Designing Human-Centric Application to Improve Service Quality of Spatial Usage for Community Mall Projects

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Abstract—This research is a case study context about designing a wayfinding system for a large-scale community mall in Thailand. Many functions of the huge area such; shopping, service, food courts, activity, car park areas and so on. These functions made administrators confront the dissatisfaction of customers when they desired to find their target place in the community. Therefore, this study aims to enhance the wayfinding service system by using application technology to guide people to find their places in the large-scale community mall. The Human Centered-Design (HCD) concept was applied to integrate the requirements of stakeholders in the project. The concept was also employed to develop the application system design and evaluation the use of wayfinding behavior from several ages of target users. The overall evaluative scores remain at strongly agreed levels including the factors of correcting direction, understanding of map symbols, UX/UI, and design legibility.

Index Terms—Human centered-design, graphical wayfinding system, information visualization

I. STATEMENT OF PROBLEM

The way-finding concept focuses on the cognitive aspect of navigation in terms of usability. The strategic and tactical elements that guide movement are its main focus [1]. The 'cognitive map' also known as a mental map, is an important aspect of wayfinding that focuses on the use and builds a guideline conceptual framework [2]. It also includes the production of knowledge about users' cognition and comprehension based on interpretative information supplied in a pattern of symbolic and pictorial representation [3]. The fundamental ideas and variables that go into creating a successful wayfinding system and the function of environmental graphic design in organizing graphical messages in the way-finding system. One of the most important capacities of agents such as autonomous robots, animals, and humans is the ability to locate points in their environment [4]. A wayfinding system outlines how an individual comprehends a new environment and the cognitive processes necessary to navigate from one area to another [5][3]. Even though they do not have a common goal or language, a way-finding system brings people together. It can direct them to the same location via a single communication system [6]. This system consists of two parts: (a) information collection and (b) decision-making processes that humans employ to orient themselves and move around in space [7]. The success of the way-finding design is determined by three variables: (1) the character of the individuals in the environment; (2) the people who will be the system's target users; and (3) the sort of environment in which the system will be implemented [6].

A. Setting Areas

Ton Tan Market operates a Community Mall for families and teens nature who want a place to relax and buy goods and services. The project has allocated space for various types of stores including; fashion stores, decorations, food and beverage, outlets, selling zones, a multipurpose performance venue, and an exhibition hall. There are more than 5,000 customers a day in the market, and there are more than 400 shops to serve consumers in an area of 6,400 square meters, with four parking zones to support and facilitate. However, Ton Tan Market will receive an outstanding entrepreneur award for the year 2019 from the Khon Kaen Chamber of Commerce. But from asking about problems from market executives in the early market, it was found that a large number of customers who come to use the service have difficulty finding routes, zones, products, and services within the project. Due to the large area of the project and there are separate zones for shops and various services, such as temporary shops, fashion, souvenirs, handicrafts, restaurants, beverages, activity grounds, museums, etc. In addition, the project also has four large parking areas. which the operator has mentioned the problem of connecting points to provide route information to customers between the parking lot arriving within the market. As above problems affect the quality of service within the project in the view of entrepreneurs selling products in the market and customers who use the services in the market. The aims of this research include; 1) Study the context of spatial usage within the market and view of demand including giving service behavior and the receiving service behavior of stakeholders within the market based on the human-centered theory of design. 2) Develop environment graphics and route search application system, to increase service efficiency by using digital technology within a large community market. 3) Evaluation of the target search behavior from the application system.

II. PARTICIPANTS

The research participation includes 4 groups of stakeholders includes;

Group 1 Ton Tan Market Executive Representative (2 people)

Group 2 representatives of the shopkeeper (6 people)

Group 3 group of representatives of service users within the Ton Tan Market (6 people)

Group 4, Sampling Group for users in Ton Tan Market (30 people)

Total 44 people

III. RESEARCH DESIGNS

In the research design process, the researcher has applied the conceptual framework of Human-Centered Design (HCD) theory according to ISO:13407 [8–9] as a guideline for formulating and developing research methods. In this topic, the researcher will explain the steps of the operation. It is classified into 6 phases as detailed below.

