

The Role of ICT-Based Spatial Design Interfaces as Mediators for Promoting Resource Rediscovery Among Local Residents

Validating the Effectiveness of Digital Stamp Rallies in Rural Areas

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Abstract—As depopulation progresses on a global scale, regional circulation-type stamp rallies have been implemented in rural areas as a means to foster civic pride and promote the rediscovery of the potential value of their region. However, traditional paper-based methods impose significant burdens on both organizers and users, presenting challenges for long-term sustainability. In this study, we developed two types of stamp rally applications leveraging augmented reality (AR), location-based services, and artificial intelligence (AI). These applications were subsequently evaluated through demonstration experiments conducted during an actual public event. Analysis of user survey data (valid responses: N=103 and N=85) revealed that self-evaluations of interest, knowledge, and regional attachment toward the target areas were associated with statistically significant positive shifts across all metrics, with this trend being generally pronounced among working adults. Furthermore, the results suggest that areas functioning as latent regional resources, such as industrial parks, hold greater potential for ICT-based spatial design intervention to uncover the latent assets of their own region. These findings suggest that user interfaces realized through mobile applications can support the rediscovery of local resources and serve as effective spatial design interfaces for local governments.

Keywords—Stamp rallies; augmented reality; location information; image recognition AI; spatial design interfaces

I. INTRODUCTION

Currently, the proliferation of depopulated regions has emerged as a significant global concern. Particularly in developed nations, the migration of population from rural areas to urban areas is pronounced, driven by disparities in labor demand and urban functionality. Indeed, population decline has been observed in at least one small region in 30 out of the 38 OECD member states in recent years [1].

While the factors underlying population outflow are multifaceted, one primary cause is that residents of rural areas have limited opportunities to recognize the latent attractiveness of their own region or the potential value of its resources. Because these elements are integrated into the daily lives of residents, they tend to perceive such attractiveness and value as self-evident, which renders the rediscovery and utilization of that potential value challenging.

Furthermore, while initiatives for regional revitalization through tourism are prevalent, the nature of famous tourist

destinations leaves room for debate regarding their suitability as venues where local residents can daily visit and reevaluate regional potential value.

Against this background, local governments have initiated public events aimed at regional revitalization by identifying hidden regional resources. This study focuses on the “stamp rally” as a strategic component of such initiatives.

A stamp rally can synchronize the trajectories of users by establishing multiple designated points. Consequently, it functions as an effective method of spatial design that transcends mere recreation; it can physically guide participants to previously overlooked locations, thereby facilitating direct engagement with the potential value of their region. Moreover, its inherent simplicity allows it to target an extensive demographic spectrum, ranging from households with infants to the student population.

Conversely, conventional analog stamp rallies impose significant administrative burdens on organizers, such as the necessity to prepare physical stamp sheets proportional to the number of participants. Participants also face challenges, including increased physical and material burdens from carrying maps and reduced ease of reach to designated points.

While digitalization is expected to mitigate these issues, it is necessary to examine the extent to which the original “role as a spatial design interface” functions within a digital environment, moving beyond mere operational efficiency. Here, we operationally define a “spatial design interface” as a digital user interface that structures physical movement to reshape users’ perception of regional spatial assets. Unlike conventional location-based applications, gamified navigation, and persuasive technologies, it specifically utilizes mobile interaction to prompt residents to re-evaluate overlooked physical environments. Conceptually, we posit that technological factors (usability and gamification) reduce interaction barriers, thereby enhancing spatial exploration and information accessibility, and ultimately facilitating higher-level psychological outcomes such as regional attachment.

In this study, we examine the potential of augmented reality (AR) stamp rally applications and location-based/artificial intelligence (AI) stamp rally applications to serve as spatial design interfaces that facilitate behavioral change through digital technology. The primary objective of this research is to

explore the efficacy of modern digital interfaces in contributing to the fundamental goal of enabling individuals to rediscover the potential value of their region. To examine this question, we developed two distinct types of stamp rally applications.

Subsequently, we conducted a demonstration experiment during a public event hosted by a local government. Specifically, we quantified the transformation of participants' interest, knowledge, and regional attachment toward the target areas based on self-assessment indicators. Based on the results of the data analysis, the paper discusses the insights gained through the demonstration experiment.

