HOW THE TRANSFORMATION OF DIGITAL MANGA INTO WEBTOONS ON MOBILE DEVICES AFFECTS USER PERCEPTION AND EXPERIENCE

Kuan-Yu Chen[a], Meng-Cong Zheng[1b] , Ching-I Chen[c]

[a] *Department of Industrial Design, National Taipei University of Technology, Taiwan, m901372@gmail.com*
[b] *Department of Industrial Design, National Taipei University of Technology, Taiwan, zmcdesign@gmail.com*
[c] *Department of Industrial Design, National Taipei University of Technology, Taiwan, zoeychen116@gmail.com*

ABSTRACT

With the widespread adoption of smartphones, Manga reading has gradually shifted from print media to mobile digital devices. Webtoons have become the dominant format due to their alignment with vertical scrolling interactions on smartphones; in contrast, page-based Manga face design challenges during the process of digital transformation. This study investigates whether extracting and transforming Manga panels into different digital presentation formats affects readers' reading comprehension, reading experience, and overall preferences, and further examines the interactive effects between Manga structures and formats.

A mixed-methods approach was adopted. In the first phase, a questionnaire survey was conducted with 149 smartphone Manga and Webtoon readers to analyze experiential differences among reader groups with different reading habits when reading Digital Manga and Webtoons on mobile devices. In the second phase, a reading experiment was conducted with 30 participants, who read Digital Manga and Webtoon prototypes featuring Fragmentation, Rhetorical Composition, and Mixed Composition structures on smartphones. Data were collected using the User Engagement Scale (UES-SF) and Semi-structured Interviews.

The findings indicate that the mobile Manga and Webtoon reading experience is influenced by readers' prior reading habits and structure. Mixed Readers also obtained higher mean scores than both Digital Manga Readers and Webtoon Readers across most questionnaire dimensions, suggesting that users with experience in both formats are better able to adapt to different reading interfaces and narrative styles. The reading experiment further showed that the narrative structure of Manga had a significant main effect on Perceived Usability (PU) ($F = 3.54$, $p = .036$).

[1] Corresponding author. No. 1, Sec. 3, Zhongxiao E. Rd., Taipei City 10608, Taiwan. zmcdesign@gmail.com

Mixed Composition also showed better overall user experience and higher preference rankings for the Webtoon format. These findings suggest that transforming Manga narrative structures into different presentation formats can influence users' reading experience and preferences, providing design references for future Digital Manga interfaces and panel extraction strategies.

Keywords: *Manga Structure*、*Webtoon*、*Panel Analysis*、 *Manga Digital Transformation*

1 INTRODUCTION

Since the 20th century, Manga has developed as a comic form serialized in print magazines and weekly publications, shaping a highly influential reading culture (Frederik L. Schodt, 1996). Through the arrangement of Panels, page-turning rhythm, and page layout, Manga has been regarded as a mature form of Sequential Art (Will Eisner, 1985). However, with the widespread adoption of smartphones, the ways in which people access information and engage in reading have gradually shifted toward digital media. According to the Digital 2024: Taiwan report, 94.9% of internet users in Taiwan primarily access the internet via smartphones, indicating that mobile devices have become a dominant reading medium in contemporary contexts (*Digital 2024*, 2024). Prior studies further indicate that comics are commonly categorized as a form of digital leisure reading, with reading motivations centered on entertainment and enjoyment, and highly dependent on device convenience and interaction fluency (Loh & Sun, 2022).

Within this context, Webtoon has rapidly emerged as the mainstream format of digital comics due to its alignment with smartphone interaction paradigms (Cho, 2021). By adopting a single reading flow, continuous vertical scrolling, and multimodal elements such as sound, Webtoon reshapes comic narrative rhythm and reading experience (Jang & Song, 2017). In contrast, Manga on smartphones is predominantly presented through scanning or zooming-based formats, which reduce the interactivity inherent to digital forms and, in turn, affect overall reading fluency and immersion (Batinic, 2017). Previous research also suggests that Manga employ diverse narrative structures through different panel arrangements and visual compositions. These structures, however, largely originate from print-based reading logic. Chavanne (2015) regarded Manga as an art form composed of multiple panels and images and proposed three panel composition types: Regular Composition, Semiregular Composition, and Rhetorical Composition. He further introduced Fragmentation as an important principle of panel arrangement to explain how different panel configurations influence the visual relationships between panels, reading paths, and narrative organization (Chavanne, 2015).

