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A Gamification Framework for Crowdsourced Couriers: Turkish E-Commerce Logistic Company Case Study

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Abstract

This study explores the potential of gamification to enhance the motivation and performance of crowdsourced transporters in last-mile delivery by integrating a gamification framework into a state-of-the-art mobile application used by couriers. The framework includes courier profiles, prize badges, and monthly leadership races to increase participation and motivation. A 41-week pilot case study conducted across five logistics company distribution branches evaluated these elements' impact using a one-sided t-test with a significance level of 0.05, revealing statistically significant improvements in key performance metrics across all examined cities. The findings demonstrate that gamification is an effective strategy for increasing courier engagement and efficiency, highlighting its potential to address challenges in last-mile delivery by fostering motivation through competition and recognition. The study contributes to the understanding of gamification in logistics, offering valuable managerial insights for logistics managers and platform developers on designing and implementing gamification elements to optimize courier behavior and operational efficiency. It underscores the importance of customizing gamification features to match courier behavior and motivation patterns, emphasizing that gamification can improve service quality and customer satisfaction. This paper represents the first exploration of e-commerce logistics that integrates a gamification framework of this level of design and application in the literature, offering a novel approach to enhancing courier motivation and performance in last-mile delivery. Future research should explore the broader application of gamification across different stages of the logistics process to assess its long-term impact on performance and operational sustainability.

Keywords: Crowdsourcing; E-Commerce Logistics; Employee Motivation; Gamification; Mobile Application.

1. Introduction

Gamification has gained remarkable popularity in both learning and workplace environments for its capacity to enhance motivation and productivity by creating challenges and opportunities for users to internalize their experiences through gameplay. Gamification aids in developing a better understanding of information within personal or social contexts, as highlighted by (Henning et al., 2017). Engagement in the tasks of users could be accomplished by game elements in gamification, as demonstrated in studies such as Koppitsch & Meyer (2022). This powerful integration of game elements can help players and enterprises improve engagement and motivation levels by realigning existing processes and using gamified approaches, as discussed in (Reis et al., 2020). While the allure of earning points and rewards is a compelling aspect for users, gamification offers more than mere entertainment. It has the potential to drive increased personal productivity and elevate organizational performance within the workplace, as emphasized by Warmelink et al. (2018).

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The COVID-19 pandemic ushered in a world of restricted movements, lockdowns, and remote/hybrid working scenarios in various countries, resulting in heightened time constraints and challenges in balancing professional and personal life. In this context, the significance of thinking smart in supply chain management and intelligent systems, as noted by (Toktaş & Palut, 2022), has become even more critical. The success and reliability of e-commerce companies are closely tied to the performance of logistics services and supply chain management. Customers' experience with the package delivery process is vital in influencing their decision to return to the same e-commerce platform. However, with rising demands and costs, such as gasoline and vehicle prices worldwide, maintaining the motivation of couriers at an optimal level has become a formidable task. Additionally, the nature of logistics tasks, being repetitive and intensive, can lead to declining interest and burnout, as mentioned by (Sainath & Sai, (2023).

Gamification, as a trend across various industries, aims to incorporate game elements into non-game settings to excite and motivate users, as highlighted in (Brigham, 2015). In the context of e-commerce and logistics, gamification can make repetitive tasks more enjoyable, fostering a more positive attitude towards these activities and driving improvements in overall performance, as indicated by (Swacha, 2016). Furthermore, with the advent of Industry 4.0 and technology integration into industries, as discussed by (Schuldt & Friedemann, 2017), the advantages of gamification have become increasingly evident, making it a valuable asset in sectors like e-commerce and logistics.

Despite the growing adoption of gamification, its implementation in logistics and courier services remains relatively underexplored, particularly within crowdsourced courier systems. Crowdsourcing is a distributed problem-solving approach that transforms problems and tasks into solutions by operating the potential of large groups via online applications rather than traditional employees. The success of crowdsourcing depends on a mass of motivated crowdsourced workers, making it crucial to design engagement strategies effectively. Many crowdsourcing platforms have increasingly incorporated motivational design features borrowed from games, a practice often called gamification Morschheuser et al., 2017). However, while gamification has been widely applied in workplace motivation and consumer engagement, research focusing on its effectiveness in sustaining the motivation and efficiency of crowdsourced couriers is limited.