II. RELATED WORK

Since the increase in depopulated regions due to population outflow significantly impacts the sustainability of society, various solutions leveraging information and communication technology (ICT) have been proposed globally under the rubrics of regional revitalization. For instance, regarding rural areas in China, a "Smart Village" development model has been proposed to promote sustainable development by clarifying rural characteristics and maximizing ICT solutions [2].

Furthermore, ICT implementation projects in rural areas of South Africa have addressed the realities and necessities of development in typical rural contexts [3]. From a practical perspective, an analysis of the digitalization of local governments in Indonesia and the village information system demonstrated that information accuracy and service quality directly influence user satisfaction and practical benefits [4]. Additionally, research into 3D virtual interactive applications aims to educate users on local historical value and promote preservation by conveying the context of historical sites through dynamic experiences [5]. Collectively, these studies present frameworks for utilizing technology like ICT to support regional revitalization for specific regions or communities.

Regarding the integration of recreational activities such as stamp rallies with gamification, research has focused on constructing and evaluating digital platform-type tourism systems [6]. In agritourism, the introduction of location-based AR games enhances visitors' experience value and increases consumption [7]. Similarly, in the context of cultural heritage tourism, location-based AR games have been shown to increase users' sense of achievement and enjoyment, thereby positively impacting their intention to use the systems [8].

Research also leverages AR and gamification to provide added value such as immersion to conventional tourism experiences. These initiatives aim to cultivate interest in points with low visibility or regions facing challenges in promotion [9]–[11]. However, these previous studies are designed targeting tourists visiting from the outside. Consequently, research remains limited regarding the use of ICT as a medium to prompt local residents to rediscover the potential value of their own region.

Therefore, for local governments in rural areas, it is essential to clarify the optimal utilization of ICT that enables local residents to rediscover the potential value of their own region, thereby contributing to the fostering of civic pride and the suppression of future population outflow.

III. DEVELOPMENT OF TWO APPLICATIONS

In this study, two types of stamp rally applications were developed for a public event organized by the Board of Education of a local municipality in Japan. In this paper, the town is referred to as "Town A." This public event integrates two concurrent stamp rallies, specifically an AR stamp rally touring local landmarks in Town A and a location-based/AI stamp rally visiting companies within the A Industrial Park. This chapter delineates the technical development of these applications.

A. AR Stamp Rally Application Development

The AR stamp rally application utilized in this project was developed using Unity. This system replaces conventional analog stamps by establishing AR markers at various locations; these markers are scanned via the application on a smartphone to acquire digital stamp data. The application architecture consists of a title screen, a map screen (Fig. 1¹), an AR marker recognition screen (Fig. 2), and a stamp collection screen (Fig. 3¹).

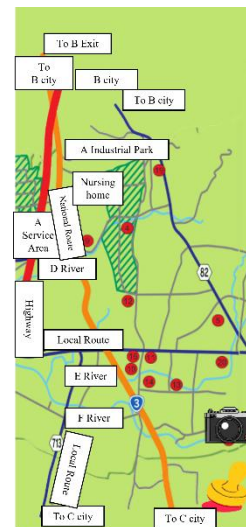


Fig. 1. Map.

Participants identify the locations of designated points via the map interface and obtain stamps by scanning the AR markers at these sites. Completion of the rally is achieved when a participant collects 20 AR markers. Given the extensive geographical range of the target area, spanning into neighboring cities, it was anticipated that participants would utilize vehicles or public transportation. Consequently, to delegate detailed route guidance to existing navigation services, a GPS-based current position identification function was intentionally excluded.

Regarding content delivery, tapping a specific spot on the map displays descriptive text for that location (Fig. 4^{1,2}).

In conjunction with application development, AR markers were created for 20 locations. To encourage participation from households with young children, markers were designed either

¹ The original Japanese text was translated into English by the author.

² The photograph of the building appearing in this figure was taken by SS.inc.

through contour extraction from photographs provided by Town A Board of Education or via hand-drawn illustrations created with GIMP. Representative examples of these markers are illustrated in Fig. 5 and 6.