Based on this context, this study employed questionnaires and reading tasks to examine readers' preferences for Digital Manga formats and to evaluate whether transforming page-based Manga into Webtoon structures enhances mobile reading experience, thereby informing future Manga digitalization design and applications.

2 METHODS

2.1 Phase One: User Survey

In this phase, the questionnaire targeted participants aged 18 years or older who had used a smartphone to read Digital Manga or Webtoon within the past six months. The questionnaire was adapted from the Digital Reading Situation Scale (Tsai, 2011) and included separate sections for Digital Manga and Webtoon reading formats. In addition to collecting demographic information, reading frequency, and preferred reading format, the questionnaire also examined whether users' reading experiences were influenced by different comic formats (Digital Manga and Webtoon).

2.2 Phase Two: Manga Reading Experiment

In this phase, 30 participants were recruited from the survey respondents to participate in a controlled laboratory experiment. The experiment was conducted using an iPhone 16 Pro with a 6.27-inch (15.93 cm) display as the reading device. Based on an analysis of contemporary serialized Manga, three narrative structures were identified for developing the experimental prototypes: Fragmentation (Semiregular Composition with Fragmentation), characterized by structured square panel layouts arranged in a simple and orderly grid; Rhetorical Composition, characterized by irregular panel layouts; and Mixed Composition, which combines features of both structures. Using Figma, each narrative structure was transformed into two presentation formats, Digital Manga and Webtoon, resulting in six experimental prototypes (A-P, A-W, B-P, B-W, C-P, and C-W). Each prototype consisted of a complete battle-oriented story segment selected from a serialized Manga. After completing the reading task, participants completed the questionnaire, evaluating their reading experience primarily based on the panel layout and composition (Table 1).

Table 1. Six experimental prototypes (with blurred processing applied)

A-P **Fragmentation * Digital Manga**	**B-P** **Rhetorical Composition * Digital Manga**	**C-P** **Mixed Composition * Digital Manga**
		
A-W **Fragmentation * Webtoon**	**B-W** **Rhetorical Composition * Webtoon**	**C-W** **Mixed Composition * Webtoon**
		

Note. A = Frieren: Beyond Journey's End； B = SAKAMOTO DAYS； C = SPY×FAMILY

To ensure the validity of the transformation from Manga to the Webtoon format, this study invited two Webtoon experts with more than one year of professional experience and publishing backgrounds to validate the experimental prototypes. The validation included 30 evaluation items, including panel layout, reading order, text placement, image processing, and overall consistency. Percentage Agreement was adopted as the validity indicator, and the results showed an agreement rate of 86.7%. In addition, interviews were conducted to collect the experts' suggestions regarding the prototypes. The findings indicated that the reading flow and panel arrangement of Webtoons can be adjusted according to the narrative rhythm. Furthermore, both experts emphasized that the gutters between panels play a critical role in the process of transforming Manga into Webtoons, significantly influencing the reading experience. Therefore, the expert feedback was incorporated into the discussion of the subsequent experimental results in this study.

2.2.1 Experimental Procedure

During this phase, the experiment adopted a two-stage design. After reading the prototypes on a smartphone, participants first completed comprehension questions to assess their understanding of the story, followed by the UES-SF questionnaire. The UES-SF consists of 12 items and was used to evaluate differences in reading experience across the experimental prototypes in terms of focused attention, perceived usability, aesthetic appeal, and reward factor (O'Brien et al., 2018). This procedure was repeated three times, with each participant reading three different experimental prototypes presented either as Digital Manga or Webtoon (Figure 1).. After completing all experimental tasks, semi-structured interviews were conducted to explore participants' reading preferences.

