Singh, 2021*). FAO reported in 2019 that in recent times, number of people using top social media platforms (*Varner, 2012*) like Facebook, WhatsApp, You Tube etc., especially in developing countries has started to climb up at a rapid rate by gathering 1 million new registered users daily i.e. an addition of 11 new users for every second. Even though the usage rate is quick-fire, it was difficult to get feedback from the farmers in any social media or in open source platforms due to various psychological concern because some farmers wanted to text something but after seeing peer feedback which conveyed what they intended to say, they drop down their decisions, whereas some have the fear regarding the grammatical issues, and some feels that their text would be judged by others and they could be humiliated (*Leki, 1994; Ferris, 2005; Hyland and Hyland, 2006; Evans et.al., 2010; Lee, 2011; Liu and Brown , 2015;* and *Matsuda, 2012*). With the advancement of agricultural sciences and technology, now ICT tools has step forward to become farmer's friend, relative and fellow farmer (*Aravindh Kumar and Karthikeyan, 2020*). The present study expounded the functions of an android app "TNAU paddy expert system", also it was intended to find out the nature of feedbacks provided by the TNAU paddy expert system app users and to foster the application more for effective usage through the feedbacks provided by the users.

Functioning of the TNAU Paddy Expert System app : The person who wants to utilize the TNAU Paddy expert system app first they have to download it directly by clicking on the below Google Playstore link *https://play.google.com/store/apps/details?id=com.cdac.tnau_paddy_eng&hl=en* or type TNAU Paddy expert system in Google play store and select "TNAU Paddy Expert System either English or Tamil version based on users preference of choice from the list of displayed results and then click install button to install TNAU Paddy expert system app, the time for installation of mobile application could be depended upon the mobile network speed and the mobile RAM and O/S. Once, the app was installed, after clicking the TNAU Paddy expert system icon a splash screen will be displayed after clicking the proceed button, the homepage of the app containing the decision support system, crop doctor, and information system appear.

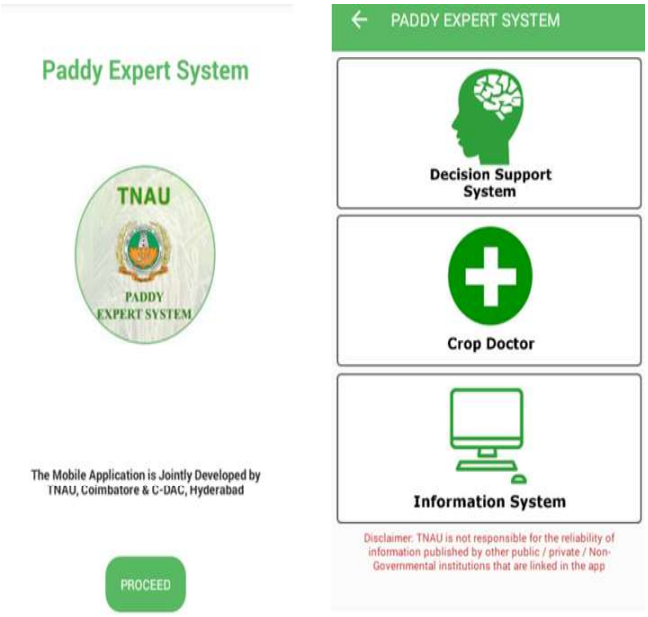

Fig. 1. Home page of TNAU paddy expert system app (English version)

If any user wanted to browse the contents of the decision support system, first they need to select the decision support system button and from the list of subtopics such as botany of the crop, season and varieties, climate, rice ecosystem, etc. related to paddy will be displayed for making a decision. Crop doctor could be accessed by clicking the crop doctor option, which would navigate to two options, paddy symptoms with secondary symptoms and paddy symptoms without secondary symptoms, once the above mentioned first option was selected it would direct towards a page in which primary symptoms that match user's field-level symptom will be displayed, if there exist any similarities, the user found in the displayed images they could click the image displayed, there would be a prompt with a message, "is this your symptom?" If a symptom is related to observed symptoms click on the 'yes' button else click on the 'no' button, on clicking secondary symptom, images related to the respective secondary symptom will be displayed. Select images that are related to the secondary symptom and click on the 'select' button (only 3 Images could be selected). On clicking the 'select' button it will prompt with a message, "is this your symptom?" If a symptom is related to observed secondary symptom click on the 'yes' button else click on the 'no' button, after selection of secondary symptoms click on the 'continue' button it would display the list of selected images, now click on 'diagnose' button list of disease(s) caused will be displayed. There will be a video section, in which users could view disease-related videos and disease management videos.

