

CARE4ANIMALS: A Multichannel Mobile Microlearning Platform for Livestock Farmers in Uganda

A Mixed-Methods Evaluation of Usability, Acceptance and User Experience

Dr. Kosea Erasto Muwanga^{1*}; Amoah John²

²Professor

^{1,2}Bugema University, Uganda

Corresponding Author: Dr. Kosea Erasto Muwanga^{1*}

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Abstract: Digital tools can make livestock information easier to reach, but simply putting information on a phone does not guarantee that farmers will find it useful, understandable, or trustworthy. This study examined CARE4ANIMALS, a multilingual mobile microlearning platform designed to provide short, practical animal-welfare lessons through a Progressive Web App (PWA) and Short Message Service (SMS). The study involved 150 livestock farmers from Central, Western, Eastern, and Northern Uganda and combined quantitative measures with interviews and focus-group discussions. The quantitative assessment covered perceived usefulness, ease of use, accessibility, language suitability, content relevance, satisfaction, trust, intention to continue, and overall usability measured with the System Usability Scale (SUS). Across the eight acceptance dimensions, farmers gave consistently positive ratings, with means ranging from 4.22 to 4.40 on a five-point scale. The overall SUS score was 76.78 (SD = 5.18). PWA users recorded a mean SUS score of 77.69 (SD = 4.56), compared with 75.42 (SD = 5.77) among SMS users. SMS users rated accessibility more highly, while PWA users recorded higher overall usability scores. Acceptance did not differ significantly among the English, Luganda, and Swahili groups. An exploratory regression accounted for 64.2% of the variance in the composite acceptance score, although this result must be interpreted cautiously because the predictors form part of the same composite measure. Taken together, the responses suggest that farmers value information that is practical, accessible, available in a familiar language, and delivered through a channel that fits their circumstances. At the same time, the study does not demonstrate changes in animal welfare, productivity, health, or farming behaviour because participants were assessed immediately after using the platform rather than over a longer period.

Keywords: Digital Agricultural Extension; Mobile Microlearning; Animal Welfare; Technology Acceptance; Livestock Farmers; Uganda; System Usability Scale; Digital Inclusion.

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I. INTRODUCTION

Livestock farming plays an important role in food security, household income, and rural livelihoods in Uganda and elsewhere in sub-Saharan Africa. For farmers, however, the value of livestock information is closely tied to what happens when that information reaches them. Advice needs to be available when a problem arises, understandable in the language they are comfortable using, and practical enough to apply on the farm. Conventional agricultural and veterinary extension remains essential, but extension workers often have

to serve large and geographically dispersed farming communities. Digital channels offer one way of extending that reach without suggesting that digital services should replace face-to-face professional support (Aker, 2011). The wider digital-agriculture context also includes growing interest in artificial intelligence and digital advisory tools for small-scale producers (World Bank, 2025).

Mobile phones create several possibilities for reaching farmers, from simple SMS messages on basic handsets to richer learning experiences on smartphones. This flexibility

matters in settings where farmers have different devices, levels of connectivity, digital experience, and ability to pay for data. Access alone, however, does not guarantee use. Network reliability, device limitations, cost, literacy, language, and whether farmers see a service as genuinely useful can all shape their experience. Research on mobile agricultural services in sub-Saharan Africa likewise points to perceived usefulness, ease of use, and the wider context in which a technology is used as important considerations (Muromba et al., 2025).

The Technology Acceptance Model (TAM) offers a useful starting point for understanding why people choose to use a technology. Davis (1989) identified perceived usefulness and perceived ease of use as central dimensions of technology acceptance, while later work expanded the model to accommodate additional influences on acceptance and use (Venkatesh & Davis, 2000). For CARE4ANIMALS, these two core dimensions are considered alongside factors that are particularly relevant to rural digital extension: accessibility, language suitability, content relevance, satisfaction, trust, and intention to continue using the service.

CARE4ANIMALS was developed around a simple idea: livestock farmers should be able to access useful animal-welfare information without having to depend on a single type of phone or internet connection. The platform therefore combines a PWA, which can support richer content for smartphone users, with SMS for people who need a simpler, lower-bandwidth option. Lessons are available in English, Luganda, and Swahili and focus on practical areas such as feeding, housing, disease prevention, and animal handling. This approach reflects growing interest in using mobile learning to complement conventional livestock advisory services while taking users' circumstances into account (Chenais et al., 2025). The project was supported through the CARE4ANIMALS research-grant programme (Welttierschutzstiftung, 2025).