The current study addresses this gap by analyzing the impact of gamification in crowdsourced courier systems based on Bartle's player typology for Multi-User Dungeons (MUDs) and Marczewski's Gamification User Types Hexad framework (Tondello et al., 2016). While Bartle's typology is widely recognized in gamification literature, it was originally designed for MUDs and may not generalize across other game genres or gameful designs. To address this limitation, Marczewski proposed the Gamification User Types Hexad, a framework that incorporates research on human motivation, player types, and practical design experience. This framework categorizes users into six types and suggests different game design elements tailored to their motivational drivers.

By applying the Hexad model, this study examines how different user types interact with gamified elements within crowdsourced courier platforms. Specifically, we explore how game mechanics such as leaderboards, rewards, progress tracking, and social interactions can influence the motivation and performance of crowdsourced couriers. Understanding these dynamics is crucial for designing effective gamification strategies that enhance engagement, reduce burnout, and ultimately improve delivery efficiency within e-commerce logistics.
Figure 1 illustrates the six user types from the Hexad model.

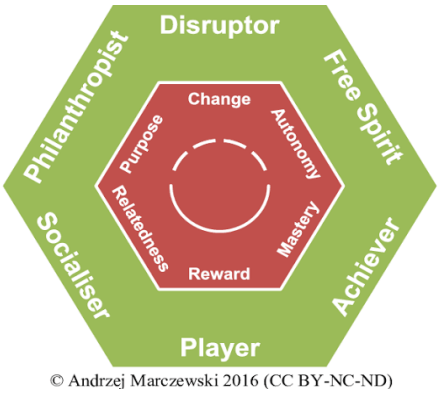

Figure 1. Six user types from the Hexad model (Tondello et al., 2016).

The user types and the game design elements suggested by Marczewski to address the motivations of each type of below:

- Philanthropists are motivated by purpose. They are altruistic and willing to give without expecting a reward
- Socializers are motivated by relatedness. They want to interact with others and create social connections
- Free Spirits are motivated by autonomy, meaning freedom to express themselves and act without external control. They like to create and explore within a system
- Achievers are motivated by competence. They seek to progress within a system by completing tasks, or prove themselves by tackling difficult challenges
- Players are motivated by extrinsic rewards. They will do whatever to earn a reward within a system, independent-ly of the type of the activity

This study aims to contribute to the existing literature by providing empirical insights into the effectiveness of gamification in enhancing the engagement and efficiency of crowdsourced couriers. By leveraging the Hexad model, we offer a structured approach to designing gamified courier systems that align with the motivations of different user types, ensuring sustainable and effective workforce engagement in the evolving landscape of e-commerce logistics.

2. Literature Review

Gamification theory has been used for purposes such as motivating companies' employees, attracting their customers' attention, and creating an alternative to traditional advertisements. Gamification is applied in many domains such as education, information studies, human–computer interaction, and health (Seaborn & Fels, 2015). Many companies invest in Gamification systems and frameworks to increase their users' participation and add fun elements for a better experience in monotonous tasks (Oliveira et al., 2023).

Gamification encompasses certain elements aimed at enhancing motivation to achieve specific goals. Among these elements are badges, leveling systems, and similar components, which emerge as significant tools to encourage user engagement, elevate interaction levels, and incentivize desired behaviors. Hamari (2017) conducted a study investigating the impact of gamification, specifically a badge system, on user activity in a sharing economy service, such as a peer-to-peer marketplace. The research observed users earning badges through common actions and tasks on the platform, aiming to assess the positive effects of badge implementation on user engagement. The study, spanning 2 years with a pre-implementation group observed for 1 year and a post-implementation group monitored for an additional full year, revealed that users in the gamified condition exhibited significantly higher engagement, including increased trade proposals, transactions, comments, and overall usage of the service.

Landers et al. (2017) conducted a study to investigate the impact of leaderboards on employee performance within the gamification context. In the experiment, participants engaged in a classic brainstorming task gamified with a leaderboard. Four traditional goal-setting levels were randomly assigned to participants alongside a leaderboard displaying initials and scores that mirrored the goal-setting conditions. The presence of the leaderboard effectively motivated participants to performance levels comparable to those set by difficult and impossible goals. This suggests that participants implicitly set goals aligned with or near the top of the leaderboard without explicit prompting. The study also assessed goal commitment, a common individual difference moderator in goal setting theory, and found that it behaved similarly in the presence of the leaderboard as it did when traditional goals were provided.