If there are no secondary symptoms, then the user needs to go for the second option, paddy symptoms without secondary symptoms to display the list of primary symptoms. Select images that are related to the primary symptom and click on the 'select' button. (Up to 3 Images could be selected), it would prompt with a message, "is this your symptom?" If a symptom is related to observed symptoms click on the 'yes' button, else click on the 'no' button. After selection of primary symptoms click on 'continue' button, on clicking 'continue' button it will display the list of selected images and then click on 'diagnose' button, list of disease(s) caused will be displayed, the user could select the symptoms, identification, and control measure to read its related content or video icons (bottom left icon and right icon) to view diseases related videos.

The information system could be explored by clicking the 'information system' button on the home page, a list of sub-topics related to paddy information systems such as botany and climate, crop protection, season and varieties, farm implements, rice ecosystem, and post-harvest technology will be displayed.

METHODOLOGY

The feedback and ratings were collected from the TNAU Paddy expert system app (both in English and Tamil version) page in the open-source platform

Fig. 2. Crop doctor page of TNAU paddy expert system app (English version)

Fig. 3. Information system page of TNAU paddy expert system app (English version)

Google play store, this android application is available in Google play store and public play store, so the person whoever resides in India, can download this application and use it, hence the study area for this research work open widely throughout India and the population of the study were the random persons who provided their feedback and ratings in the application interface present in the Google play store. A total of 63 reviews and 109 users' ratings were collected from the application interface present in the Google play store to find out the nature of feedback and the level of satisfaction of the users. Once, the process of data collection is done, then the process of data cleaning started to prepare the data for sentimental analysis (opinion mining). This will show the nature of the text either positive or negative or neutral. The range of the score exhibited by the azure machine learning software was used for analyzing the sentiment will lie between 0 and 1.

Sentiment	Sentiment Score
Positive	Closes to 1
Neutral	Circles around 0.5
Negative	Closes to 0

Most of the social media users prefer to use their mother language for expressing their thoughts, feelings, and sentiments, hence language identification needed to be certain, while doing sentimental analysis removal of emoticons, punctuations, hashtags, URLs, hyperlinks, multi-characters of the world plays, and repeated words were necessary to feed the data into computer for machine learning, it was done. After collecting and cleaning the data then the data had to be pre-processed, the pre-processing of data was carried out through the method of tokenization, it is the process of breaking down a word into small meaningful units known as tokens, so that computers can understand text into words (*Mittal, 2013*; and *Singh, 2021*). The reviews were written by expressing the Tamil meaning in the English language, without affecting the meaning of the feedback all the feedback were translated into the English language for feeding into the computer. The social media users have the habit of using abbreviations and acronyms more like pls. (please), f9 (fine), and G8 (Good), grt. (Great), asap (As soon as possible), etc., all those abbreviations and acronyms used in the feedback were expanded, after pre-processing the data, sentiment analysis was carried out with the help of MS Excel 365 and azure machine learning software. Then the data was also subjected to factor analysis with the help of Statistical Package for Social Sciences (SPSS) 16.0, to find out the major opinions that were expressed by the TNAU Paddy expert system app users. The collection of ratings aimed to find out the level of satisfaction gained by the app users, which was found using the user satisfaction (USAT) per cent,

$$\text{USAT index} = \frac{\text{STRRA}}{\text{STR}}$$

$$\text{USAT per cent} = \text{USAT index} \times 100\%$$

Where :