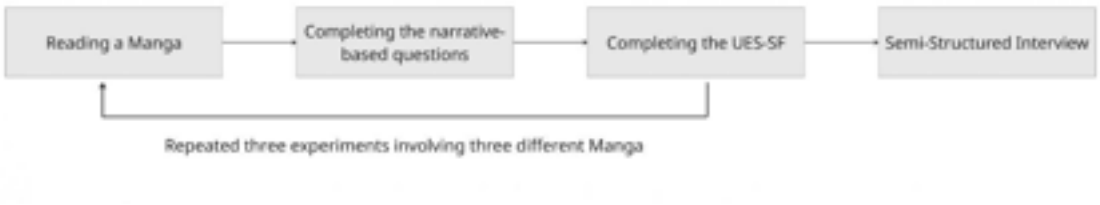

Figure 1. Reading Experimental Procedure

3 RESULT

3.1 Survey Analysis

A total of 149 valid questionnaires were collected. In terms of demographic characteristics, the majority of participants were female (n = 102, 68.5%), while males accounted for 47 participants (31.5%). Regarding age distribution, participants aged 20–29 constituted the largest proportion of the sample (89.3%), followed by those aged 30–39 (8.1%). This demographic distribution indicates that the sample primarily consisted of digital readers in their twenties.

Overall, participants demonstrated substantial reading experience with both Digital Manga and Webtoons. For Digital Manga, 58.4% of participants reported more than five years of reading experience. The most common reading frequency was "once per month" (24.8%), followed by

"once every six months" (22.8%), with typical reading sessions lasting 30–60 minutes (40.9%). For Webtoons, 50.3% of participants reported more than five years of reading experience, and 19.5% indicated that they read Webtoons almost daily. The predominant session length was also 30–60 minutes (32.9%). Overall, participants tended to engage in relatively short reading sessions, with 30–60 minutes being the most common duration for both Digital Manga and Webtoon reading.

3.1.1 Digital Manga & Webtoon Readers Usage Analysis

This study employed a 0–100 scale (with 10-point intervals) to measure participants' relative reading proportions across different comic formats. Lower scores indicated a stronger preference for Digital Manga, whereas higher scores indicated a stronger preference for Webtoons. Based on these scores, participants were classified into three groups: Digital Manga Readers (0–30; n = 35, 23.5%), Webtoon Readers (70–100; n = 56, 37.6%), and Mixed Readers (40–60; n = 58, 38.9%), who frequently read both Digital Manga and Webtoons.

To examine differences in reading experiences among the three reader groups when reading Manga on smartphones, one-way ANOVA was conducted. The results indicated that, when reading Digital Manga on smartphones, significant differences were observed across reading groups in screen size (F = 4.91, p = .009) and ease of interface operation (F = 5.31, p = .006). In addition, for reading fluency (F = 5.10, p = .007), reading comfort (F = 4.73, p = .010), and font size (F = 5.34, p = .006), Mixed Readers reported significantly higher ratings than Webtoon Readers. The results indicated that, compared with Webtoon Readers, Mixed Readers reported higher satisfaction with reading comfort and text presentation when reading Digital Manga on smartphones (Table 2).

Table 2. Differences in Mobile Digital Manga Reading Experience Among Different Reader Groups

Variable	Group 1 (n=35)	Group 2 (n=56)	Group 3 (n=58)	*F*	*p*	Post-hoc (Scheffé)
Planning of content layout	3.46 (0.98)	3.29 (0.89)	3.62 (0.90)	1.92	.151	n.s
Diverse reading experiences	2.91 (0.82)	3.05 (0.86)	3.03 (0.99)	0.28	.755	n.s
Unique reading experience	2.94 (0.84)	2.66 (0.81)	2.98 (0.96)	2.14	.121	n.s
Screen size	3.14 (1.06)	2.63 (0.91)	3.09 (0.82)	4.91**	.009	1,3>2
Reading comfort	3.20 (1.13)	2.80 (0.80)	3.29 (0.80)	4.73*	.01	3 > 2
Font size	2.80(1.08)	2.45(0.87)	3.02(0.91)	5.34**	.006	3 > 2
Text and image resolution	3.54 (0.82)	3.45 (0.76)	3.36 (0.83)	0.56	.571	n.s
Reading fluency	3.69(0.83)	3.20(0.98)	3.71(0.94)	5.10**	.007	3>2
System response speed	3.49 (0.74)	3.20 (0.96)	3.43 (0.99)	1.36	.26	n.s
Ease of interface operation	4.00(0.77)	3.48(0.91)	3.93(0.88)	5.31**	.006	1,3>2

Note. Group 1 = Digital Manga Readers; Group 2 = Webtoon Readers; Group 3 = Mixed Readers.* p < .05. **p < .01.