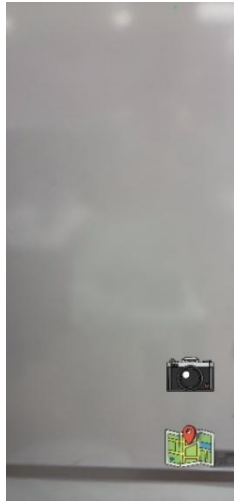


Fig. 2. Camera.

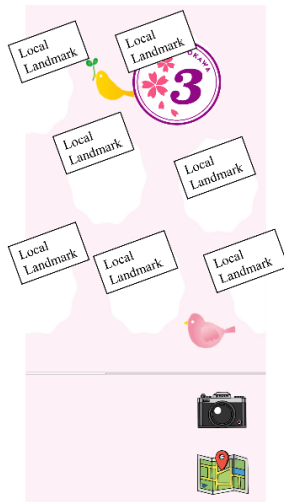


Fig. 3. Stamps.

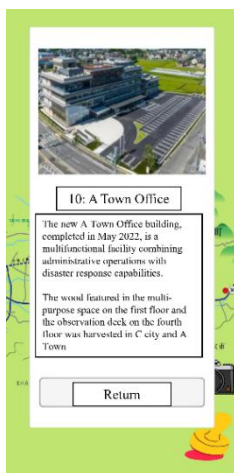


Fig. 4. Explanation.

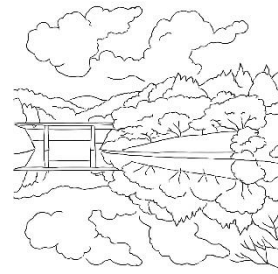


Fig. 5. An AR Marker.



Fig. 6. An AR Marker.

B. Location-Based/AI Stamp Rally Application Development

1) *Frontend*: The location-based/AI stamp rally application was similarly developed using Unity. The interface consists of a title screen, a map screen, a photography screen (Fig. 7¹), a quiz screen (Fig. 8¹), and a stamp display screen (Fig. 9). Participants initiate the process by photographing a company's nameplate; subsequently, activating the "AI Judgment" function transitions the user to a quiz interface.

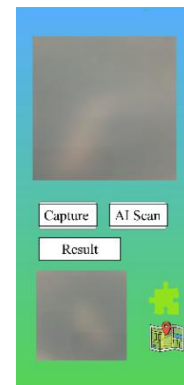


Fig. 7. Camera.

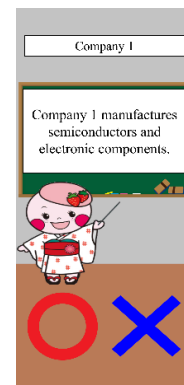


Fig. 8. Quiz.



Fig. 9. Stamps.

Three quiz questions are presented for each company; consecutive correct answers from the participant yield a digital stamp featuring motifs of the company's products. The stamp acquisition process is finalized by placing the acquired stamp in its designated position, and the rally is completed upon the collection of all 12 stamps.

2) Backend

a) Transition from photography screen to quiz screen:

The transition between these interfaces is primarily managed via global positioning system (GPS), which identifies the company at the shortest distance from the participant's current coordinates.

This approach prioritizes stability, ensuring consistent performance throughout the month-long public event. Specifically, a "geofence" with 30-meter radius was established around each company's signboard.

However, for the companies located at the northernmost and southernmost ends, the radius was extended to 50 meters because they were located far from other participating sites. By contrast, certain areas within the industrial park contain signboards situated within 30 meters of each other, resulting in overlapping geofences.

To overcome the physical limitations of location-based technology, a hybrid configuration was implemented, utilizing image recognition AI to classify photographed signboards and accurately determine the target company.

b) Image recognition AI using signboard photographs:

Photographs of company signboards were resized to 224×224 pixels. Data augmentation techniques, such as 360-degree random rotation, were then applied to generate a dataset of 840 training images per company. Although models were trained for all 12 companies, the application-side interface was restricted to the two companies characterized by overlapping geofences to ensure practical stability during the public event.