The study was deliberately focused on farmers' immediate experience of the platform. Participants interacted with CARE4ANIMALS for a relatively short period, so the evaluation can tell us how useful, accessible, understandable, and usable the service appeared to them at that point. It cannot, by itself, tell us whether farmers later changed their practices, whether animal welfare improved, or whether productivity increased. Those questions require follow-up over time.

➤ Research Questions

- How usable is CARE4ANIMALS as measured by the System Usability Scale?
- What is the level of user acceptance across perceived usefulness, ease of use, accessibility, language suitability, content relevance, satisfaction, trust, and intention to continue?
- How are the measured constructs associated with the composite overall acceptance score?

- How do user perceptions differ between the PWA and SMS channels?
- How do farmers describe the usefulness, accessibility, language, trustworthiness, and practical value of CARE4ANIMALS?

II. LITERATURE REVIEW AND CONCEPTUAL FRAMING

➤ Digital Extension and Smallholder Farmers

Digital agricultural extension encompasses communication technologies such as mobile phones, SMS, web applications, voice services, and social media. These technologies can supplement conventional extension by reducing the time and physical distance between farmers and sources of technical advice. Aker (2011) identified mobile-based information services as a potentially useful mechanism for addressing information constraints in developing-country agriculture, while also emphasizing design and implementation limitations. Recent work on agricultural extension personnel similarly applies the Technology Acceptance Model to cyber-extension use (Padmaningrum et al., 2024).

Digital extension has particular potential for livestock farmers where farmers require concise advice on feeding, housing, disease prevention, animal handling, and welfare. The effectiveness of such systems, however, depends on the fit between the technology and users' actual conditions. The CARE4ANIMALS design therefore treats device access, connectivity, language, content relevance, and practical usefulness as integral components of the user experience.

➤ Technology Acceptance Model

TAM proposes that perceived usefulness and perceived ease of use are central to users' acceptance of information technology (Davis, 1989). Perceived usefulness concerns the extent to which a system is believed to improve task performance, whereas perceived ease of use concerns the effort associated with using the system. Later work extended TAM by incorporating additional determinants and behavioural processes (Venkatesh & Davis, 2000).

In CARE4ANIMALS, perceived usefulness and ease of use represent the core TAM dimensions. Accessibility captures whether the service can be reached through the participant's available device and connectivity. Language suitability captures comprehension and familiarity of the language used. Content relevance reflects whether the lesson addresses farmers' actual livestock problems. Satisfaction and trust capture user experience and confidence in the service, while intention to continue reflects behavioural intention.

➤ *Conceptual Model*

Table 1 Conceptual Constructs and Operational Definitions for CARE4ANIMALS Technology Acceptance and Usability Evaluation

Construct	Role	Operational meaning
Perceived usefulness	Core TAM construct	The service provides useful information for livestock decisions.
Ease of use	Core TAM construct	The service is understandable and requires manageable effort.
Accessibility	Contextual construct	The service can be accessed with the available device, network, and resources.
Language suitability	Contextual construct	Language and translation support comprehension and comfortable use.
Content relevance	Contextual construct	Lessons address real livestock-welfare needs and provide applicable advice.
Satisfaction	User-experience construct	The service experience meets users' expectations.
Trust	Contextual factor	The information and its source are perceived as credible and dependable.
Intention to continue	Behavioural-intention construct	The participant expects or intends to use the service again.
SUS	Global usability measure	Overall perceived usability on the standard 0–100 SUS scale.

III. METHODOLOGY➤ *Study Design*

The study combined quantitative and qualitative approaches so that farmers' ratings could be considered alongside their own descriptions of the experience. The quantitative data provided a structured picture of acceptance and usability, while interviews and focus-group discussions helped explain what stood behind those ratings and which aspects of the platform mattered to farmers.

➤ *Participants and Sampling*

The study included 150 livestock farmers from four regions of Uganda. Participants were recruited using purposive and stratified procedures to obtain variation in region, age, gender, livestock profile, language, and digital channel. Recruitment was supported by veterinary officers and extension workers. Participants were active livestock farmers, owned or had access to a mobile phone, and agreed to participate.