First Phase: The researcher analyzed and compiled related documents including environmental graphic design, map design principles, creating a pictogram system along with studying and analyzing related research and theories that will be applied in research, including information design theory and human-centered theory of design. The researcher analyzes the problem and inquiries about needs with entrepreneurs' problems to improve the service of searching routes within the market along with the review of relevant documents and research.

Second Phase: the researcher has collected data on usage in the area, consisting of; 1) land used to study and various zones in the project. 2) Function analysis and service within the project area and the number of shops, and point nodes at various intersections in the project; as well as studying the environment and the structure of the area in the context of buildings, structures, environments, and thoroughfares in Ton Tan Market. 3) The researcher asked questions from executive representatives (Group 1), operator representatives (Group 2), and customer service representatives (Group 3). The questions focused on finding service zones within the project and designing research tools that will be used to collect data to be suitable for the selected experimental group. In this process, case study data will be collected to observe the phenomenal perspectives on the behavior of using the area in search of target groups of sugar palm market users. The results obtained from this data were analyzed in a triangulation method combined with collecting documentary information, theory, and observation results. The results of this analysis will be synthesized and defined as design concepts before entering the design and development process of the graphical route map prototype.

Third Phase: In this step, a triangular analysis of the data is carried out by taking the field data from areas 1 to 3, analyzing and correlating the relationships before forming design concepts of environmental graphics for routing within the project. At this stage, this includes the development of a conceptual framework for creating a working diagram of a Wayfinding System Application that will be used as a digital route finder within the project. The details consist of; The content analysis of the relevant papers and research is completed. The researcher analyzed the data obtained from the observation of phenomena in the field in 3 aspects: 1) the target search behavior of the insider group and outsiders' groups 2) a study of the environment and the structure of the area in the context of buildings, structures, and environment, and 3) traffic routes in the Ton Tan Market area. After the observation, the researcher performed a note-taking analysis by typological analysis of the data set into sections by typological analysis. The analysis classifies the data into tiers that begin with the search for a group of keywords. The researcher recorded each event to expand the relationship to find the relationship

with the word group recorded in other events that are continuity or significant by using the domain analysis technique. After the researcher has finished analyzing the data of each aspect. The researcher used the results of the keyword group analysis of each data set obtained from field observations to aggregate the triangulation analysis [10–11]. The variables obtained from the synthesis and conclusion of Analytic Induction will be defined as a Design Concept to serve as a framework in the process of designing and developing a prototype graphical route map of the market.

Fourth Phase: The design at this stage brings the Design Concept and Application Site-map in Phase 3 to design and develop into a set of environmental graphical map signs to tell directions within the node points of the project. This process includes application development, and project path discovery, where the entire graphical environment will be compatible with the manufactured application system.

Fifth Phase: at this stage evaluated the wayfinding application that the researcher has produced with the sampling group within the market (Group 4); to analyze and assess the defects of the prototype and bring it to complete amendments. The details in this step consist of; the evaluation of the efficiency of the utilization of the prototype route mapping system consists of; two main evaluation components: 1) the evaluation form of the wayfinding application system usage. This component has the sub-dimensions in the assessment consisting of user interaction (UI) design, usability efficiency, and design comprehension and satisfaction. 2) the environmental graphics system assessment form with sub-dimensions consisting of; the assessment of the wayfinding map system of the market and on the side of the prototypical guidepost. The four key assessment issues based on O'Neill's [12] wayfinding accuracy theory consisted of 1) understanding of the path system within the market 2) understanding of the symbols displayed on the wayfinding mapping system 3) understanding of the route directions that appear on the map system 4) the understanding of the graphical building and 5) the understanding of the icons of the facilities shown on the map.
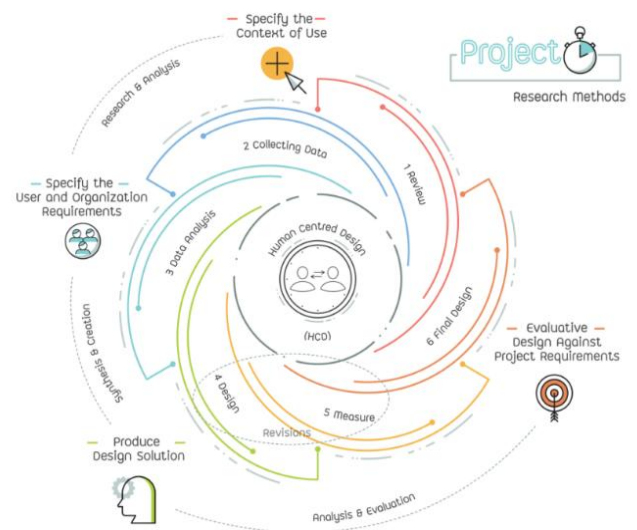