Considering the diverse range of devices used by participants, the lightweight EfficientNet V2 (B0) model was selected for its ease of conversion to the ONNX format. Transfer learning and fine-tuning were performed in TensorFlow by appending a custom output layer to the pre-trained EfficientNet V2 (B0) architecture. Both stages utilized the Adam optimizer, with learning rates set to $1e-4$ (100 epochs) for transfer learning and $1e-5$ (50 epochs) for fine-

tuning. Subsequent evaluation using 45 validation and 45 test images per company yielded a classification accuracy of 100%.

While this high accuracy demonstrates strong performance on the augmented dataset, it may partially reflect overfitting inherent to offline data augmentation generated from stationary signboard photographs. In the field deployment, the AI component served primarily as a complementary hybrid safeguard alongside GPS and was applied specifically to two companies with overlapping geofences to maintain operational stability.

The final model was converted to ONNX format and integrated into the application.

IV. QUESTIONNAIRE SURVEY TARGETING STAMP RALLY PARTICIPANTS

In this study, the objective was to quantify the impact of the developed applications on participants' interest, knowledge, and regional attachment. During the demonstration experiment, an online questionnaire seamlessly accessible from within the applications was implemented to obtain responses without compromising the user experience (UX).

In this survey, to minimize interference with the UX during the event, a "Retrospective Pre-test/Post-test Design" was adopted, where the "before participation" and "after participation" states were answered simultaneously after the game was completed. This method promotes participants' self-reflection and enables evaluation that considers changes in subjective criteria before and after the experience, namely the response shift.

The two stamp rallies were held from 2025/10/1 to 11/25. Regarding the distribution of the applications, the iOS version was released through the App Store [12], [13], while the Android version was distributed as an APK file via a dedicated website [14], [15].

The questionnaires for the game applications are shown in Table I, and the respondents for these items are presented in Table II. As shown in Table II, working adults were the most frequent participants, followed by junior high school students.

It was explicitly stated to participants that their data would be processed statistically in an anonymous format, with all personal identifiers removed. Participation was entirely voluntary, and respondents were informed of their right to skip any items they did not wish to answer. Consequently, while the total number of users recorded in the attributes (Table II) was 106 for the AR stamp rally application and 88 for the location-based/AI stamp rally application, the number of valid responses—defined as those with no missing values across all items—was 103 and 85, respectively.

A. Changes in Interest, Knowledge, and Regional Attachment Through the Two Applications

To investigate how interest, knowledge, and regional attachment regarding local landmarks via the AR stamp rally and regarding the industrial park via the location-based/AI stamp rally changed depending on the applications, an online questionnaire survey was conducted on the items shown in Table I.

TABLE I. QUESTIONNAIRE

A: AR Stamp Rally Applications			B: Location-based/AI Stamp Rally Applications		
Topics	Number	Questions	Topics	Number	Questions
Participant Demographics	A-1	Tell us about yourself. (Have the users select the participant demographics shown in Table II.)	Participant Demographics	B-1	Tell us about yourself. (Have the users select the participant demographics shown in Table II.)
Interest in local landmarks (LC-1)	A-2	Before participating in (Event Name) using this app, how interested were you in the local landmarks of Town A? Please reflect on your feelings prior to the event and select the option that best describes your interest.	Interest in industrial park (IC-1)	B-2	Before participating in (Event Name) using this app, how interested were you in “A Industrial Park” of Town A? Please reflect on your feelings prior to the event and select the option that best describes your interest.
	A-3	Now that you have participated in (Event Name) using this app, how interested are you in the local landmarks of Town A? Please reflect on your feelings after participating and select the option that best describes your interest.		B-3	Now that you have participated in (Event Name) using this app, how interested are you in “A Industrial Park” of Town A? Please reflect on your feelings after participating and select the option that best describes your interest.
Knowledge in local landmarks (LC-2)	A-4	Before participating in (Event Name) using this app, how much did you know about the local landmarks of Town A? Please reflect on your feelings prior to the event and select the option that best describes your knowledge.	Knowledge in industrial park (IC-2)	B-4	Before participating in (Event Name) using this app, how much did you know about “A Industrial Park” of Town A? Please reflect on your feelings prior to the event and select the option that best describes your knowledge.
	A-5	Now that you have participated in (Event Name) using this app, how much do you know about the local landmarks of Town A? Please reflect on your feelings after participating and select the option that best describes your knowledge.		B-5	Now that you have participated in (Event Name) using this app, how much do you know about “A Industrial Park” of Town A? Please reflect on your feelings after participating and select the option that best describes your knowledge.
Attachment in local landmarks (LC-3)	A-6	Before participating in (Event Name) using this app, did you feel a sense of attachment to Town A? Please reflect on your feelings prior to the event and select the option that best describes your attachment.	Attachment in industrial park (IC-3)	B-6	Before participating in (Event Name) using this app, did you feel a sense of attachment to “A Industrial Park” of Town A? Please reflect on your feelings prior to the event and select the option that best describes your attachment.
	A-7	Now that you have participated in (Event Name) using this app, do you feel a sense of attachment to Town A? Please reflect on your feelings after participating and select the option that best describes your attachment.		B-7	Now that you have participated in (Event Name) using this app, do you feel a sense of attachment to “A Industrial Park” of Town A? Please reflect on your feelings after participating and select the option that best describes your attachment.
UI on Application	A-8	How would you rate the usability of this app?	UI on Application	B-8	How would you rate the usability of this app?