Table 2 Distribution of Study Participants by Demographic, Livestock, Language, and Digital-Channel Characteristics

Characteristic	Distribution
Region	Central: 44 (29.3%); Western: 41 (27.3%); Eastern: 39 (26.0%); Northern: 26 (17.3%)
Gender	Male: 84 (56.0%); Female: 66 (44.0%)
Age group	18–29: 22 (14.7%); 30–39: 40 (26.7%); 40–49: 47 (31.3%); 50–59: 29 (19.3%); 60+: 12 (8.0%)
Livestock profile	Cattle: 61 (40.7%); Goats/Sheep: 38 (25.3%); Mixed: 27 (18.0%); Poultry: 24 (16.0%)
Preferred language	Luganda: 75 (50.0%); English: 45 (30.0%); Swahili: 30 (20.0%)
Channel	PWA: 90 (60.0%); SMS: 60 (40.0%)

➤ *CARE4ANIMALS Platform*

CARE4ANIMALS provides short animal-welfare learning units through a PWA and SMS. The platform supports English, Luganda, and Swahili. Lessons address practical areas such as feeding, housing, disease prevention, and animal handling. The micro learning approach was designed to make lessons manageable for farmers with limited time, variable digital experience, or limited access to long-form online learning.

➤ *Data Collection*

Each participant interacted with either the PWA or SMS version for at least 15 minutes. A post-interaction questionnaire was administered by trained research assistants in the participant's preferred language. Twenty participants participated in semi-structured interviews, and four regional focus-group discussions were conducted with approximately 8–10 participants each.

➤ *Measures*

The quantitative instrument contained 32 acceptance items distributed across eight constructs and the 10-item System Usability Scale (SUS). Acceptance items used a five-point response scale. The SUS was scored using the standard 10-item procedure, producing a single 0–100 usability score (Brooke, 1996). The present analysis retains the original questionnaire for reporting the current dataset. A revised instrument is recommended for future administration because several items addressed outcomes, such as productivity improvement, that cannot reasonably be established immediately after a short exposure.

➤ *Reliability and Measurement Considerations*

Internal-consistency estimates were calculated for the eight acceptance constructs and the overall 32-item acceptance scale. The coefficients ranged from $\alpha = .268$ for content relevance to $\alpha = .650$ for ease of use, while the overall 32-item scale had $\alpha = .551$. These results do not support

describing the instrument as a fully validated high-reliability scale. The current instrument should instead be treated as a context-specific evaluation questionnaire requiring further expert review, cognitive interviewing, translation/back-translation, and pilot testing before confirmatory use.

➤ *Ethical Considerations*

The supplied research protocol specifies voluntary participation, informed consent, confidentiality, anonymity, data protection, and the right to withdraw. Bugema University Research Ethics Committee is the relevant ethics body. The study materials specify encryption, access controls, role-based permissions, a five-year retention period after study completion, and secure deletion or destruction procedures.

➤ *Data Analysis*

The participant-level dataset was analysed using descriptive statistics, Pearson correlations, Welch's independent-samples tests to compare the PWA and SMS groups, one-way ANOVA to examine language-group differences, and multiple linear regression. Means, standard deviations, medians, and positive-response percentages were calculated for the acceptance measures, while SUS scores were reported on the standard 0–100 scale. Statistical tests used a significance level of $\alpha = .05$. One caution is important when interpreting the regression. The predictor variables are themselves components of the overall acceptance score. As a result, there is mathematical overlap between the predictors

and the outcome. The regression is therefore treated as an exploratory description of the relationships within the acceptance measure, not as evidence that these variables independently cause or predict acceptance.

IV. RESULTS

➤ *Participant Characteristics*

The final dataset contained 150 participants drawn from four regions of Uganda. Central Uganda contributed 44 participants (29.3%), Western 41 (27.3%), Eastern 39 (26.0%), and Northern 26 (17.3%). Men represented 56.0% of the sample and women 44.0%. Participants aged 40–49 years formed the largest age group (31.3%), while cattle farmers represented the largest livestock category (40.7%). Half of the participants preferred Luganda, and the platform was used through the PWA by 60.0% of participants and through SMS by 40.0%.