USAT = User satisfaction per cent

STRRA=Sum of the total number of ratings received actually

STR= Sum of the total number of ratings

RESULTS AND DISCUSSION

The result deciphered from the sentiment analysis performed through azure machine learning software showed from the Table 1 and 2 that the majority (57.14%) of the feedbacks sentiment outstretched by the users were positive in the face of shaping and appreciating the TNAU Paddy expert system app and their sentiment score was more than 0.6364, Feedback number 35 "*It was a really good app it can also be used in offline mode it made to me to take right decisions"*, turns to be the highly positive feedback received with the sentiment score (0.907944), this single feedback ensured how well this application had been effective in various dimensions like time-saving, cost-saving, low or no consumption of mobile data since it also could be accessed in offline mode for getting agricultural information, and nurturing the users to make right decisions. When the coin was flipped the other side showed the negative sentiment expressed by the users also, it was very few (04.77%) users exhibited their unhappiness yet it was very important to make the app

Table 1. Distribution of Feedbacks according to the sentiments expressed by the app users

Feedback type	No.	%
Positive (0.6364 -0.9079)	36	57.14
Neutral (0.4805 – 0.5543)	13	20.63
Negative (0.3210 – 0.4415)	03	04.77
Junk	11	17.46
Total	63	100.00

Table 2. Feedbacks (FNo.), Feedback sentiments, and its scores

FNo.	Feedback	Sentiment	Score
F1	Very good app for farmers cultivating paddy gives various options like organic and chemical-based control of insects and diseases	Positive	0.835643
F2	Fantastic application the diagnosis part should be really useful for farmers	Positive	0.793559
F3	Awesome very useful for paddy cultivation farmers excellent	Positive	0.812499
F5	Excellent	Positive	0.747275
F6	Make it in Kannada so it will help Karnataka farmers also	Positive	0.794757
F7	Very useful	Positive	0.694353
F8	No need for this app worst it takes a lot of time to enter	Negative	0.414578
F9	Best	Positive	0.798272
F10	Useful	Positive	0.758126
F11	Good	Positive	0.661100
F13	Super	Positive	0.794386
F14	This is the first useful app for Tamil farmers	Positive	0.724113
F15	Super	Positive	0.794386
F16	Most welcoming mobile application	Positive	0.761586
F18	Needed all the crops and their details in a single app	Positive	0.636400
F19	It is a good app for rice protection	Positive	0.719596
F20	Very useful to us	Positive	0.736610
F22	Very useful app	Positive	0.650098
F23	No brain in making app it is worst	Negative	0.441511
F24	Excellent app including the traditional way of controlling pest it will be even better if we would have included traditional paddy verities and their seasons	Positive	0.844601
F25	Too much size to download	Neutral	0.480533
F26	Need more nursery information about paddy crop	Neutral	0.492623
F27	Not get impressed with the content	Neutral	0.516955
F29	Bad app	Neutral	0.554347
F30	Bad	Neutral	0.514384
F31	Worst	Neutral	0.548166
F32	Good apps	Positive	0.711437
F33	Very bad	Neutral	0.486656
F34	Good	Positive	0.661100
F35	It was a really good app it can also be used in offline mode it made me take the right decisions	Positive	0.907944
F37	Useful app for agri	Positive	0.677329
F38	Wonderful application for farmers	Positive	0.668738
F39	Good	Positive	0.661100
F40	Very super thanks for the information	Positive	0.747275
F41	Need more improvisation and updation	Neutral	0.530954
F42	Excellent	Positive	0.747275
F43	Best way to provide agricultural information	Positive	0.742896
F45	Not that useful	Neutral	0.532556
F46	Great work	Positive	0.803715
F47	Useful app	Positive	0.653715
F49	Good initiative it can be made as Facebook and WhatsApp like	Positive	0.794739
F50	Good	Positive	0.661100
F51	Useful app	Positive	0.653715
F52	Very good but I expect some video content	Positive	0.795281
F53	A lot of spelling mistakes in the description	Neutral	0.480533
F55	The crop doctor was not working properly total disappointing waste of time	Negative	0.321086
F56	Need more updation	Neutral	0.492623
F57	Very little content about organic cultivation	Neutral	0.516955
F59	Marketing details can also be added to this application	Neutral	0.554347
F60	Good	Positive	0.661100
F61	Excellent and time-saving application	Positive	0.641300
F62	The way the app delivered the information was Good	Positive	0.754931
	Mean of the sentiment scores		0.661170*