TABLE II. RESULTS FOR QUESTION 1

Demographics	A-1 (N=106)	B-1 (N=88)
Working adults	61.3%	60.2%
University students · Vocational school student	2.8%	4.5%
Junior high school students · High school students	17.0%	14.8%
Elementary school students	11.3%	13.6%
Kindergarteners · Preschoolers	1.9%	2.3%
Other	1.9%	1.1%
Decline to answer	3.8%	3.4%

TABLE III. RESULTS OF WILCOXON SIGNED-RANK TEST

A: AR Stamp Rally Applications (N = 103, only working adults' N=65)					B: Location-based/AI Stamp Rally Applications (N = 85, only working adults' N=52)				
Topics	Question number	Median (After inversion)	P-value	RBC	Topics	Question number	Median (After inversion)	P-value	RBC
LC-1	A-2	3	1.477×10-9	0.851	IC-1	B-2	3	3.441×10-10	0.903
	A-3	4				B-3	4		
	A-2 (Working adults)	3	1.106×10-7	0.919		B-2 (Working adults)	2	1.506×10-8	1.000
	A-3 (Working adults)	4				B-3 (Working adults)	4		
LC-2	A-4	3	3.675×10-15	0.953	IC-2	B-4	2	3.519×10-10	0.948
	A-5	4				B-5	4		
	A-4 (Working adults)	3	2.191×10-10	0.950		B-4 (Working adults)	2	1.378×10-7	0.956
	A-5 (Working adults)	4				B-5 (Working adults)	4		
LC-3	A-6	3	4.622×10-9	0.914	IC-3	B-6	3	1.047×10-10	0.951
	A-7	4				B-7	4		
	A-6 (Working adults)	3	9.333×10-7	0.933		B-6 (Working adults)	2	1.023×10-7	0.970
	A-7 (Working adults)	4				B-7 (Working adults)	4		

Users responded to these on a 4-point Likert scale. When users responded, they were asked to answer with 1: Agree, 2: Somewhat agree, 3: Somewhat disagree, 4: Disagree; however, the numbers were reversed from the perspective of statistical processing to facilitate interpretation. The collected retrospective pre-questionnaire and post-questionnaire data were analyzed using the Wilcoxon signed-rank test after excluding missing values. Furthermore, a subgroup analysis was performed specifically focusing on working adults, the primary target demographic of this system, using the same statistical test. The significance level for all analyses was set at 5%. The results are shown in Fig. 10–13 and Table III.

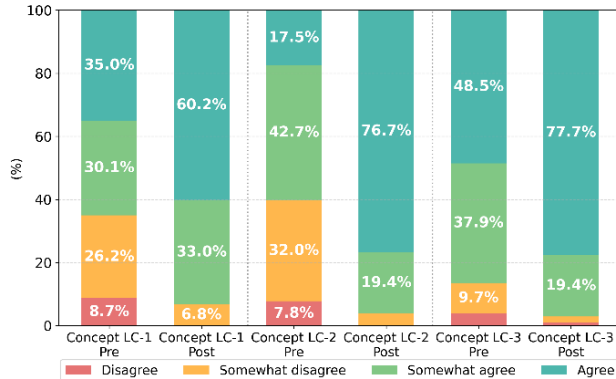


Fig. 10. Stacked bar chart of results - A: AR stamp rally applications.