Fig. 1. The methods of this study applied the concept HCD [14]

Sixth phase: In this step, it is to take the reflection from the previous phase to modify it to be a complete design and to transfer knowledge of technology to use to entrepreneurs. However, if the results of the assessment in all dimensions and the sum of the score criteria in each aspect and an overall criterion of more than 2.7 or more than 67% are considered to have met the criteria for assessing the quality of public information design that can be implemented by the requirements of ISO7001 [13]. (Fig. 1 presents research methods)

IV. KEY FINDINGS

Based on the key research findings, the researcher classified the dataset into 3 parts, consisting of steps 1) before design. (Pre-Design), 2) the design process (Production) and 3) the evaluation stage (post-production), with details of important research data as follows:

Finding 1: (pre-design) the key results found in this section reflect the relative dimensions of the spatial application context within the upmarket and demand perspective. Research findings include service behavior and intra-market services derived from the integration of all stakeholders' ideas based on the human-centered theory of design. From the results of in-depth interviews with users of Ton Tan Market both one-time and regular users of 6 people found that finding the place you want to go is inconvenient and requires asking for directions from the shop owner or other users nearby; because there is no map or signpost within Ton Tan Market. While the customer group Regular users will be proficient in the route. Moreover, the problems that executives want to urgently solve are preparing a map of the wayfinding system and signs that will be used within the market to provide services to customers who come to use the service. Because the market has a large area and has a large number of users. There is also marketing by bringing tourists both domestic and foreign to use more services in the market. Therefore, mapping systems and road signs are urgently needed and the market needs to be prepared to support the use of the services of a large number of one-time customers in the future. Zones of service areas within the Ton Tan Market are classified into 5 types: 1) activity fields as 7 points 2) Service points such as offices, restrooms, and ATMs, 3) Brand-name stores, 4) parking as 5 places, 5) food courts, and 6) a pick-up point for group tours.

Finding 2: (production-wayfinding map systems) After the researcher took the demand analysis data from the stakeholder groups, the data was developed into a market wayfinding map prototype. Fig. 2 shows the prototype design and development process and Fig. 3 presents the first draft of the wayfinding map prototype.

Fig. 2. Example of steps for developing Wayfinding Map graphics from the schematic diagram

Fig. 3. The first draft of Wayfinding Map and environmental graphic design of market

Finding 3: (production application systems) this part is the design of an application system that works together with the graphic environment of the Way Finding Map system. The internal function that has been designed consists of 6 topics: 1) sugar palm market information, 2) news, 3) location search, 4) product image and atmosphere, and 5) contact the market. The topics in the application are drawn from the needs of sugar palm market executives and customers who use one-time services. An example of application system design and development is shown in Fig. 4.
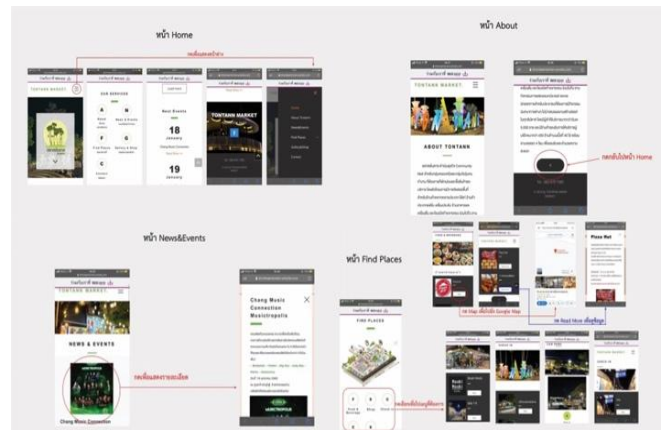