Meder et al. (2018) experimented with 20.000 users in the mobile e-commerce application in order to investigate the effect of intangible and tangible rewards in gamification. In general, gamification has been seen to increase user interaction, but this increase varies according to the type of reward. The tangible reward group was 4.1 times more active than the intangible reward group, at the same time, the intangible reward group was 1.12 times more active than the non-gamified group. Liang et al. (2017) researched the user impact of the Superhost badge on Airbnb. They concluded that those who have this badge receive more positive reviews and that guests spend more. In an article authored by Putz-Egger et al. (2022), the logistics and transportation industry's significant challenge of coping with a global shortage of skilled workforce is addressed. The study explores the integration of gamification with augmented reality (AR) as a novel approach to attract interest in the logistics sector. The article aims to determine whether an AR-based application is a viable strategy for enhancing the attractiveness of logistics jobs. The assessment indicates

that the combination of gamification and augmented reality holds promise as a tool to attract individuals to the logistics sector and reshape their perceptions of logistics professions. It can be concluded that the gamified AR approach has the potential to increase interest in jobs within a specific industry.

Alanazi et al. (2025) explores how gamification influences customer engagement in the hospitality sector in KSA, focusing on dimensions like enjoyment, usability, usefulness, and social influence. Surveying 726 five-star hotel guests in Riyadh, the research applied structural equation modeling (SEM) to test its hypotheses. Findings suggest that these gamification elements positively impact engagement, leading to recommendations such as loyalty programs with rewards and badges to enhance customer participation. Bitrián et al. (2024) investigate the impact of gamification on e-training systems for information security and data protection. Analyzing data from 1,178 employees using structural equation modeling, they find that gamification enhances information quality, system quality, and enjoyment, which in turn improve perceived usefulness, satisfaction, and security self-efficacy. Additionally, a study on phishing responses confirms that gamified e-training reduces susceptibility to attacks and promotes better security behaviors. Lai and Langley (2024) examine the increasing use of gamification in FinTech intermediation, highlighting its role in shaping user behavior through socio-technical knowledge, behavioral science, and UX/UI design. Their analysis of case studies, including TMRW bank, Razer, and Ant Forest, demonstrates how financial and technology firms leverage gamification to enhance user engagement and competitive positioning. The study also emphasizes the labor market implications of these shifts, with growing demand for expertise in digital marketing and UX/UI design. Additionally, they suggest that new performance metrics, such as Net Promoter Scores and App Store ratings, may become more relevant in evaluating FinTech success. Cheung and Willoughby (2024) explore how gamification can enhance technology adoption among older adults, addressing the challenge of lower adoption rates due to design biases favoring younger users. Using a purpose-built gamified learning system on a mobile payment platform, they applied structural equation modeling based on the Technology Acceptance Model. A study in Hong Kong revealed that gamification significantly improved knowledge transfers and adoption intentions among older adults, highlighting its potential to support digital inclusion. The findings suggest important policy implications for the silver-hair market, emphasizing the role of gamification in facilitating technology acceptance in aging populations.

3. Methodology

The research project is structured with a series of sequential steps. Commencing with User Profile Analysis, the study delves into understanding the characteristics and preferences of the target audience. Subsequently, data analysis is used to analyze relevant data and extract meaningful insights. The project progresses to Implementation, where strategies and methodologies are implemented based on the insights gained. Finally, the study culminates in the Analysis of the Results, a critical phase where the outcomes are thoroughly examined and interpreted, providing a comprehensive understanding of the research findings. This systematic approach ensures a thorough and methodical exploration of the subject matter, fostering a rigorous and insightful research process.

3.1. User Profile Analysis

Quantitative and qualitative research were conducted to analyze courier profiles. Quantitative data are obtained from courier performance parameters such as number of daily packages, turnover rate, and surveys. Qualitative data are obtained from meetings with couriers, reasons for leaving the job, meetings with training departments, and investigations of distribution and cross-docks. Courier profile analysis studies started with analyzing operational data. Courier performance and operational factors affecting performance were examined.