The results across both questionnaires revealed statistically significant differences in interest, knowledge, and regional attachment between the pre-participation and post-participation phases. These findings suggest the stamp rally experience provided by the applications consistently contributed to a transformation in users' awareness, regardless of their age or attributes.

Additionally, the subgroup analysis of working adults showed that for all items—except those regarding changes in knowledge of local landmarks (LC-2)—the rank biserial correlation (RBC), which indicates effect size, was higher than that of the overall participant group.

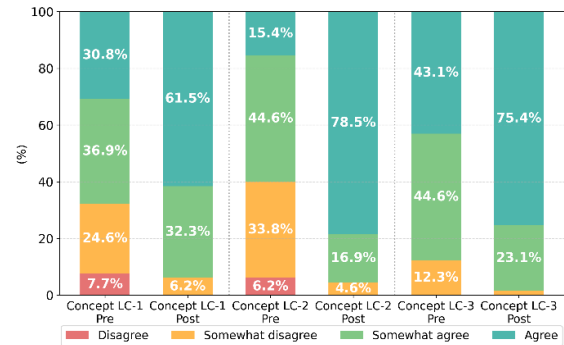


Fig. 11. Stacked bar chart targeting working adults of results: AR stamp rally applications.

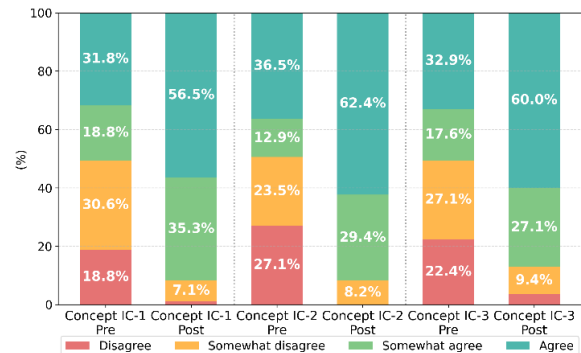


Fig. 12. Stacked bar chart of results - B: Location-based/AI stamp rally applications.

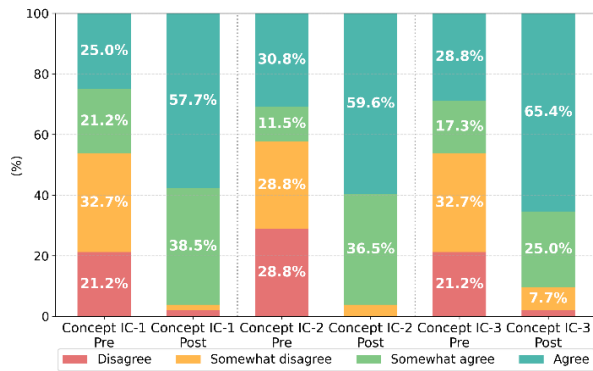


Fig. 13. Stacked bar chart targeting working adults of results - B: Location-based/AI stamp rally applications.

B. Factor Analysis of the Increase in Self-Assessment Focused on UI

To examine the factors underlying the transformation of self-assessment described in the previous section, the correlation between UI usability and the results of the post-questionnaire was analyzed. Since the results of the pre-questionnaire could potentially influence both the post-questionnaire and UI evaluations, a partial correlation analysis (Spearman's rank correlation) was conducted. In this model, the retrospective pre-questionnaire results were utilized as a covariate. The results of this analysis are presented in Tables IV–V.

The partial correlation analysis revealed positive correlations across all items. Furthermore, statistically significant positive correlations were observed across most items at the 5% significance level, with the exception of interest in local landmarks (LC-1). These results suggest that

application usability is positively associated with the rediscovery of regional resources.

In the subgroup analysis of working adults, higher correlation coefficients were confirmed for most items; however, knowledge of local landmarks (LC-2) did not reach statistical significance ($p = 0.191$). This indicates that while usability serves a supportive role, its degree of association varies depending on the specific resource and participant attributes.

V. DISCUSSION

In this demonstration experiment, both the AR stamp rally application and the location-based/AI stamp rally application resulted in significantly increased self-assessments regarding “interest,” “knowledge,” and “attachment” across all participants. The factors driving these transformations are discussed from the following three perspectives.

