A Hybrid Model using Online and Operator for Traveler Assistance Via Smartphone

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Abstract: *This paper proposes a hybrid model for use by travelers on a smartphone. The principles lie in the combined deployment of 24x7 network that directly serves the travelers and links the existing phone service as an alternate backup choice. Such a redundancy will insure higher reliability in an urgent situation, where many available communication channels are often jammed by panic calls and accesses. In addition, off-line service is also provided as an optional access means to ease the network traffic, whereby important information can be immediately conveyed to the travelers in need of assistance. An information management workflow is also set up to effectively disseminate the relevant information. The proposed system is implemented and tested by volunteers. The results are compared with the predicted outcomes obtained from the preliminary test. It was found that once the users are familiar with the answers, they tend to prematurely exit the application. However, it is not the case with operator assistance as they can continue inquiring freely with the human operator. Future artificial intelligent techniques can be employed to enhance the non-human operations to become as lively as the human service.*

Index Terms: *traveler assistance, multimodel information, access routes, smartphone.*

I. INTRODUCTION

As technology advances and population grow, so do the needs for travel. The proliferation of internet has brought about new means of communication that shrinks the world to be reachable from anywhere. Hence, the number of travelers grows considerably. What follows is various forms of unwanted mishaps to the travelers such as loss of possession, direction lost, and accidents. In such predicaments, people certainly need immediate help, not some time later. Information of service and personnel is vital to relieve the mishaps. One compelling question is whether any assistance services are available, and if so, are they available 24x7? Typically, assistance call is available in many places. The advent of internet connectivity expands even greater communication means. From SMS, MMS, social media, to the various wearable and smart devices such as smartphone, smart watch, etc., the open horizon of connectivity seems to be abundant and boundless.

Unfortunately, many disasters have proven that under such circumstances, connection was virtually unavailable despite the improvement of equipment and software reliability to service 24x7. There should be provision for integrating local service to serve as a connection back-up. This back-up not only supports users who are in need of help, but also service personnel whose communication channels are disrupted and cannot perform

their duty. As a consequence, coverage of assistance services for traveler must be carefully planned to ensure effectiveness of help contact when they are needed.

This research proposes a hybrid model for traveler assistance that combines the existing internet capability and local phone lines to set up a reliable means. This in turn will provide an assistance using the internet facilities at 24x7 and the local phone lines.

The organization of this paper is as follows. Section 2 recounts some relevant prior works that could be exploited in this research. Section 3 proposes a hybrid model that encompasses a number of design considerations such as layered architecture, modular independence, and probabilistic routing. Section 4 elaborates on implementation and experiments of the proposed model. Some human utilization behavior is uncovered in Section 5. The final thought and future work are given in the last Section.

II. RELATED WORK

A number of research efforts were attempted to help travelers gain access to their destination as soon as possible. A. Douglas et al. [3] used cluster analysis to explore business travelers using mobile devices. Jenkins et al. (2013) proposed the use of smartphone to decide on reaching a proper emergency facility (particularly hospital) for the timely service under several temporal parameters, for instance, travel time, wait time, service time, traffic and GPS status data, etc. Yu et al. [7] utilized location-based social network (LBSNs) to personalize travel package that suit the non-local users' need, save time, and unduly arrangement. Adler and Blue [1] presented the Advanced Traveler Information Systems (ATIS) for more efficient distribution of travelers to routes and modes. Travelers would have more choices which helped reduce significant time, anxiety, and stress associated with the urgent situation. Lotan and Koutsopoulos [5] presented a realistic route choice model for Intelligent Vehicle Highway Systems (IVHS) that could be adopted to improve the operator assistance service capability.

Zhang et al. [8] employed the mining technique on the digital traces left by the users while interacted with Web applications and wearable devices to reveal individual and group behaviors, social interactions, and community dynamics. Zheng et al. [9] presented GPS data management services that mined the point-of-interest to recommend the users during their visit.