Courier Turnover Status. To thoroughly investigate and comprehend the turnover among couriers, an in-depth analysis was conducted by engaging in interviews with couriers who resigned within a six-month timeframe. The focus was explicitly on discerning the reasons behind their decision to leave. Upon reviewing the findings presented in Table 1, it is evident that a significant proportion, namely 47%, opted to leave their courier job in pursuit of alternative employment opportunities during the observed six-month period. This data sheds light on the primary cause of courier turnover and emphasizes the notable prevalence of couriers transitioning to other job opportunities within the specified timeframe. The comprehensive exploration of these departure motives contributes to a more nuanced understanding of courier turnover dynamics within the studied period.

Table 1. Reasons behind courier's turnover

Reasons for Leaving	Rate
Found another job	47%
Left on trial	12%
Disciplinary behavior	10%
Not provided a vehicle	8%
Financial problems	6%
Family problems	5%
Not provided a vehicle after car accident	4%
Health problems	3%
Unable to start a company	3%
Unable to acquire necessary documents	2%
Moving to somewhere else	2%

Delivery Performance. Distribution performances of 311 couriers from different distribution areas over a two-month period were analyzed. Within this two-month period, the-longest term couriers delivered for 47 days and the shortest-term couriers delivered for 5 days. Number of the daily average deliveries was calculated to be 64, and the standard deviation was calculated to be 18.8. When we look at the number of days worked, couriers ran their operations on an average of 42 days with 9.2 standard deviation (see Table 2).

Table 2. Courier Performance Statistical Metrics

	Mean	Standard Deviation	N
Daily Package	64,3762	18,8487	311
Days Worked	42,0418	9,2161	311

Courier Survey. In order to determine courier profiles, "The Gamification User Types Hexad Scale" method (Tondello et al., 2016) was used. Within this scope, in order to determine the user types, the Turkish Version of the Gamification User Type Hexad Scale (Akgün & Topal, 2018) questionnaire with a total of 24 questions was sent to cross-docks, and the couriers were asked to fill this questionnaire anonymously. In addition to 24 questions, couriers were asked to evaluate their satisfaction with using the mobile application and working with the company on a scale from 1 to 10.

3.2. Data Analysis

A total of 215 questionnaires from 13 cross-docks were evaluated. Received questionnaires were fed into the system through the website in order to determine user types according to Hexad Gamification Technique (Tondello et al., 2016). Cross- Docks and their corresponding average mobile app and overall satisfaction can be seen at Table 3. The survey results were analyzed on a cross-dock basis (see Table 4). The most prominent user type for couriers found to be "Philanthropist" with a percentage of 18.9%, followed by "Socialiser" with 18.3%.

Table 3. Average mobile app and overall satisfaction survey statistics.

Cross-Dock	Survey Count	Mobile App Satisfaction	Overall Satisfaction
1	30	8,3	8,9
2	23	8,1	9,8
3	20	6,6	9,5
4	20	5,8	8,3
5	18	8,3	9,2
6	16	8,2	8,9
7	15	8,2	8,7
8	14	7,5	7,8
9	14	8,6	8,5
10	13	8,3	8,3
11	11	7,9	8,6
12	11	7,2	9,3
13	10	9,5	9,8
Total	215	7,8	8,9

Table 4. Couriers' Hexad Gamification survey result statistics.

Cross -Dock	Philanthropist	Socialiser	Achiever	Free Spirit	Player	Disruptor
1	5,8	5,5	5,3	5,5	5,0	2,9
2	4,3	4,4	4,0	4,0	3,9	2,5
3	3,8	3,7	3,4	3,3	3,3	2,5
4	3,8	3,6	3,4	3,5	3,2	2,4
5	3,4	3,2	3,2	3,1	3,2	2,0
6	3,3	3,1	2,9	2,5	2,6	1,6
7	2,8	2,8	2,6	2,6	2,4	1,8
8	2,7	2,6	2,5	2,3	2,3	1,7
9	2,7	2,5	2,6	2,4	2,3	1,6
10	2,2	2,1	2,3	2,2	2,2	2,2
11	2,1	2,2	2,0	1,9	1,8	1,1
12	2,2	2,1	2,0	1,8	1,7	1,2
13	1,8	1,8	1,7	1,8	1,8	1,2
Sum	40,6	39,4	37,9	36,7	35,7	24,6
Perc.	18,9%	18,3%	17,6%	17,1%	16,6%	11,5%

The satisfaction rate for Mobile App is 7.8 on a scale of 10 (see Figure 2). Average satisfaction rate of couriers working for the company is 8.9 on a scale of 10 (see Figure 3). Upon looking at the relationship between transporters' satisfaction with mobile applications and their satisfaction with working, the scatter graph comes out as follows. There is no linear relationship between the two (see Figure 4). Their satisfaction with the mobile application is lower than the overall satisfaction.