Fig. 4. The function of the wayfinding application system of the Ton Tan market

Finding 4: (evaluation–post-production) This section is an assessment of target search behavior data from the application of a route search application system to optimize service to market customers. The results of the assessment found that 50% of the participants were males and females at 50 percent. while the age group of those who participated in the trial had the most participants being 21–25 years old at 36 percent; the age group 26-30 years came in second place with a value of 26.7 percent; the third place was the age group between 15–20 years, with an average of 16.7 percent and aged between 31–40 years and 41–45 years old an average of 10 percent. Therefore, it can be seen that the experimental group who use the services in the market is between 15–30 years old, which is the proportion with the highest volume. However, the assessment was divided into two parts: 1) the wayfinding map system environment graphical use assessment; and 2) the wayfinding map system usability assessment of the wayfinding application system. The assessment was in the form of a rating scale, sorted from a score of 5 strongly agree to 1 point, very disagree.

TABLE I. THE ASSESSMENT OF THE USING WAYFINDING MAP

TOPICS	N	Min	Max	Mean	Std.
Comprehensive wayfinding within the market?	30	3	5	4.00	.525
Comprehensive map symbols on the wayfinding map?	30	3	5	4.07	.521
Comprehensive direction on the wayfinding map?	30	3	5	3.90	.481
Comprehensive graphic building on the wayfinding map?	30	3	5	3.97	.490
Comprehensive service icons on the wayfinding map?	30	3	5	4.10	.548
Valid N (listwise)	30	3	5	4.00	0.51

In Table I, the evaluation results of the wayfinding map system of the market found that the average was at the agreed level with an average score of 4.00. The highest score value was ranked number one with an average score of 4.10 points, including the understanding of Icons, and the facilities shown on the map. The comprehension of the symbols displayed on the Wayfinding mapping system averaged 4.07 points. The Understanding of the routing system within the Ton Tan market averaged 4.00 points. While understanding building graphics the average score was 3.90 points and the understanding of the direction of the route that appears on the map system with an average score of 3.90 points. In terms of building graphics comprehension, the average score was 3.90 points, and the comprehension of the directions of the route displayed on the map system was averaged 3.90 points.

TABLE II: THE ASSESSMENT OF THE MODEL PILLAR ASSESSMENT WITHIN THE MARKET

TOPICS	N	Min	Max	Mean	Std.
Comprehensive wayfinding within the market?	30	3	5	4.00	.455
Comprehensive map symbols on the wayfinding map?	30	3	5	4.20	.551
Comprehensive direction on the wayfinding map?	30	3	5	4.00	.525
Comprehensive graphic building on the wayfinding map?	30	3	5	4.03	.490
Valid N (listwise)	30	3	5	4.05	0.50

The results of the survey of the model pillars within the Ton Tan market showed that the average was at a very good level, with an average score of 4.05 The highest score was ranked number one with an average score of 4.20, namely the appropriateness of the size of the signposts. While the beauty aspect of the direction sign design has an average score of 4.03 The comprehension of the symbol system used on the road signs and the appropriateness of the height of the road signs were equal to 4.00 points. (see Table II)

TABLE III: THE ASSESSMENT OF WAYFINDING APPLICATION

TOPICS	N	Min	Max	Mean	Std.
The speed performance of interactive processing?	30	3	5	4.03	.490
Readability with content on the user interface?	30	3	5	4.07	.521
Clarify the display image on the user interface?	30	3	5	4.13	.507
Valid N (listwise)	30	3	5	4.07	0.50

The UI performance evaluation was found to be rated as "agree" with an average score of 4.07. The aspect with the highest score ranked number one with an average score of 4.13 points was the visual clarity of the display. While the user's ability to read information had an average score of 4.07 points and the speed of processing with a mean score of 4.03 points. (see Table III)

From the results of the data analysis on understanding and satisfaction with UI design, it was found that the average was in the 'agree' level with an average score of 4.10. The aspect with the highest average score of 4.17 points was the suitability of the typeface of the characters in the application system. while in terms of aesthetics the design of the symbol system has an average score of 4.13 points. The aesthetics of the color scheme in the application system averaged 4.10 points, and the comprehension of the information presented was an average of 4.00 points. (see Table IV)