In the context of reading Webtoons on smartphones, Webtoon Readers reported significantly higher ratings for a unique reading experience (F = 7.02, p = .001) and screen size (F = 5.07, p = .007) than Digital Manga Readers. For reading comfort (F = 10.70, p < .001), font size (F = 6.52, p = .002), Planning of content layout (F = 13.14, p < .001), and Diverse reading experiences (F = 6.41, p = .002), both Webtoon Readers and Mixed Readers reported significantly higher ratings than Digital Manga Readers (Table 3).

Table 3. Differences in Mobile Webtoon Reading Experience Among Different Reader Groups

Variable	Group 1 (n=35)	Group 2 (n=56)	Group 3 (n=58)	*F*	*p*	Post-hoc (Scheffé)
Planning of content layout	3.40(0.88)	4.25(0.61)	3.97(0.84)	13.14***	.000	2,3>1
Diverse reading experiences	3.17(0.99)	3.86(0.92)	3.76(0.90)	6.41**	.002	2,3>1
Unique reading experience	3.34(0.80)	4.02(0.77)	3.72(0.91)	7.02**	.001	2>1
Screen size	3.71 (0.71)	4.18 (0.64)	3.95 (0.71)	5.07**	.007	2>1
Reading comfort	3.57 (1.01)	4.32 (0.58)	4.09 (0.73)	10.70***	.000	2,3>1
Font size	3.74(0.78)	4.27(0.57)	4.14(0.74)	6.52**	.002	2,3>1
Text and image resolution	4.06 (0.73)	4.36 (0.70)	4.22 (0.68)	2.01	.138	n.s
Reading fluency	3.74(0.82)	4.02(0.77)	3.72(0.91)	7.85**	.001	2>1,3
System response speed	3.69 (0.68)	4.02 (0.80)	3.81 (0.87)	2.03	.135	n.s
Ease of interface operation	4.00 (0.73)	4.34 (0.64)	4.17 (0.78)	2.47	.089	n.s

Note. Group 1 = Digital Manga Readers; Group 2 = Webtoon Readers; Group 3 = Mixed Readers. * p < .05. ** p < .01. *** p <0.001.

3.2 Manga Reading Experiment

Based on the mean scores of the UES-SF five-point Likert scale, all six prototypes demonstrated moderately high mean scores across all four dimensions. Among the six prototypes, Mixed Composition × Digital Manga (C-P) achieved the highest mean scores across most dimensions, whereas Fragmentation × Digital Manga (A-P) obtained the lowest mean scores (Table 4).

Table 4. Mean UES-SF Scores for Webtoon and Digital Manga Across Four Dimensions

Dimension	A-P	A-W	B-P	B-W	C-P	C-W
FA	3.69	4.2	4.18	4.24	4.36	4.18
PU	3.09	3.69	3.8	3.93	4.07	3.8
AE	3.84	3.84	4.07	4.22	4	3.93
RW	3.87	4.11	4.09	4	4.24	3.98
Overall Score	3.62	3.96	4.03	4.1	4.17	3.97

Subsequently, Linear Mixed Models (LMMs) were employed to examine the effects of Manga structure, presentation format, and their interaction on the four UES-SF dimensions. For Perceived Usability (PU), a significant main effect of Manga structure was observed (F = 3.54, p = .036), indicating that PU scores differed across Manga structures. No significant main effects of Manga structure were found for Focused Attention (FA), Aesthetic Appeal (AE), or Reward Factor (RW). Furthermore, neither presentation format nor the interaction between Manga structure and presentation format had significant effects on any of the four UES-SF dimensions. These findings indicate that presentation format did not have a significant effect on users' reading experience across the four UES-SF dimensions (Table 5).