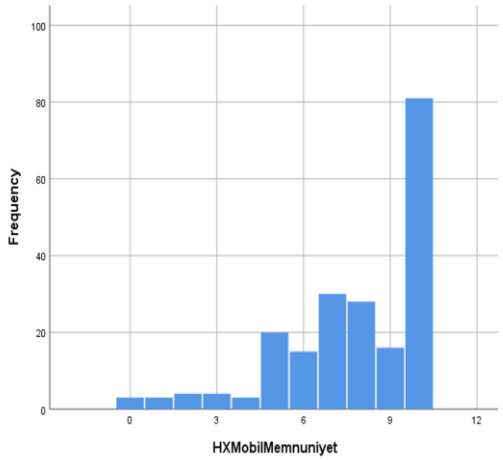

Figure 2. Courier mobile app satisfaction.

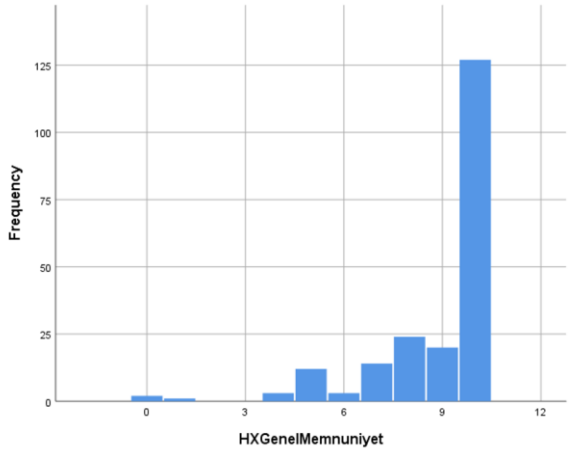

Figure 3. Overall company satisfaction of couriers.

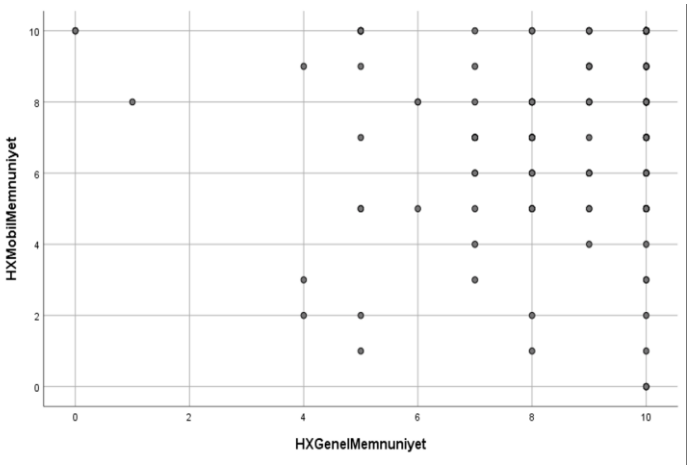

Figure 4. The relationship between mobile application and overall satisfaction of couriers.

User motive combinations. Some of the underlying motivations of these types of users are related to each other. Achievers and Players are motivated by success, but their focus differs; while Players focus on external rewards Achievers focus on competence. Philanthropists and Socialisers are motivated by interacting with other people, but the interest of Socialisers lies in the interaction itself, while Philanthropists' interest lies in helping others. Both Free Spirits and Disruptors are motivated by creativity and autonomy. Having said that, Free Spirits stay within the boundaries of the system with no intention of altering it or interfering with it, whereas Disruptors try to break the limits and change the system. 18.9% of couriers showed a tendency towards Philanthropist, while this rate is 18.3% for Socialisers, 17.6% for Achievers and 11.5% for Disruptors (Tondello et al., 2016).

3.3. Implementation

Gamification system implementation layers are structured as follows: job success score calculation, level design, courier leadership race, and badges.

Job Success Score Calculation. The criteria used for calculating the Job Success Score were successful delivery, and number of days worked by courier. These criteria had different weights. While the weight of successful delivery was 80%, the weight of the number of days worked by the courier was 20%.