TABLE IV: THE ASSESSMENT OF COMPREHENSION AND SATISFACTION OF UI DESIGN ON THE WAYFINDING APPLICATION SYSTEM

TOPICS	N	Min	Max	Mean	Std.
Comprehensive of presenting information?	30	3	5	4.00	.455
Artistic with the design of a symbol system?	30	3	5	4.13	.571
Artistic with the color of user interface design?	30	3	5	4.10	.548
Suitable of the typeface used on the user interface?	30	3	5	4.17	.531
Valid N (listwise)	30	3	5	4.10	0.52

V. DISCUSSIONS

From the score table for evaluating the route map graphics system within the sugar palm market, the researcher found the results of the information that are interesting in the following points:

Issue 1: According to interviews with market executives, there is a need to design a wayfinding map and road signs to provide service information to customers who come to receive services in the market. The market executives give design guidelines by wanting the design to be modern and suitable for teenagers to working-age groups. Because the market executives want the image of the Ton Tran market to be diverse, family, and commerce. From this point, the researcher has made improvements to the prototype together with the management by the important issues to fix, consisting of; 1) adding new tourist drop-off points, 2) adding roman characters on all four parking, 3) adding the main entry from three routes of roads surrounding the market, and 4) designing into two layouts for convenience use. (See a design solution in Fig. 5)

Fig. 5. Sample image of the wayfinding map system revision with the executives

Issue 2: the behavioral analysis test of cross-tabulation for UI design satisfaction found interesting data obtained from cross-tabulation of age variables and preferences for layout styles and UI elements at a good level of 79% in the group of age between 15–30 years. Due to the UI with a white background and as much emphasis on graphics as needed, it is easy to consider and separate content while reading or searching (see Table V). While analyzing the crosstab correlation of age variables and the visual appraisal of the letters used in the application, it was found that the legibility to see and understand the content of the letters used in the application up to 90% of the scores were good level, between the ages of 15 and 30 years. The test results showed that the font size used was 5 points, which was consistent with the Thai font research that set the visual readability value between 4–6 points [15]. The testing results are presented in Table VI.

Issue 3: the cross-tab relationship distribution analysis in the design of the Wayfinding Map System found that by crossing the relationship between age and comprehension of walking direction when looking at a map with the sampling group. Results showed that 78% gave a good score in reading and comprehension of maps based on their age ranges 15–30 years, even though the designs were isometrics view and not based on the actual geographical features and location. This is because the isometric design can clearly represent landmarks and connect a sense of place between the actual observation of the place compared to the simulated map. In this design, the researchers applied Lynch's [5] five-component theory and the conceptual combination of; 1) path, 2) edge, 3) district 4) node and 5) landmark. The result of applying Lynch's principles shows good design results with large floor plans. (see details in Table VII)

TABLE V: CROSSTAB RELATIONSHIP DISTRIBUTION FOR AGE AND USER INTERACTION DESIGN

			Age					Total
			15-20 yr.	21-25 yr.	26-30 yr.	31-40 yr.	41-45 yr.	
Design Layout UI?	Undecided	Count	0	2	0	0	0	2
		% Within designing the layout of UI?	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
		% Within age	0.0%	18.2%	0.0%	0.0%	0.0%	6.7%
		% of Total	0.0%	6.7%	0.0%	0.0%	0.0%	6.7%
	Agree	**Count**	**5**	**6**	**8**	**3**	**2**	**24**
		% Within designing the layout of UI?	**20.8%**	**25.0%**	**33.3%**	**12.5%**	**8.3%**	**100.0%**
		% Within age	**100.0%**	**54.5%**	**100.0%**	**100.0%**	**66.7%**	**80.0%**
		% of Total	**16.7%**	**20.0%**	**26.7%**	**10.0%**	**6.7%**	**80.0%**
	Strongly Agree	Count	0	3	0	0	1	4
		% Within designing the layout of UI?	0.0%	75.0%	0.0%	0.0%	25.0%	100.0%
		% Within age	0.0%	27.3%	0.0%	0.0%	33.3%	13.3%
		% of Total	0.0%	10.0%	0.0%	0.0%	3.3%	13.3%
Total		Count	5	11	8	3	3	30
		% Within designing the layout of UI?	16.7%	36.7%	26.7%	10.0%	10.0%	100.0%
		% Within age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	16.7%	36.7%	26.7%	10.0%	10.0%	100.0%