Table 5. Linear Mixed Model (LMM) Results of the UES-SF Across Different Formats and Structures

Dimension	Effect	df	*F*	*p*
Focused Attention (FA)	Structures	62.93	1.912	.156
	Formats	72.53	0.963	.330
	Structures * Formats	62.92	2.196	.120
Perceived Usability (PU)	Structures	58.08	3.536*	.036
	Formats	83.39	0.760	.386
	Structures * Formats	58.08	1.962	.150
Aesthetic Appeal (AE)	Structures	63.48	1.563	.218
	Formats	75.07	0.046	.831
	Structures * Formats	63.48	0.294	.746
Reward Factor (RW)	Structures	61.65	0.236	.790
	Formats	80.41	0.061	.805
	Structures * Formats	61.65	0.993	.376

Note. *p<0.05.

Bonferroni-adjusted post hoc pairwise comparisons indicated that Mixed Composition yielded significantly higher Perceived Usability (PU) scores than Fragmentation (mean difference = 0.544, p = .048).No other pairwise comparisons among the Manga structures were statistically significant (Table 6).

Table 6. Post Hoc Pairwise Comparisons of Different Manga Structures on the PU

Comparison I vs J	Mean Difference(I-J)	SE	*p*	Post-hoc (Bonferroni)
A vs B	−0.478	0.224	.112	n.s
A vs C	−0.544	0.219	**.048***	**A<C**
B vs C	−0.067	0.213	1.000	n.s

Note. A = Fragmentation; B = Rhetorical Composition; C = Mixed Composition. *p<0.05.

3.2.1 Analysis of Interface Preferences and Ranking Results Among All Participants

The Friedman test revealed significant differences in preference rankings among the six experimental prototypes ($\chi^2 = 14.99$, $p = .010$), indicating that overall preferences differed across the six prototypes. Among the six experimental prototypes, the Webtoon version of the Mixed Composition (C-W) obtained the lowest mean rank (2.93), indicating the highest overall preference. In contrast, the Digital Manga version of the Fragmentation structure (A-P) obtained the highest mean rank (4.60), indicating the lowest overall preference (Table 7).

Table 7 Preference Rankings of Six Prototypes Structures and Friedman Test Results

Variable	Mean Rank	Rank Order	Statistical Summary
C-W	2.93	1	
B-P	3.13	2	
A-W	3.33	3	N = 30
B-W	3.33	4	$\chi^2 = 14.99$
C-P	3.67	5	df = 5
A-P	4.6	6	$p = .010$*

Note1 . *p<0.05.

3.3 Participant Interviews

The verbatim transcripts from the semi-structured interviews were analyzed using thematic analysis to identify key themes related to the effects of different layout formats on mobile reading experiences. The analysis revealed three primary themes: reading flow, information density, and immersion. Participants consistently emphasized that appropriate gutter spacing in Webtoons helps maintain the reading rhythm, whereas excessive gutter spacing disrupts narrative continuity. Device operability also emerged as a recurring theme, as reading Digital Manga on smartphones often requires frequent zooming, which interrupts the overall reading experience.

4 DISCUSSION

This study investigated the effects of transforming page-based Manga into different digital reading formats for smartphones on users' reading experience. Drawing on Donald Norman's Emotional Design theory, the findings are interpreted through the three levels of visceral, behavioral, and reflective design to explain how different Manga structures and digital reading formats shape users' reading experiences and perceptions (Norman, 2004).

Visceral Level: The mobile reading experience of Digital Manga and Webtoons was jointly influenced by readers' prior reading habits, Manga structure, and digital reading format. The preliminary questionnaire indicated that readers' prior reading experience affected their evaluations of different reading formats. Furthermore, Mixed Readers obtained higher mean scores than both Digital Manga Readers and Webtoon Readers across most questionnaire dimensions. These findings suggest that users with experience reading both Digital Manga and

Webtoons are better able to adapt to different reading interfaces and narrative styles and are less likely to experience a decline in their overall reading experience when the reading format changes. They further indicate that experience with multiple comic reading formats enhances users' adaptability to different digital reading formats.

Behavioral Level: The reading experiment further demonstrated that users' reading experience was primarily influenced by Manga structure and panel composition. Among the three Manga structures, Mixed Composition demonstrated better overall performance in user experience, Perceived Usability (PU), and preference rankings in the Webtoon format, suggesting that appropriately incorporating irregular panel layouts into Manga structure can enhance the mobile reading experience. In contrast, Fragmentation received lower evaluations in both Perceived Usability (PU) and preference rankings in the Digital Manga format. Combined with the interview findings, the results further suggest that panel arrangement and gutter spacing influence users' reading perceptions and overall reading experience.