Level Up Rules. After calculating the job success score for each active courier, the current level of the courier is determined. Levels serve as a marker for players to know where they stand in a gaming experience over time. In game design, level difficulty is not linear (Zichermann & Cunningham, 2011). A leveling algorithm was used to detect levels. A new courier started at level 1 and can go up to level 20. Rising to the next level is increasingly harder. The formula for this calculation was given in the following formula (1).

$$next\_level = 500*(level\text{^}2) - (500 * level) \quad (1)$$

By using the formula above, the job success score range to be reached for each level has been calculated and shown in the table below (see Table 5). The courier's current level is determined according to the corresponding range in this table.

Table 5. The courier's levels and required experiments.

Level	Required Exp.	Level	Required Exp.
1. Level	0	11. Level	55.000
2. Level	1.000	12. Level	66.000
3. Level	3.000	13. Level	78.000
4. Level	6.000	14. Level	91.000
5. Level	10.000	15. Level	105.000
6. Level	15.000	16. Level	120.000
7. Level	21.000	17. Level	136.000
8. Level	28.000	18. Level	153.000
9. Level	36.000	19. Level	171.000
10. Level	45.000	20. Level	190.000

Courier Leadership Race Design. The purpose of a leaderboard is to make simple comparisons. Unsurprisingly, most people don't need any explanation when they encounter a leaderboard (Zichermann & Cunningham, 2011). Levels and leaderboards by themselves neither make nor break users' intrinsic motivation in non-game contexts. Instead, it is assumed that they act as progress indicators, guiding and enhancing user performance (Mekler et al., 2013). Regarding accomplishment elements, leaderboards are to be designed with care to avoid demotivating. The end users should be compared with meaningful people and they should not be placed at the bottom of a ranking, but instead between other users (Zichermann & Cunningham, 2011).

In this study, leaderboard design has been made considering user motive combinations (see Table 4). Since the positive effects of the user motive combinations (Sailer et. al, 2017), we focused on social competition and teamwork. While making the leadership ranking, it is planned to create social competition by evaluating couriers from each region within itself. Couriers can see the 3 highest-performing couriers and their own rank in the region they work (see Figure 5). Couriers' scores are used as ranking criteria. Scores are calculated according to 3 performance criteria: Delivery performance, average evaluation points and route compliance rate. These performance criteria had different weights since their importance differed. While the weight of delivery performance was 70%, it was 25% for average evaluation scores and 5% for route compliance rate.

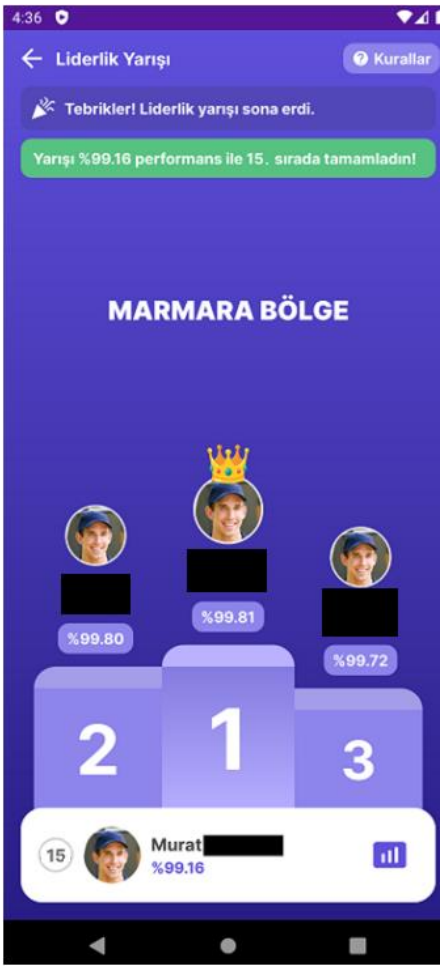

Figure 5. Leadership race mobile application screenshot

Another teamwork factor is "cross-docks wars" which is designed by qualifying the most successful cross-docks of the month. Each courier can see his/her individual contribution to the cross-dock performance he / she works**.**

Badges. For game designers, badges are an excellent way to encourage social promotion of their products and services. Badges also mark the completion of goals and the steady progress of play within the system (Zichermann & Cunningham, 2011). The virtual car gallery has been designed as a reward system in the badge module due to its compliance with the courier profile. Badge level was determined based on the number of packages distributed by each courier. Couriers will be eligible to choose a new vehicle when they double the number of delivered packages. Mobile application badge pages' screenshots are given in Figure 6.