Eagle et al. [4] analyzed human behavior based on contextualized proximity and communication data logged by the mobile phones. It helped explore the research on human interactions and the cognition by their behavior. This would be essential in the training of operator assistance to travelers. Bovy and Stern [2] presented a general scheme of route selection by travelers to optimize their satisfaction needs, while making the best possible choice available to them. However, in an urgent situation, most of these prior works could not connect the needed services. Anyhow, their principles will be adopted in the design of the proposed system. Sophatsathit [6] made use of IoT devices to harness the reliability of internet-based services is a principal basis for the design philosophy of the proposed system.

The proposed system focuses on services for traveler that, in an urgent situation, becomes unavailable. The design philosophy is to make use of as much conventional technology as possible to serve as an additional provision, thereby connection unavailability could be reduced. The rationale of such a technique is straightforward. These conventional technologies are still available but less popularly used today. By tapping into their under-utilized potential in proper situations such as urgent assistance or disastrous events, where communications are overwhelmed by panic calls, they may serve as a good alternate service to the desire contact. Details on principles and methods of the proposed system are described in the following subsections.

III. HYBRID MODEL

The proposed hybrid model is a comprehensive architectural design and management of support information infrastructure to handle the three urgent situations using existing technologies and well-established management principles. The proposed model assumes average scenarios where the probabilities of network utilization and local connectivity hold for the duration of use. This does not include all transient network traffic resulting from real-time loads. The proposed hybrid model is summarized in a step-by-step process as follows:

1. Establish the reference architecture and elucidate in Section III.A.
2. The corresponding information management workflow and support are exemplified in Section III.B

A. Reference Architecture

The proposed hybrid model operates on user accessibility by focusing on management of the availability and accessibility of the system. The emphasis of this model is modes of a multimodel information paradigm that permits different access routes such that the additional redundant routes will enhance the reliability of communication in all circumstances. Users can rely on this wayfinding to information that is vital to their needs without wait, no pre-trip planning, or pre-determined retrieval patterns. Thus, they can request for assistance either from the 24x7 line or local line from any connecting devices in the client cluster, e.g., personal computers, smartphones, internet café, etc. Fig. 1 depicts the reference architecture of the proposed system. At the outset, the users place their request from the client cluster. They may operate either from the desktop or smartphone, which in turn connect to the connection middleware via the 24x7 line or the local line. The 24x7 line (hereafter will be referred to as fast line) designates normal network access, whereas the local line (hereafter will be referred to as slow line) furnishes both normal and voice access. Applications in the connection middleware, e.g., 'network' module will retrieve search details from the information repository and send them directly to the destination resource via the fast line. However, some special requests will be re-routed via the 'network access' lines to obtain the designated assistance in the application center. The slow line that links from both desktop and smartphone will permit access to the yellow pages directory assistance in the connection middleware. Search details are be retrieved from the information repository and passed on to the application center in the map or phone modules. This line also serves as the backup line in an urgent situation when the fast line is down or jammed by panic call traffic. This is perhaps the most important aspect of the reference architecture.