➤ *Acceptance of CARE4ANIMALS*

Farmers responded positively across all eight acceptance dimensions. Accessibility received the highest mean rating ($M = 4.40$, $SD = 0.32$), followed by perceived usefulness ($M = 4.37$, $SD = 0.33$) and content relevance ($M = 4.36$, $SD = 0.28$). Trust had the lowest mean ($M = 4.22$, $SD = 0.38$), although it was still clearly above the midpoint of the five-point scale. Overall acceptance averaged 4.31 ($SD = 0.13$).

Table 3 Descriptive Statistics for CARE4ANIMALS Acceptance Constructs

Construct	M	SD	Median	Positive (%)
Perceived usefulness	4.37	0.33	4.40	94.7
Ease of use	4.27	0.34	4.20	89.3
Accessibility	4.40	0.32	4.40	95.3
Language suitability	4.32	0.34	4.25	93.3
Content relevance	4.36	0.28	4.25	98.7
Satisfaction	4.26	0.37	4.33	90.0
Trust	4.22	0.38	4.00	89.3
Intention to continue	4.30	0.36	4.33	94.0
Overall acceptance	4.31	0.13	4.30	98.7

➤ *System Usability*

The reanalysed dataset produced an overall SUS score of 76.78 ($SD = 5.18$). PWA users had a mean SUS score of 77.69 ($SD = 4.56$), whereas SMS users had a mean of 75.42 ($SD = 5.77$). The Welch comparison indicated a statistically significant difference, $t(111) = 2.57$, $p = 0.012$; the degrees of

freedom are omitted from the narrative because the supplied analysis did not report a consistent rounded value. The SUS is a 0–100 usability score and should not be interpreted as a percentage.

➤ *Reliability*

Table 4 Internal Consistency Reliability of CARE4ANIMALS Acceptance Constructs

Construct	Items	Cronbach's α
Perceived usefulness	5	.610
Ease of use	5	.650
Accessibility	5	.591
Language suitability	4	.591
Content relevance	4	.268
Satisfaction	3	.555
Trust	3	.626
Intention to continue	3	.484
Overall acceptance	32	.551

The reliability results call for some caution. The items did not behave as a consistently strong scale across all constructs, with particularly low internal consistency for content relevance and intention to continue; none of the individual constructs exceeded $\alpha = .65$. These results do not invalidate the farmers' responses, but they do suggest that the questionnaire needs further refinement before it is used for confirmatory measurement or comparison across larger samples.

➤ Associations with Overall Acceptance

The eight constructs were all positively related to the overall acceptance score. The strongest relationships were observed for perceived usefulness ($r = .468$), intention to continue ($r = .447$), and content relevance ($r = .430$). These relationships are useful for describing the structure of the responses, but they should be interpreted carefully because

the individual constructs contribute to the composite acceptance score itself. The correlations therefore reflect both substantive relationships and the overlap created by the way the measure was constructed.

➤ Exploratory Regression

The five-component exploratory regression was statistically significant, $F(5, 144) = 51.72$, $p < .001$, and accounted for $R^2 = 0.642$ of the variance in Overall Acceptance (adjusted $R^2 = 0.630$). All five component coefficients were statistically significant: perceived usefulness, $B = 0.162$, $p < .001$; ease of use, $B = 0.112$, $p < .001$; accessibility, $B = 0.104$, $p < .001$; language suitability, $B = 0.123$, $p < .001$; and content relevance, $B = 0.165$, $p < .001$.

➤ PWA and SMS Comparison

Table 5 Comparison of CARE4ANIMALS Acceptance, Usability, Accessibility, Usefulness, and Satisfaction Between PWA and SMS Users

Measure	PWA M (SD)	SMS M (SD)	Welch t	p
Overall acceptance	4.289 (0.132)	4.343 (0.126)	-2.54	0.0124
SUS	77.69 (4.56)	75.42 (5.77)	2.57	0.0116
Accessibility	4.331 (0.307)	4.500 (0.318)	-3.23	0.0016
Perceived usefulness	4.358 (0.312)	4.377 (0.357)	-0.33	0.7394
Satisfaction	4.248 (0.382)	4.278 (0.364)	-0.48	0.6330

The comparison between channels tells a more nuanced story than a simple preference for one technology over another. SMS users gave higher ratings for accessibility, whereas PWA users recorded higher SUS scores. Perceived usefulness and satisfaction did not differ significantly between the two groups. In practical terms, the results suggest that the two channels may be serving different needs: SMS helps address access constraints, while the PWA offers a richer and more usable experience for those able to use it.