Table 6. The courier's badges and required number of transactions.

Coefficient	Number of Transactions	Car Category
2	10.000	A1
2	20.000	A2
2	40.000	A3
1,5	60.000	B1
1,5	90.000	B2
1,5	135.000	B3
1,2	162.000	C1
1,2	194.400	C2
1,2	233.280	C3
1,1	256.608	S

When the courier reaches each of the transaction numbers in the table above, it will be entitled to add one new vehicle to his/her virtual gallery. Vehicle selection is planned to start from at least 10,000 (2018 average) transactions.

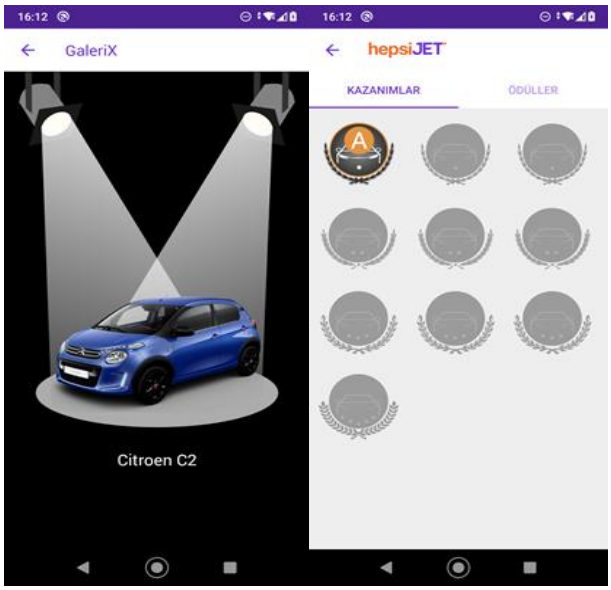

Figure 6. Mobile application badge pages' screenshots.

3.4. Hypothesis Testing for Performance Change

The study meticulously employed a one-sided t-test, a powerful statistical method chosen to rigorously evaluate the influence of gamification on last-mile delivery performance. This method allowed for a nuanced examination of the mean performance differences between the experimental and control groups. With a pre-established significance level (α) of 0.05, the analysis of p-values (p_cityid) became a critical component of the hypothesis testing process. The null hypothesis (H0) postulated that there would be no significant divergence in performance, while the alternative hypothesis (H1) anticipated a positive impact of gamification. The consistent attainment of p-values below the significance threshold bolstered the empirical evidence, providing compelling grounds for rejecting H0 and supporting the conclusion that gamification led to a statistically significant improvement in last-mile delivery performance.

In assessing the reliability of the statistical results, special attention was devoted to normality assumptions. Ensuring that the distribution of the data approximated a normal curve was crucial for the validity of the analysis. Furthermore, confidence intervals were systematically considered to provide a comprehensive range within which the true effect

size of gamification on performance was likely to reside. This meticulous statistical methodology, which intricately combined a one-sided t-test, a predetermined significance level, rigorous adherence to normality assumptions, and careful consideration of confidence intervals, not only fortified the robustness of the findings but also contributed to the academic rigor of the study. Such a comprehensive approach facilitated a profound and insightful understanding of the sustained effects of gamification on the intricate dynamics of last-mile delivery performance.

4. Experiment

This study embarked on a comprehensive exploration of the influence exerted by gamification strategies on weekly courier performance across diverse urban environments. Using a statistical research design, two branches were meticulously chosen in each of the five cities, ensuring a harmonized alignment regarding geographical coverage, operational scale, and demographic characteristics of served neighborhoods. The overarching objective aimed to gauge the statistical significance of integrating gamification elements, with a focus on enhancing key performance indicators, including weekly delivery counts, courier numbers, and a composite metric comprising on-time delivery, customer ratings, and route compliance rates.

The validity of this experiment extends from its robust experimental design and methodological rigor. The careful selection of comparable branches within each city played a pivotal role in eliminating potential confounding variables, ensuring that any observed differences in courier performance could be confidently attributed to the introduction of gamification strategies. This meticulous branch selection process, which considers geographical, operational, and demographic aspects, enhances the internal validity of the study.