more effective in the future, in considering the sentiment score (0.321086), feedback number F55 "*Crop doctor was not working properly total disappointment waste of time*", seizures to be the highly negative feedback delivered by the user, the essence of this statement showed that the user was disgruntled with the crop doctor section of TNAU Paddy Expert system application, the way it took time to generate a result for him was the main reason for providing feedback like this. This feedback should not be considered as light in nature, there must be sufficient action needed to be taken for providing the results quicker. There was 20.63 per cent of the sentiment remained to be neutral, this neutral sentiment was also vital because, in the long run of usage of this application the neutral mind setter can shift their direction either to positive or negative if there is no regular updation and new agricultural information about paddy cultivation the neutral persons could lean towards the negative side which would drastically reduce the user satisfaction (USAT) index in turn that increases the negative feedback, that would decrease the star rating of this application in Google play store which ultimately interrupts the enrolment of new users and withdrawal of old users of this application. The mean of the sentiment score was 0.661170 it was evident that the majority of users' sentiment windfall towards positive in nature. There was 17.46 per cent of the users' feedback remained as junk statements (incomplete, not meaningful, and inappropriate) which were not used for calculating sentiment analysis.

Table 3. Distribution of opinions expressed by the TNAU Paddy expert system app users

Opinions	Eigen-values	% of variance	Cumulative %
Opinion - I	4.280	25.814	25.814
Opinion - II	3.172	21.677	47.491
Opinion - III	2.551	18.439	65.930
Opinion - IV	1.102	14.943	80.873

Opinion-I : From Table 3, Sixteen instituting statements of the opinion-I in order of the factor loadings were: Very good app for farmers cultivating paddy gives various options like organic and chemical-based control of insects and diseases (F1), Fantastic application the diagnosis part should be really useful for farmers (F2), Best (F9), Super (F13), Super (F15), Most welcoming mobile application (F16), Good apps (F32), It was a really good app it can also be used in offline mode it made to me to take right decisions (F35), Wonderful application for farmers (F38), Very super thanks for the information (F40), Excellent (F42), the Best way to provide agricultural information (F43), Not that much useful in marketing (F45), Good (F50), Excellent and time-saving application (F61), and The way the app delivered the information was good (F62). According to the nature of the feedbacks which pooled and created the opinion-I was named as "Proficient feedback". In concerning the highest eigenvalues of this opinion (eigenvalue 4.280 and variance 25.814 %), it deliberately shows that majority of the users provided the feedback based on their experience with the usage of the TNAU paddy expert system app.

Opinion -II : Fifteen consecutive statements of the opinion- II in order of the factor loadings were: Awesome very useful for paddy cultivation farmers excellent (F3), Make it in Kannada so it will help to Karnataka farmers also (F6), Needed all the crops and its details in a single app (F18), Excellent app including the traditional way of controlling pest it will be even better if we would have included traditional paddy verities and their seasons (F24), Need more nursery information about paddy crop (F26), Good (F39), Great work (F46), Useful app (F47), Good initiative it can be made as Facebook and WhatsApp like (F49), Very good but I expect some video content (F52), Lot of spelling mistakes in description (F53), Need more updation (F56), Marketing details can also be added with this application (F59), and Good (F60),. According to the oddity of the feedbacks which grouped and formed the opinion-II was named as "Constructive feedback". The eigenvalue 3.172 and variance 21.677% showed that next to proficient major number of feedbacks provided by the TNAU paddy expert system app users boned to be a tower builder for the development of TNAU paddy expert system app.

Opinion-III: Fourteen progressing statements of the opinion-III in order of the factor loadings were: Excellent (F5), Very useful (F7), Useful (F10), Good (F11), This is the first useful app for Tamil farmers (F14), It is a good app to rice protection (F19), Very useful to us (F20), Very useful app (F22), Bad (F30), Good (F34), Useful app for agri (F37), Useful app (F51). According to the feature of the feedbacks which created the opinion-III had 2.551 eigenvalues and 18.439 per

cent of the variance in that most of the feedbacks were on the usage of TNAU paddy expert system app, hence opinion-III was named as "Utilitarian feedback".