➤ Language Comparison

- English: $n = 45$, $M = 4.286$, $SD = 0.122$.
- Luganda: $n = 75$, $M = 4.327$, $SD = 0.141$.
- Swahili: $n = 30$, $M = 4.306$, $SD = 0.122$.

A one-way ANOVA found no statistically significant difference in overall acceptance among English, Luganda, and Swahili groups, $F(2, 147) = 1.41$, $p = 0.247$. The findings do not establish that language caused acceptance, but they indicate that the three language groups reported broadly similar levels of overall acceptance in this sample.

➤ Qualitative Findings

Farmers' comments added useful context to the numerical results. Five themes stood out. Farmers repeatedly valued information that addressed problems they actually encounter, especially feeding and disease prevention. Accessibility also mattered: SMS was useful for participants who did not have smartphones or who preferred a simpler service, while PWA users appreciated having access to richer and more visual material. Language emerged as another practical consideration, with local-language content

described as easier to understand and less technical. Trust was connected to the credibility of veterinary officers and the university associated with the service. At the same time, farmers mentioned familiar challenges such as unreliable network coverage, limited phone battery life, and literacy barriers. These experiences help explain why accessibility, usefulness, and content relevance received strong quantitative ratings.

V. DISCUSSION

➤ Practical Usefulness and Content Relevance

The strong ratings for perceived usefulness and content relevance suggest that farmers saw CARE4ANIMALS as addressing information needs that mattered to them. This is consistent with the central role given to usefulness in TAM and with recent work on mobile agricultural services in sub-Saharan Africa (Davis, 1989; Muromba et al., 2025). What the study captures, however, is perceived value at the time of use. It does not establish that farmers subsequently changed their practices or that those changes produced better farm outcomes.

For future development, the message from farmers is fairly straightforward: lessons should start with the livestock problems they recognize and should end with something they can act on. Short lessons are most useful when they deliver one clear and practical takeaway rather than trying to cover too much information at once.

➤ Complementarity of PWA and SMS

The differences between the two channels are important because they point toward complementarity rather than replacement. SMS was associated with stronger perceptions

of accessibility, while PWA users reported higher overall usability. This supports keeping both channels available: SMS can help include farmers who face device or connectivity constraints, while the PWA can provide richer learning experiences where smartphones and internet access are available. This kind of flexibility is consistent with the broader role of mobile learning in extending advisory services while responding to infrastructure limitations (Aker, 2011; Chenais et al., 2025).

➤ *Language and Localization*

Although the three language groups did not differ significantly in overall acceptance, farmers' comments suggest that language still shaped how comfortable some participants felt with the material. This is an important distinction. A language option can make information feel more familiar and easier to understand even when it does not produce a statistically different overall acceptance score. Future evaluations should therefore examine actual comprehension and learning, rather than relying only on satisfaction or acceptance ratings.

➤ *Trust and Institutional Credibility*

Trust received the lowest mean of the eight acceptance dimensions, although the rating remained positive. Farmers' comments linked trust to the credibility of veterinary personnel and the university behind the service. This suggests that digital animal-welfare platforms should make the source of their advice clear and should remind users when a livestock problem requires professional assessment rather than self-guided information alone.

➤ *Measurement Implications*

The experience also raises a measurement issue. After roughly 15 minutes with a digital service, participants can reasonably comment on whether it was easy to use, accessible, understandable, relevant, and apparently useful. They cannot reasonably determine whether it has increased farm productivity or improved animal welfare over time.