Typical services that run on the slow line include voice calls, loss and found report, direction/location assistance, and all other help requests. Note that there are two options for phone contact, namely, operator assistance and dispatching agent. The former is just a regular phone call, whereas the latter is a pre-recorded messaging system. All outputs are transmitted to the physical service facilities.
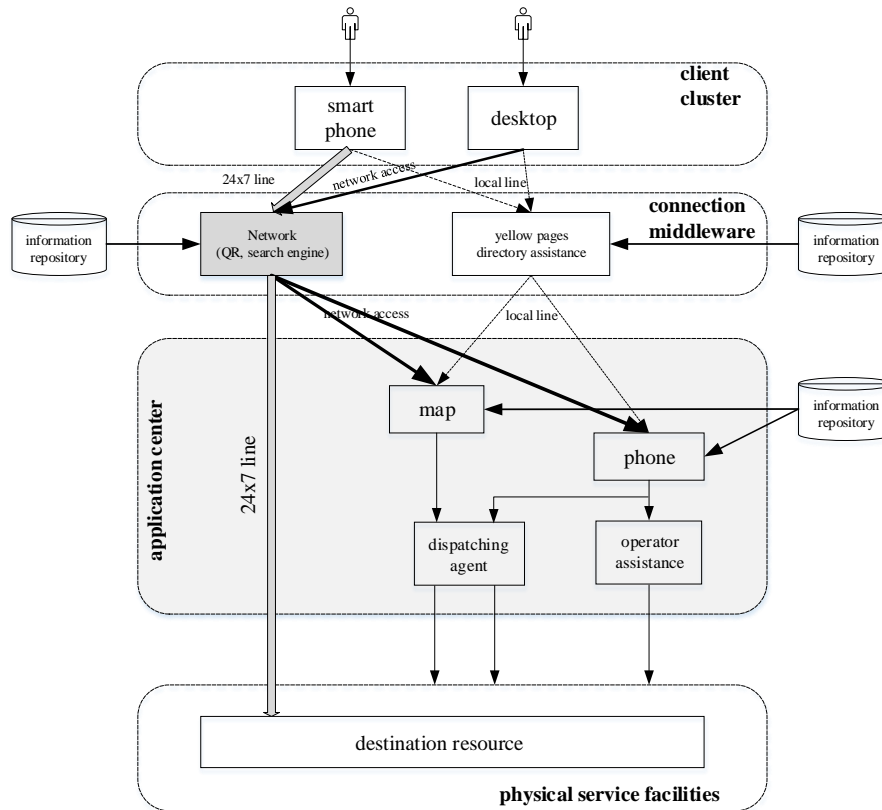
Fig. 1. Reference architecture of the proposed hybrid model.

This layered architecture offers a few design advantages. Firstly, the layers shield the idiosyncrasies of those above and below layers from interferences and side effects. Secondly, such operational independence permits modifications, rearrangement, or replacement of components within each layer without affecting adjacent layers. And last, operations in each layer are transparent to others, thereby easing future maintenance and evolution.

The above design philosophy instills further elaborates on detailed configurations of the application center and physical service facilities. Fig. 2 demonstrates the extent of how urgent situation is handled.
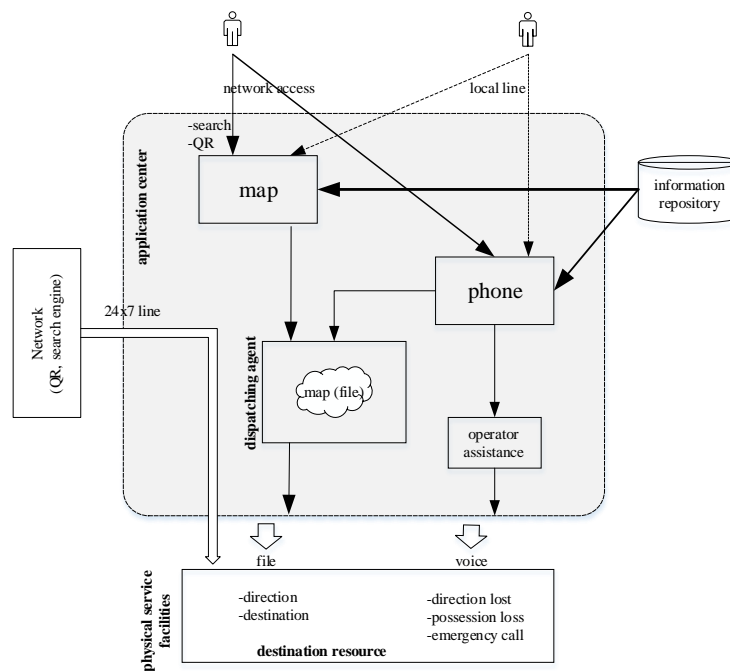

Fig. 2. Application workflow of user connection.