Opinion -IV : Ten constituting statements of the opinion-IV in order of the factor loadings were: No need for this app worst it takes a lot of time to enter (F8), No brain in making app it is worst (F23), Too much size to download (F25), Not got impressed with the content (F27), Bad app (F29), worst (F31) and very bad (F33), Need more improvisation and updation (F41), Crop doctor was not working properly total disappointment waste of time (F55), Very few contents about organic cultivation (F57), According to the features of the feedbacks which made the opinion-IV was named as "Destructive feedback". This destructive feedback with 1.102 eigenvalues constitute 14.943 per cent of variance, was the least provided opinions by the TNAU expert system app users.

Table 4. Distribution of TNAU paddy expert system app users according to the ratings they provided for this app.

Rating	No.	%
5	78	71.55
4	22	20.19
3	04	03.68
2	00	00.00
1	05	04.49
Total	109	100.00
User Satisfaction (USAT) index		0.9082
USAT per cent		90.82%

Totally out of 63 feedbacks, 52 feedbacks were grouped as four opinions constituted about 80.873 per cent of contributions and the rest 19.127 per cent were from the junk feedbacks. The remaining 11 feedbacks were considered as junk not grouped in any opinions. These opinions cannot be used to update or develop the TNAU Paddy expert system app in any case.

Regarding Table 4 majority (71.55%) of the users gave a five-star rating to the TNAU Paddy expert system app, which showed that a great number of users had been very well satisfied with the contents and results offered by this application. More than one-fifth (20.19%) of the users catered four-star rating to the application, this overwhelming percentage of five and four-star ratings also denoted that the decisions regarding agricultural activities performed in paddy cultivation had been taken with the help of this app by the users had delivered satisfying results. The crop doctor section was the highly utilized section by the farmers, to know what the disease was or pest attacked their field and what were the remedies for that, this TNAU Paddy expert system app appeared as a time and cost-saving tool for the farmers. Very few users (04.49% and 03.68%) bestowed one-star and three-star ratings to the TNAU Paddy expert system app, this shows less than 10 percent of the users had been dissatisfied with the results, contents, and decisions bequeathed by the mobile app, the USAT index also proved this result by indicating 90.82 per cent of the users were highly satisfied and the TNAU Paddy expert system remained and will remain to be a bonanza for the farmers in future also.

CONCLUSION

TNAU Paddy expert system mobile application has proved again that ICT had the potential to satisfy the knowledge and information needs of the farmers, and supported them to make the right decisions at right time, which ultimately leads to attaining significant livelihood growth. The expert system app integrates farmers, agricultural researchers, extensionists to provide knowledge, information, and crop diagnostics tool in a single reliable source so that farmers need not depend on various sources for better farming and improved livelihoods. The sentiment analysis performed through azure machine learning software showed that users expressed their opinions about the TNAU Paddy expert system app in positive, negative, and neutral ways, among them positive nature was predominantly found. This showed that this particular mobile app had been most effective in producing and providing more reliable information and satisfactory results whenever the user used it. As supporting the result, the USAT index also touched the peak which again proved that the TNAU Paddy expert system app had given enough satisfaction to its users. Feedback received was categorized with the help of factor analysis into four major opinions as proficient, constructive, utilitarian, and destructive feedback in the view of fostering an effective mobile application. The negative feedback offered by the users would be very useful for further development of this particular mobile

application since it showed the flaws in the application. The points expressed by the neutral sentiment users should be taken care of, if they fall into the negative side, it would lead to downstream. The users in this mobile application wished to have a set up like other social platforms have so that they can share and gain their new information and marketing contacts, and also they expect in future it might expand its optical fiber in supply chain management also. TNAU Paddy expert system app was the application of scientific research which imparts the scientifically proven paddy technologies and practices for the betterment of the farming community, that aids farmers to make right decisions at the needed time and through crop doctor technology it helps them by protecting their crop and reducing the time and cost.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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