VI. IMPLICATIONS FOR PRACTICE

The findings have several important implications for the design and implementation of digital animal-welfare education interventions. First, lessons should be designed around real livestock-management decisions and commonly encountered animal-welfare problems so that learning content is directly relevant to farmers' everyday experiences. Practical, context-specific learning materials are likely to make the intervention more meaningful and facilitate the translation of knowledge into practical action. SMS should also be retained as an intentional inclusion channel rather than being treated merely as a temporary fallback for users with limited internet connectivity or digital skills. Its accessibility and relatively low technological requirements make it particularly valuable for reaching farmers who may not have consistent access to smartphones, mobile data, or reliable internet services. At the same time, the progressive web application (PWA) can be used to provide richer learning experiences through multimedia content, demonstrations, images, and interactive learning activities. This suggests that

SMS and PWA-based delivery should be viewed as complementary rather than competing approaches.

The development and deployment of local-language content should involve farmers in the testing and validation process before wider implementation. Local-language translations should be assessed for clarity, cultural appropriateness, accuracy, and ease of understanding to minimize the risk of linguistic or contextual barriers to learning. In addition, the professional source of animal-welfare information should be clearly identified and presented in a credible manner.

Future implementations should also distinguish actual engagement and learning from users' perceived acceptance of the intervention. Measures of platform use, completion of learning activities, knowledge acquisition, and demonstrated understanding should therefore be collected alongside measures of satisfaction, perceived usefulness, and intention to continue using the system. Finally, longitudinal follow-up should be incorporated to determine whether increased knowledge is translated into sustained changes in livestock-management practices and, ultimately, measurable improvements in animal-welfare outcomes. Such follow-up would provide stronger evidence of the practical effectiveness and longer-term value of digital animal-welfare education.

VII. LIMITATIONS

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional, post-interaction design limits causal inference and does not establish whether participants would sustain their use of the intervention over time. Because the assessment was conducted following interaction with the intervention, the findings primarily reflect participants' immediate experiences and perceptions rather than long-term adoption or behavioral change.

Relatedly, the study captures immediate perceptions rather than long-term changes in behavior, knowledge retention, animal-health outcomes, animal-welfare outcomes, productivity, or household income. Consequently, although the findings provide evidence regarding participants' responses to the intervention, they cannot establish whether exposure to the digital learning platform ultimately produces sustained improvements in livestock-management practices or broader livelihood outcomes. Longitudinal studies would therefore be necessary to assess these longer-term effects.

The use of purposive recruitment, together with support from extension personnel during participant recruitment or engagement, may also limit the generalizability of the findings. Participants who were willing or able to engage with the study may differ systematically from farmers who were not recruited or who had limited interaction with extension services. Furthermore, the involvement of extension personnel may have introduced selection or social-desirability bias, whereby participants provided responses that they perceived to be more acceptable or favorable.

VIII. RECOMMENDATIONS FOR FUTURE RESEARCH

Future research should move beyond immediate acceptance and examine whether microlearning produces measurable learning and practice changes. A stronger evaluation would use a pre-test/post-test design for knowledge, a follow-up assessment after several weeks or months for behaviour, and selected objective indicators of animal welfare where feasible. Future studies could compare text, audio, image, and video microlearning formats and assess how channel choice affects actual engagement.

IX. CONCLUSION

Overall, the 150 farmers in this evaluation responded positively to CARE4ANIMALS. Accessibility, perceived usefulness, and content relevance attracted the strongest ratings, and the overall SUS result reflected a favorable user experience. The two delivery channels also showed different strengths: SMS was associated with higher accessibility ratings, while PWA users reported higher usability. Acceptance was broadly similar across the English, Luganda, and Swahili groups.

Taken together, the study points toward a practical model for digital animal-welfare extension: start with farmers' real information needs, keep lessons concise and actionable, offer more than one route to the information, and communicate in languages farmers are comfortable using. The results should nevertheless be kept in perspective. They describe how farmers experienced the platform at the time of the evaluation; they do not establish improvements in animal welfare, productivity, or sustained farming behavior.

DECLARATIONS

- Ethics approval: (BU-REC-2026-133) the supplied study documentation identifies the Bugema University Research Ethics Committee as the reviewing body and describes informed consent, voluntary participation, confidentiality, anonymity, and data protection procedures.
- Consent to participate: Participants provided voluntary informed consent, including signature or thumbprint procedures as specified in the study materials.
- Funding: The manuscript states that the study was supported by the Welttierschutzstiftung.
- Conflict of interest: The authors report no conflict of interest.
- Data availability: The study dataset is available from the corresponding author on reasonable request, subject to applicable ethical and data-protection requirements.

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