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Consider a request for direction assistance. The user submits it from network access with the required search parameters or using one-click QR code to retrieve. The map function checks if the relating information to the parameters or QR code exists in the repository, for example, nearby hospital or police station. If this is the case, the desired information is retrieved from the information repository in the form of map file and sent to the destination resource directly. Otherwise, additional alternatives are provided, for example, information on taxi or public transportation, operator assistance, etc. In a normal situation, the above transaction is often performed via the 'network access' line by map module. On an unusual situation such as busy network traffic, the user could be re-routed through operator assistance based on the probability of traffic routing model as depicted in Fig. 3.
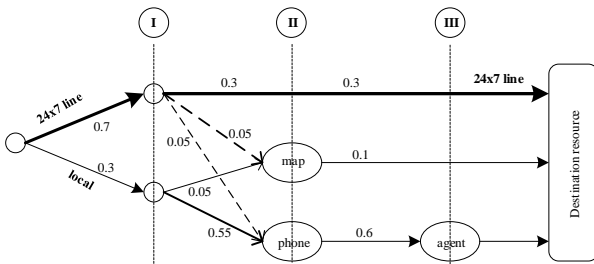

Fig. 3. Traffic routing model.

The probability associates with the service routes in stage i = I, II, III is assigned as follows:

$$P_i \text{ (local)} = 1 - (u(\text{network}) * L(\text{network})) \qquad (1)$$

where $u(\text{x})$ denotes the utilization percentage of route x, and $L(\text{x})$ denotes the load proportion of route x. Case in point of stage I, if utilization of the 24x7 line is 60%, and the distribution of traffic or load proportion of this line is 0.7 (that is to say, 70% of the normal traffic is routed to the 24x7 line), the chance of new arriving traffic will be re-routed to the local line according to Equation (1) is equal to $1 - (0.6*0.7) = 0.58$. To stretch the capacity of the local line for urgent situation, the thresholding load to provide will be

$$H_i \text{ (local)} = P_i \text{ (local)} / (1 - L(\text{network})) \qquad (2)$$

where $H_i(\text{x})$ denotes the thresholding capacity of route x. In the above scenario, $H_i \text{ (local)} = 0.58/0.3 = 1.93$ or 193% of the normal traffic would be handled by the local line.

The above traffic routing model gives us the limiting local line capacity that we must make every effort to accommodate for the worst scenario. As the proposed model is deployed to be a supporting mechanism for user's request, proper information management planning must be established to serve the assistance mandate. Details are further described in the next subsection.

B. Information Management Workflow and Support

In order to exercise the proposed model efficiently, a support structure to classify and administer information is also proposed as shown in Fig. 4. The conventional management information system is used as a guideline to set up the horizontal structure, that is, the lowest tier or operation management (OM), the middle tier or tactical management (TM), and the highest tier or strategic management (SM). The OM tier collects typical user information such as point-of-interest (POI) pamphlets or flyers, travel routing, accommodation, etc. This information is grouped into internal (I) and repository (R) to be handed over to next level. The TM tier disseminates this information passed from OM through proper distribution channels to optimize the expenses and ensure broadly access in the physical service facilities. The SM tier takes charge of planning on summarization, projection, update, and service innovation to capture as much user bases and interests as possible. The vertical structure, on the other hand, is broken down into two segments, namely, internal and information repository having accessibility as the goal. Detailed information of the OM tier usually is collected locally and summarized by internal staffs to serve the travelers' needs. Meanwhile, any inadequacy or enhancement of data can be supplemented with additional information from external data sources to make them complete. This information will be archived to the information repository for subsequent use. To maintain the longevity of this urgent assistance, up-to-date information such as highlight, one-touch connection, etc., must be selectively compiled and incorporated to ensure operational accessible service and user satisfaction. Then the two segments are loosely connected for accessibility to share the resource so requested by the users.
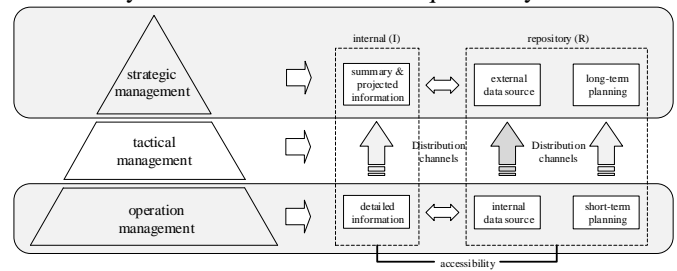

Fig. 4. Support information structure.