A. Association Between Interface Usability and Awareness Change

The results of the partial correlation analysis revealed a positive correlation between the evaluation of the application's usability and the improvement in the three self-assessments, regardless of participant attributes (Tables IV–V). This suggests that the usability of the application likely functioned as a “supportive factor” that facilitates awareness change.

Regarding participant attributes, given that working adults were the most frequent participants, followed by junior high school students and high school students (Table II), the affinity between general mobile device usage habits in modern mobile society and the stamp rally format is considered a factor promoting this mechanism of transformation in awareness.

TABLE IV. RESULTS OF PARTIAL CORRELATION ANALYSIS (SPEARMAN'S CORRELATION ANALYSIS) - A: AR STAMP RALLY APPLICATIONS

Topics	X	Y	Covariate	Correlation coefficient	p-value
LC-1	A-3	A-8	A-2	0.173	0.082
	A-3 (Working adults)	A-8 (Working adults)	A-2 (Working adults)	0.317	0.011
LC-2	A-5	A-8	A-4	0.341	0.000
	A-5 (Working adults)	A-8 (Working adults)	A-4 (Working adults)	0.165	0.191
LC-3	A-7	A-8	A-6	0.231	0.019
	A-7 (Working adults)	A-8 (Working adults)	A-6 (Working adults)	0.259	0.039

TABLE V. RESULTS OF PARTIAL CORRELATION ANALYSIS (SPEARMAN'S CORRELATION ANALYSIS) - B: LOCATION-BASED/AI STAMP RALLY APPLICATIONS

Topics	X	Y	Covariate	Correlation coefficient	p-value
IC-1	B-3	B-8	B-2	0.235	0.031
	B-3 (Working adults)	B-8 (Working adults)	B-2 (Working adults)	0.303	0.031
IC-2	B-5	B-8	B-4	0.476	0.000
	B-5 (Working adults)	B-8 (Working adults)	B-4 (Working adults)	0.523	0.000
IC-3	B-7	B-8	B-6	0.347	0.001
	B-7 (Working adults)	B-8 (Working adults)	B-6 (Working adults)	0.451	0.001

The particularly strong correlation observed among working adults between UI usability evaluation and the transformation in awareness suggests that the interface functioned as a “transparent channel” that does not hinder the transmission of information. Specifically, the utilization of the applications as an efficient means to acquire information regarding regional resources is considered to have led to this more pronounced transformation in awareness.

Furthermore, while conventional analog stamp rallies faced difficulties in providing detailed or supplementary information for each location due to the physical constraints of paper, these functions were successfully realized through these applications (e.g., Fig. 4). This improvement in “information accessibility” is considered a key factor in the increase of self-assessments across all items (Table III).

B. Visual Clarity and Gamification

For the AR stamp rally application, unique AR markers were developed to intuitively evoke the characteristics of local landmarks. The design prioritized simple operability, allowing users to acquire digital stamp data by scanning the markers with a smartphone at various locations.

In contrast, for the location-based/AI stamp rally application, stamp illustrations with unique designs were developed to enable participants to intuitively understand the business operations of companies within the industrial park, encouraging them to tour the area with the objective of collecting these stamps. Additionally, as a unique function, a gamification component involving quizzes related to the companies was implemented (e.g., Fig. 8).

The visual clarity and gamification realized through these application formats likely evoked deeper insights and impressions regarding the local landmarks and industrial park, resulting in a high RBC (Table III).

C. Efficacy of Digital Intervention for “Latent Regional Resources”

It is a noteworthy finding that self-assessments in this questionnaire significantly increased regarding the industrial park and the initiatives of its resident companies, which are areas that typically receive less attention than local landmarks (Table III).

Nevertheless, the analysis identified several exceptional trends. First, regarding interest in local landmarks (LC-1), the partial correlation analysis showed a positive correlation with usability. However, no statistically significant difference was obtained (Table IV). Given that self-assessments for LC-1 itself significantly increased after participation, it is possible that the “stamp rally content experience itself,” including visiting the sites, searching for AR markers, and engaging in the physical spatial experience, stimulated the arousal of interest, rather than usability serving as a mediatory factor.