Rather than simply digitizing printed pages, Manga should be transformed for smartphone reading by restructuring panel arrangements to accommodate scrolling-based interaction. Design strategies such as panel extraction and panel reorganization may provide a more effective approach for adapting Manga to digital reading, offering valuable design implications for the future publication and distribution of Digital Manga.

Reflective Level: Overall, the findings suggest that the effectiveness of digital Manga transformation depends on the underlying Manga structure. Future research could further investigate digital transformation strategies by incorporating additional Manga design elements, such as speech balloons, visual effects, and panel transitions. According to feedback from both interview participants and expert reviewers, excessive gutter spacing in combat scenes may increase scrolling distance when Digital Manga is transformed into the Webtoon format, thereby disrupting reading fluency. This finding supports the argument that panel spacing influences readers' perception of narrative pacing and immersion (Dewey, 2022). The present study extends this perspective by demonstrating that gutter spacing also influences scrolling behavior and reading continuity during smartphone Webtoon reading. Therefore, gutter spacing should be considered a critical design parameter when transforming page-based Manga into Webtoon formats.

These findings further suggest that effective digital transformation should be tailored to the narrative structure and panel composition of Manga, rather than applying a one-size-fits-all conversion approach.

5 CONCLUSION

This study investigated how the transformation of Digital Manga into Webtoon formats for smartphone reading influences users' perception and reading experience through the perspective of Emotional Design Theory. The findings demonstrate that the effectiveness of Digital Manga-to-Webtoon transformation depends on Manga structure, panel composition, and digital reading design. Rather than simply converting printed page layouts into scrolling interfaces,

effective transformation should adapt panel arrangement and gutter spacing according to different Manga structures to better support smartphone reading experiences. These findings provide practical design implications for the future digital transformation of Manga and offer a foundation for future research on mobile comic reading interfaces and Webtoon design.

REFERENCES

Batinic, J. (2017). "Enhanced Webcomics1": An Exploration of the Hybrid Form of Comics on the Digital Medium. *Image & Narrative*, *17*(5). https://www.imageandnarrative.be/index.php/imagenarrative/article/view/1384

Chavanne, R. (2015). The Composition of Comics. *European Comic Art*, *8*(1), 111–144. https://doi.org/10.3167/eca.2015.080108

Cho, H. (2021). The Platformization of Culture: Webtoon Platforms and Media Ecology in Korea and Beyond. *The Journal of Asian Studies*, *80*, 1–21. https://doi.org/10.1017/S0021911820002405

Dewey, M. (2022). Pondering Pauses: Experiencing Stillness in Scrolling Webcomics. *Honors Projects*. https://digitalcommons.spu.edu/honorsprojects/171

Digital 2024: Taiwan. (2024, February 23). DataReportal – Global Digital Insights. https://datareportal.com/reports/digital-2024-taiwan

Schodt, F. L. (1996). *Dreamland Japan Writings On Modern Manga*. http://archive.org/details/dreamland-japan

Jang, W., & Song, J. E. (2017). Webtoon as a New Korean Wave in the Process of Glocalization. *Kritika Kultura*, (29). https://doi.org/10.13185/KK2017.02908

Loh, C. E., & Sun, B. (2022). The impact of technology use on adolescents' leisure reading preferences. *Literacy*, *56*(4), 327–339. https://doi.org/10.1111/lit.12282

Norman, D. (2004). Emotional Design: Why We Love (or Hate) Everyday Things. Basic Books.

O'Brien, H. L., Cairns, P., & Hall, M. (2018). A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. *International Journal of Human-Computer Studies*, *112*, 28–39. https://doi.org/10.1016/j.ijhcs.2018.01.004

Tsai, P. (2011). *A Study of Situation and Flow Experience on Digital Reading* [National Taiwan University of Arts]. https://hdl.handle.net/11296/24aj7d

Eisner, W. (1985). *Will Eisner Theory of Comics and Sequential Art*. http://archive.org/details/Will_Eisner_Theory_of_Comics_and_Sequential_Art