The above structural support is mapped onto the proposed hybrid model, forming an accessibility of destination resource which is further described in the user access schematic flow as shown in Fig. 5.

Consider a user assistance function accessed via either the network or local line by activating a smartphone application, the map function helps guide the user through the three most popularly accessed options, i.e., accident, possession loss, and direction lost. Each option is taken care of by succeeding services of the OM layer. In case of an accident, the user may inform responsible officers at the police station, rush the patient to hospital, call emergency rescue, or contact insurance for damage claim. The resulting actions boil down to giving direction of the destination, contact information, or out-going (operator-assisted) call. This will ensure immediate and life-saving assistance. For possession loss, particularly important documents that can be eradicated to stop further losses inflicting on the users may in most cases contact police station or bank. Lastly, direction lost could be the most straightforward help request to fulfill. Information on bus or train services can be downloaded as needed.

If all else fails, the users can obtain contact information from tourism center to reach their destination safely. It is apparent that the extra provisions for information access channel are invaluably supplementary assets that not only save time and cost, but also unaccountable grievances for many travelers who have nowhere to turn.
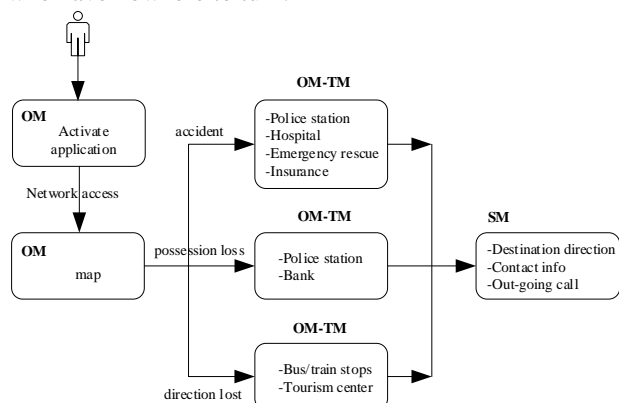

Fig. 5. User access schematic flow.

The information obtained above is distributed to proper support information archives in Fig. 4, namely, OM, TM, and SM. This will enhance the comprehensiveness of the archives as part of information management workflow and support improvement.

IV. IMPLEMENTATION AND EXPERIMENTS

Data of the experiments were collected from a group of 256 volunteers who acted as travelers in need of assistance. Their profile is summarized in Table 1. Each volunteer at least had been in one of the three situations, i.e., accident, possession loss, or direction lost.

Table I Statistics of input dataset

Category	Percentage	Remark
Demographic		
age	23.6	years
Male	51.3	%
Household size	4.3	Persons
Education		
below bachelor	20.6	%
bachelor	74.3	%
above bachelor	5.1	%
Career		
employee	86.4	%
self employed	10.2	%
others	3.4	%
Emergency experience		
lost&found	31.5	%
accident	57.2	%
direction lost	10.2	%
others	1.1	%

Analysis of the proposed model was demonstrated through various options, causes, and influential factors being sorted out using a mind map as the breakdown of the proposed system configuration. Fig. 6(a) shows eight principal factors established, namely, (1) planning, (2) data collection, (3) system analysis, (4) design, (5) implementation, (6) user's manual, (7) testing, and (8) installation. These factors were further broken down into causes and options to be implemented. Some of the factors

were dropped or combined to simplify the GUI design. For instance, planning cost was dropped whereas user's information was combined into the information access and retrieval for use in all subsequent accesses as shown in Fig. 6(b). They consequently became design parameters and decision criteria of system implementation.
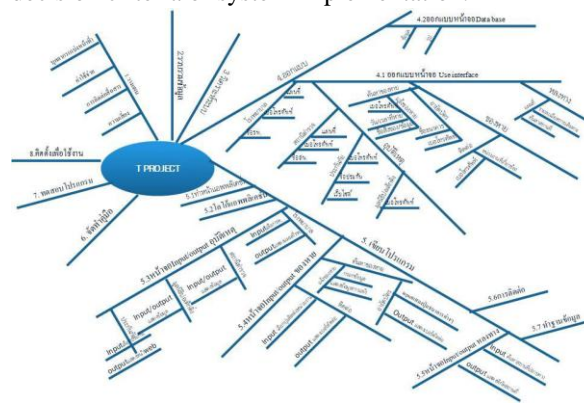