Table 7. City based performance change hypothesis testing results

City ID	p value	Performance Change
1	0.001*	+1.23567
2	0.003*	+0.87654
3	0.002*	+1.51234
4	0.004*	+0.92345
5	0.002*	+1.37456
* signed rows are below the significance level of 0.05		

To further fortify the study's validity, a rigorous comparative analysis was conducted to ensure the baseline comparability of the selected branches. This comparative analysis, which employed statistical methods to validate the comparability of the experimental and control groups, helped establish a solid foundation for assessing the impact of gamification interventions on courier performance metrics. The experimental group, exposed to gamification elements such as performance-based incentives, recognition programs, and competitive challenges, was carefully delineated from the control group, which adhered strictly to conventional operational practices, providing a clear contrast for evaluation.

In this study, the weighting of performance metrics was determined in collaboration with the operation team, ensuring alignment with real-world logistics priorities. Delivery performance was assigned the highest weight (70%) because it directly impacts operational efficiency and customer satisfaction. Average evaluation scores, weighted at 25%, reflect customer feedback and service quality, which are essential for maintaining a positive user experience. Lastly, route compliance rate was given a 5% weight, as adherence to optimized routes contributes to efficiency but has a relatively lower impact compared to the other two criteria. These weightings were established based on the operation team’s expertise and practical considerations in last-mile delivery management.

Statistical analysis was executed using a one-sided t-test framework with a predefined significance level (α) of 0.05. The consistent and statistically significant results across all cities, as evidenced by p-values (p_cityid) consistently falling below the significance threshold given in the Table 7, underscore the external validity of the findings. This uniformity in results across diverse urban landscapes reinforces the generalizability of the observed impact of gamification on courier performance, emphasizing the robustness of the statistical outcomes.

The experiment's validity is further strengthened by the duration of the study. The collection of data over 41 weeks provides a robust dataset for evaluating the sustained impact of gamification on courier services. This extended

duration is especially valuable for hypothesis testing, aligning with normality assumptions and ensuring that the distribution of weekly courier performance data approximates normality over the course of the experiment. The prolonged observation period enhances the reliability of the statistical findings, allowing for a comprehensive and nuanced understanding of the sustained effects of gamification on courier performance.

5. Conclusion

To enhance the sustainability and success of crowdsourced transportation, this study proposes a gamification framework implemented through a mobile application. By integrating gamification elements such as courier profiles and monthly leadership races, the research demonstrates positive effects on courier motivation and participation.The structured research project, characterized by user profile analysis, data analysis, implementation, and analysis of results, ensures a comprehensive and methodical exploration of the subject matter. The gamification system's implementation layers, including job success score calculation and level design, contribute to a dynamic and engaging experience for couriers.The empirical findings, supported by a robust statistical research design and analysis, demonstrate a statistically significant improvement in key performance indicators across diverse urban environments. Employing a one-sided t-test framework with a predefined significance level (α) of 0.05, consistent p-values falling below the significance threshold underscore the external validity, highlighting the statistical outcomes' robustness. The careful selection of comparable branches and a rigorous comparative analysis, validating the comparability of experimental and control groups through statistical methods, enhance the study's internal validity. The 41-week duration strengthens the study's reliability, allowing for hypothesis testing alignment with normality assumptions and providing a nuanced understanding of gamification's sustained effects on courier performance. This research contributes valuable insights into gamification's role in addressing last-mile distribution challenges and motivating crowdsourced transporters, with statistical proof reinforcing the study's credibility.

Additionally, the study provides key managerial insights by illustrating how gamification elements can be strategically applied to improve courier engagement and efficiency. These insights offer practical guidance for logistics managers and platform developers aiming to optimize crowdsourced transportation systems. Gamification could be an important tool to be applied to other employees of logistics such as first-mile couriers. Additional research should be conducted to investigate the effects of gamification throughout various stages of logistics.

Future research could explore the long-term effects of gamification on courier retention, customer satisfaction, and overall operational efficiency in last-mile delivery. Additionally, investigating the impact of different gamification elements across various stages of the logistics process, such as warehousing and order fulfillment, could provide deeper insights into its broader applicability. Comparative studies across different geographic regions and logistics models could further refine the understanding of how gamification influences performance in diverse operational environments.

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