Second, regarding the knowledge of local landmarks (LC-2) among the working adult demographic, the RBC was slightly lower than that of the overall participant group (Table III). Furthermore, the correlation between this metric and UI usability was weaker compared to the overall trend, with no statistically significant correlation obtained. This is likely

attributable to the fact that the target users were local residents rather than tourists. For working adults who are presumed to have resided in the area for a long term, the basic information regarding local landmarks provided by the application (e.g., Fig. 4) was likely within a range that could be easily inferred due to their familiarity with the region.

Consequently, the improvement in the self-assessment of “knowledge of local landmarks” (LC-2) was smaller, leading to a slightly lower RBC compared to the younger demographic.

Conversely, the substantial effect size indicated by RBC values of 0.9–1.0 within the industrial park suggests an exploratory hypothesis that areas with lower prior recognition may offer substantial headroom for ICT-based intervention. On the other hand, direct causal comparison between the two rally conditions remains confounded by several distinct factors: 1) application mechanisms, 2) spatial environments, and 3) evaluated constructs. Therefore, this observation serves as an exploratory hypothesis for future controlled studies rather than a definitive causal conclusion.

VI. LIMITATIONS

Several methodological limitations of this study should be noted. First, the evaluation employed a retrospective pre-test/post-test design administered upon game completion. While this design minimized participant drop-off, it reflects perceived attitudes rather than objective learning or sustained behavioral change, and inherently introduces potential recall bias. Second, the study lacked a control group or a conventional analog stamp rally baseline group. Consequently, the high effect size (RBC) reported in Table III should be interpreted with caution, as it may partially reflect response artifacts inherent to single-sitting retrospective ratings. Third, UI usability was evaluated using a single-item metric, and because the two applications integrated distinct interaction mechanisms and content formats, isolated feature effects cannot be disentangled. Moreover, partial correlation analysis reflects statistical associations rather than causal mediation. Future studies should use validated multi-item instruments (e.g., System Usability Scale) alongside factorial designs and structural equation modeling. Finally, statistical and sampling limitations should be acknowledged. Because the applications were distributed through mixed channels (the App Store and APK downloads via a dedicated website), potential self-selection bias was introduced. Furthermore, individual differences in digital literacy, independent application use and system exposure were not explicitly controlled. Additionally, future studies should report 95% confidence intervals and pre-registered hypotheses to strengthen inferential rigor.

VII. CONCLUSION

This study examined the technical efficacy of utilizing AR, location-based, and AI-integrated stamp rally applications aimed at regional revitalization to facilitate a transformation in users’ awareness through a case study. Specifically, two distinct types of applications were developed: an AR stamp rally application visiting local landmarks and a location-based/AI stamp rally application visiting an industrial park. Participant evaluations were then obtained through a

demonstration experiment during a public event hosted by a local government.

The results of the analysis revealed that the stamp rally experience provided by these developed applications was associated with statistically significant positive changes in self-reported awareness regarding interest, knowledge, and regional attachment, with these effects being particularly pronounced among the working adult demographic. Furthermore, these findings suggest the possibility that the uniqueness of the user interface served as a factor underlying this transformation in awareness.

Regarding future challenges, a comparison with conventional analog stamp rallies remains to be addressed. Additionally, based on the insights gained through this study, it is necessary to integrate the concept of a spatial design interface specialized for latent regional resources into a framework that can be deployed in other regions to verify its efficacy.

Along with deepening these insights regarding spatial design, future work is expected to involve the construction of a new platform that provides personalized experiences tailored to individual user preferences by expanding the scope of AI application.

DECLARATION ON GENERATIVE AI

The author utilized Gemini to refine the phrasing and linguistic expression of this manuscript. All text generated with assistance was rigorously reviewed by the author, who takes full responsibility for the final content.

ACKNOWLEDGMENT

The author thanks the Town A Board of Education for organizing the stamp rally event and the participating companies within the A Industrial Park for their invaluable cooperation. The author also thanks Hinata Machitori, Yudai Tsutsumi, Masaki Sakai, Mikuru Shimazaki, Takumi Kai, Haruka Nishio and Kouta Fukushima for their dedicated efforts and significant contributions to the development of the stamp rally applications, AR markers, and digital stamps.

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