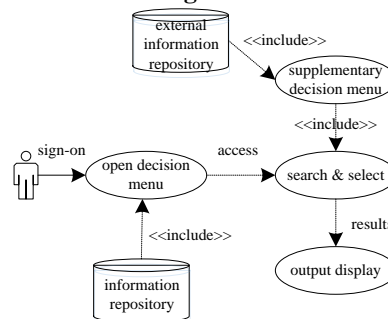**Fig. 6(a). Mind map of the proposed system configuration.**

Fig. 6(b). Information access and retrieval.

The proposed information management workflow and support were not created due to limited resource and scope of application that were confined to usable software for the experiment. They would be needed in the production system if the proposed model was adopted and put to real use.

Allocation of volunteers upheld the traffic routing model to distribute the load probability established earlier in Fig. 3 as follows: 0.3, 0.1, and 0.6 out of 256 to fast line, map, and phone, respectively. This was equivalent to 77, 26, and 153 persons. When the user signs on, the system displays a number of available choices for the information repository. The user can quickly decide on what they need to search for answers (*open decision menu*). At this point, external sources may be called for as a supplement to enhance the completeness of information being searched and to complement the information repository established earlier in Fig. 4. Thus, the user can decide on the selection and view the output display accordingly. These are crucial design stages as they involve human interaction and user involvement.

Since this was intended to be an application running on smartphone, the program size was an important design consideration. Thus, many attributes were trimmed from the above mind map to keep only the necessary ones. Fig. 7 illustrates the class diagram of the location class and its member search and map classes.

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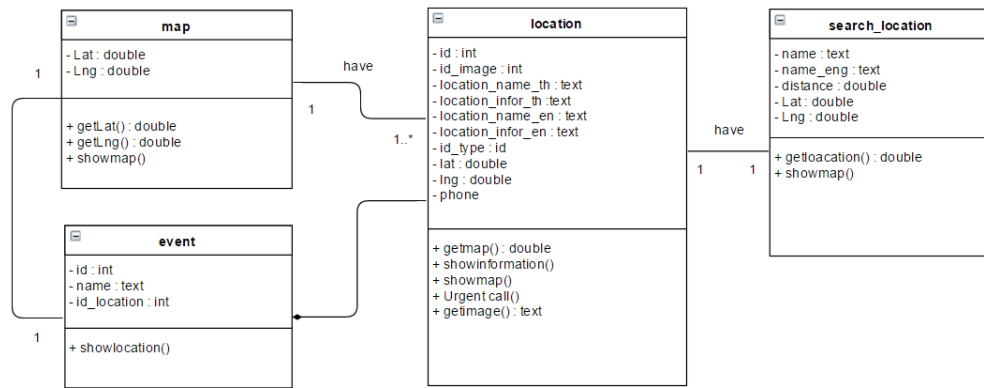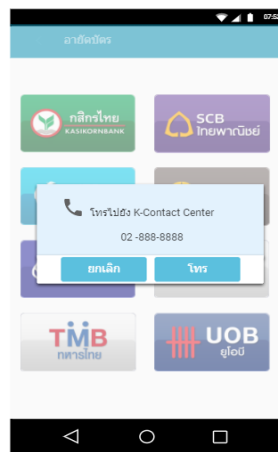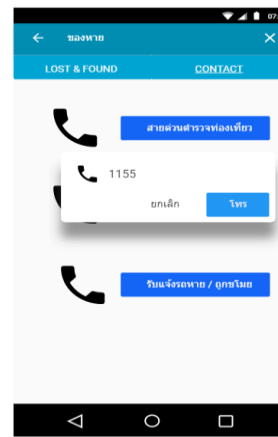

Fig. 7. Class diagram.