TABLE VI: CROSSTAB RELATIONSHIP DISTRIBUTION FOR AGE AND EFFICACY USED OF THE CHARACTERS USED IN THE APPLICATION

			Age					Total
			15-20 yr.	21-25 yr.	26-30 yr.	31-40 yr.	41-45 yr.	
Suitable of Text size and Legibility?	Undecided	Count	0	1	1	1	0	3
		% Within suitable legibility?	0.0%	33.3%	33.3%	33.3%	0.0%	100.0%
		% Within age	0.0%	9.1%	12.5%	33.3%	0.0%	10.0%
		% of Total	0.0%	3.3%	3.3%	3.3%	0.0%	10.0%
	Agree	**Count**	**5**	**7**	**6**	**1**	**1**	**20**
		% Within suitable legibility?	**25.0%**	**35.0%**	**30.0%**	**5.0%**	**5.0%**	**100.0%**
		% Within age	**100.0%**	**63.6%**	**75.0%**	**33.3%**	**33.3%**	**66.7%**
		% of Total	**16.7%**	**23.3%**	**20.0%**	**3.3%**	**3.3%**	**66.7%**
	Strongly Agree	Count	0	3	1	1	2	7
		% Within suitable legibility?	0.0%	42.9%	14.3%	14.3%	28.6%	100.0%
		% Within age	0.0%	27.3%	12.5%	33.3%	66.7%	23.3%
		% of Total	0.0%	10.0%	3.3%	3.3%	6.7%	23.3%
Total		Count	5	11	8	3	3	30
		% Within suitable legibility?	16.7%	36.7%	26.7%	10.0%	10.0%	100.0%
		% Within age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	16.7%	36.7%	26.7%	10.0%	10.0%	100.0%

TABLE VII. CROSSTAB CORRELATION OF AGE AND WALKING DIRECTION COMPREHENSION WHILE USING THE MAP

| | | | Age | | | | | |
			15-20 yr.	21-25 yr.	26-30 yr.	31-40 yr.	41-45 yr.	Total
Comprehensive Of direction on the wayfinding map	Undecided	Count	0	0	4	0	1	5
		% Within comprehensive direction on the wayfinding map?	0.0%	0.0%	80.0%	0.0%	20.0%	100.0%
		% Within age	0.0%	0.0%	50.0%	0.0%	33.3%	16.7%
		% of Total	0.0%	0.0%	13.3%	0.0%	3.3%	16.7%
	Agree	**Count**	**5**	**9**	**4**	**3**	**2**	**23**
		% Within comprehensive direction on the wayfinding map?	**21.7%**	**39.1%**	**17.4%**	**13.0%**	**8.7%**	**100.0%**
		% Within age	**100.0%**	**81.8%**	**50.0%**	**100.0%**	**66.7%**	**76.7%**
		% of Total	**16.7%**	**30.0%**	**13.3%**	**10.0%**	**6.7%**	**76.7%**
	Strongly Agree	Count	0	2	0	0	0	2
		% Within comprehensive direction on the wayfinding map?	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
		% Within age	0.0%	18.2%	0.0%	0.0%	0.0%	6.7%
		% of Total	0.0%	6.7%	0.0%	0.0%	0.0%	6.7%
Total		Count	5	11	8	3	3	30
		% Within comprehensive direction on the wayfinding map?	16.7%	36.7%	26.7%	10.0%	10.0%	100.0%
		% Within age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	16.7%	36.7%	26.7%	10.0%	10.0%	100.0%

VI. CONCLUSION

Finally, in this study and research are still limitations in creating a complete system-wide route-finding graphics system. Due to the scope of building a complete wayfinding Map system, there must be all project areas in which the market is still in the process of adding service areas. In addition, the market executives need additional vendor database systems that control the storage, such as rent, water, and electricity. However, in the development of information systems, it is necessary to consider security systems such as Blockchain technology, since the data used in the new service system involves customer databases and payment and payment transactions with the company. This technology is necessary to bring in new applications for joint development with the Ton-Tan market [16–17]. Finally, the case study of the market is a model that the private sector has service areas in the community mall market. It can be applied to improve the quality of information services and efficient route searches.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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