Fig. 8(a) depicts the first screen of the proposed system implemented as a smartphone application on Android. The icons include (in clockwise direction) the Thai Red Cross, police, public emergency service, and insurance companies. Fig. 8(b) shows major bank accesses. Fig. 8(c) shows contact points for lost&found. Fig. 8(d) shows route for bus line #30.
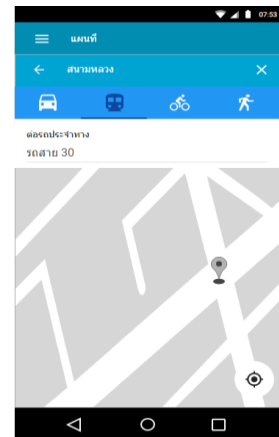

(a)   (b)

(c)   (d)

Fig. 8. Screen caption of the proposed system.

The following metrics were taken as performance evaluation measurements, namely, number of transactions (A), number of transactions waiting in client cluster (the fast line did not have any waiting transactions) (B), number of request fulfillment counts in physical service facilities (C), and number of transactions completed (D). The results were then compared with those of predicted outcomes from the above traffic routing model in Fig. 3. Table 2 summarizes the resulting statistics collected.

Table II Statistics of A, B, C, D and percentage of differences

trial	A	B	fast line	fast_abort	C	%fast_abort	%abortB	D	%fast	%B	%overall
1	220	64	156	8	57	0.05	0.11	205	94.87	89.06	93.18
2	165	37	128	26	28	0.20	0.24	130	79.69	75.68	78.79
3	192	26	166	27	14	0.16	0.46	153	83.73	53.85	79.69

From Table 2, some users on fast line tended to prematurely terminate the transactions (fast abort) after a few accesses since they could anticipate the answers received. The same went for the slow line in the map option, whereas the operator assistance option had 100% completion as they could converse with the operator freely. Notice that the slow line accomplished higher completion rate than its fast line counterpart since users preferred to get information from a live source than that of the electronic source. Fig. 9(a) and 9(b) exhibit the statistical plots of the shaded columns in Table 2.
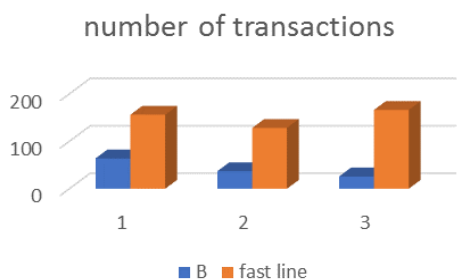
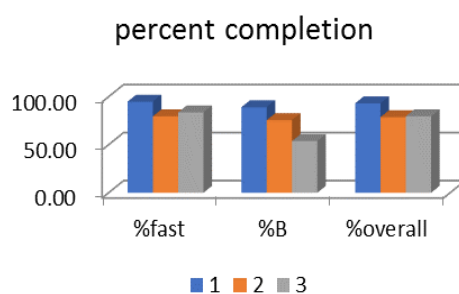**Fig. 9(a). Statistics of number of transactions.**

Fig. 9(b). Statistics of percent completion.

Table 3 shows the predicted volume of transactions from user access model. The main discrepancy that affected the largest differences on both fast and slow lines was the assumption of no user's premature termination. Thus, the number of fulfillment counts (C) and transaction completions (D) was anticipated to be higher having the same completion rate. Fig. 10(a) and 10(b) exhibit the statistical plots of the shaded columns in Table 3.

Table III Predicted statistics of A, B, C, D and percentage of differences

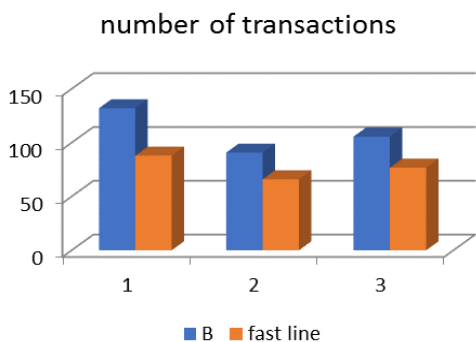| A	B	fast line	C	D	%fast_abort	%abortB	diff_fast	diff_B	%diff_fast	%diff_B
220	132	88	141	141	0	0	6	37	6.82	28.33
165	91	66	61	61	0	0	4	30	5.45	32.58
192	106	77	71	71	0	0	6	44	8.10	41.46

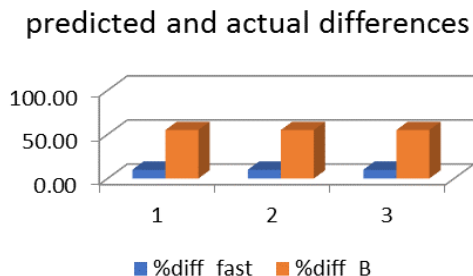**Fig. 10(a). Predicted statistics of number of transactions.**

Fig. 10(b). Predicted and actual differences.

Table 4 shows user satisfaction feedback on three-level scale since other choices did not apply to this experiment. The phone (operator assistance) selection overwhelmed other means since the users could inquire to greater extent as oppose to reading from preset description on web page. Fig. 11 depicts the corresponding plots.

Table IV User satisfaction feedback

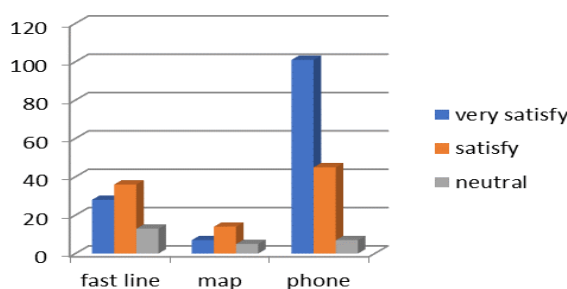|	Fast line	Map	Phone	Total
very satisfy	28	7	101	136
satisfy	36	14	45	95
neutral	13	5	7	25
Total	77	26	153	256
Prob.	0.3	0.1	0.6	

Fig. 11. User satisfaction feedback.

V. DISCUSSION

There were a number of discrepancies to be noted from the experiments. (1) The number of clients waiting in client cluster (slow lines) merely denoted all users not using the fast line; (2) some of the user's requests were prematurely terminated during the course. This behavior coincided with the above cited prior works.

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Hence, the request fulfillment counts only represented fully completed transactions; and (3) provisions for assistance by the proposed model could not be fully exercised as it was not possible to simulate the real urgent situation where the communication lines were overwhelmed by panic network accesses and phone calls.

From the three trials, it could be inferred that as the users became familiar with the systems after the first trial, they tended to abort the search request if the scenarios were the same. For instance, as they seek to get help for lost&found, they would get the same contact information as that was the only channel to turn. Thus, both 2nd and 3rd trials exhibited the yields that were very close completion percentage, i.e., 78.79% and 79.69%, respectively.

The experiment was performed by volunteers since it was unlikely to obtain real data from all of the above sources accurately. Anyhow, one advantage of using volunteers was that details of experiment could be recorded for further researches.

VI. CONCLUSION

This research proposed a hybrid model to assist travelers in an urgent situation when communication lines were often unavailable due to the overwhelming accesses or by other causes. The proposed model was set up as independent layered architecture to permit flexibility of implementation and focused on provisions for redundant connectivity, whereby user access could be established under urgent situation. The principle was to combine existing local line with the 24x7 network to serve both electronic information source and human-assisted source. The latter source ensured reliable service in the absence of internet availability. The experiment was conducted on 256 volunteers who acted as travelers in need of assistance. It was found that users tended to quit the application prematurely as they had experienced with the choice of assistance and anticipated the answers well. Nonetheless, the intriguing finding was their preference of human-assisted source to the electronic one because it offered flexible and unlimited inquiries.

Despite the limitations on sources of answer (such as there is only one emergency number for ease of recall and contact), the apparent future enhancement is to provide variations of answer to reduce the static and mundane presentations by means of artificial intelligent techniques. More avenues of contact can be incorporated such as SMS, recorded message or voice mail, hearing impair display aids, and offline retrieval by QR code that will help lessen network download traffic and increase available bandwidth considerably.

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