Using traditional and intelligent organizational means to solve traffic problems in Baghdad/ Maysaloun Intersection

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Abstract: The widespread use of vehicle has led to new problems in the city because of the need for these vehicles in the organization of movement and parking, especially in areas characterized by increased congestion in the morning and evening peak, which is one of the problems of the great urban growth that hit the city of Baghdad. Accordingly, this study dealt with identifying the traditional and intelligent organizational means to regulate traffic, and the most important specifications and requirements for their distribution within cities. An applied case study of Maysaloun intersection in Al-Ghadeer municipality in Baghdad city was studied for identifying the streets that suffer from the lack of traditional organizational means and the imbalance in their spatial distribution. Through field surveys of the study area, it was noted that the streets suffer from congestion in the morning and evening rush hours resulting from a spatial distribution deficit and a large deficit in the number of traffic signs that have a significant role in regulating traffic and traffic management. Service levels as a street condition were compared with US HCM standards using the HCS2010 program. It was found that all streets of the study area with a service level (LOS) are lower than level (C) and therefore this condition is met by the applicability of Variable message sign (VMS). Finally, a digital photo map using a satellite image of the study area has been prepared as a proposal showing the streets where the requirements for the deployment of intelligent signs (VMS) and basic traffic signs are available to regulate and control the traffic movement and to fill the deficit and imbalance in the number and spatial distribution.

1. Introduction

Traffic accidents have significant social, economic and environmental impacts, as well as human safety and property. Therefore, this issue is of great importance at the local and global levels, and concerns many decision makers, specialists and interested. The importance of using regulatory means of traffic has emerged as it helps to manage traffic safety, as it reduces the level of traffic congestion and its problems. The research problem was tackled through the use of statistical analytical methodology, the study of the reality of the study area and the collection of information and data. Traffic problems in the study area. Assuming that the application of traditional and intelligent traffic regulatory methods to roads leading to one of the most important intersections in the study area will contribute to the regulation of transport traffic, and to find solutions to transport problems and control.

2. Traditional Signs: Concept and Classifications

There are two Traditional sign classifications based on their place, they are traffic signs and road markings. The main goal of them is to reach safe and well-organized traffic [1]. Traffic engineering assessment determines where to install traffic signs. In addition, they are needful to advise motorists about traffic regulations that apply in certain locations and / or in certain times and to warn of danger that may not be intuitive. As well the information about interesting roads, destinations and location can be given by the traffic signs to the motorists. [2]

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2.1 Traffic Signs: Concept and Classification
The main aim of traffic control devices is to give visual information to the road user. The information is
given in three ways to the road user: as regulations, as warnings and as guidance [2].

2.1.1 Traffic Sign Characteristics:
- Function of signs: Guidance information, warnings, and regulations that are given to road users are
  the functions of signs. In the messages of the signs are used symbols and words. [3] The information
  concerning highway road, direction, service points, and journey’s target are given within the signs.
  The signs are necessary to give information on special regulations which are putted only at
  appointed places or at certain times. They are fundamental to inform drivers about hazards which
  are unexpected. The performance of a sign depends fundamentally on: “the attention value of the
  sign, the legibility of the sign, the ease of comprehending the sign message, and the appropriateness
  of the sign message” [2].
- Legal authority: It should be the authority of a public body or a competent official who placed the
  traffic signs. The traffic sign must not has any commercial advertising. Any other organization using
  temporary signs to protect equipment and workers engaged in construction, maintenance or repair
  work on a public highway should see that signs conform to the standard in size, shape and colour
  [1].
- Material: currently, to give the signs an illumination appearance, also to the object markers there are
  many materials presently available and diverse methods. Every day come out new materials and
  methods can be used in traffic signs, as long as they meets the colour criterion (the colour must be
  easy to recognize in the day and the night) [5].

2.1.2 Classification of Signs:
There are three sign classifications based on their intended function [1]:
- Warning signs: as their name implies should be used for warning traffic of hazardous situations on
  the road or adjacent to it. Warning signs require caution on the part of motorist and generally call for
  reduction of speed in the interest of his safety and that of other motorist and pedestrians. Improved
  highway design generally reduces the need for the warning signs. Typical locations and hazards that
  may warrant the use of warning signs are: curves, intersections, usually sharp changes in alignment,
  advance warning of traffic signals, hills and bumps, narrow carriageways and structures, approaches
to and exits from dual carriageways, railway crossings, and other dangerous spots (Figure 1).
- Regulatory signs: give the highway user notice to traffic regulations that apply at any given
  highway. It is an offence to disregard such signs (Figure 2).
- Guide signs: show route designations, destinations, directions, distances, points of interest and other
  geographical or cultural information (Figure 3).

![Figure 1. Examples of warning signs [4].](image1)
![Figure 2. Examples of regulatory signs [4].](image2)
![Figure 3. Examples of guide signs [4].](image3)

2.2 Road Markings: Concept and Classifications
2.2.1 Marking Characteristics

- Functions of markings: Road markings may be defined as markings on the road surface, which serve to control, warn, guide or inform road users. There are specific functions for all markings, which put within an appropriate plan of traffic control. But, sometimes the markers' work are be integral with signs' work. Therefore, the markers perform duties or services to transport some organizational messages and warnings which are not clear. [6].
- Legal authority: only the public authority is responsible for place the markers [1].
- Standardisation: markings must be unvarying (uniform) in design, place and usage, that to be recognized and comprehend (understood) immediately.
- Material and colour: "spray painting" is often used in pavement markings, and sometimes using more "durable products", and by using "glass beads" or "spheres embedded" is achieved the visibility in the night [6].

2.2.2 Types of Markings

- Pavement markings [6]: they are center lines, lane lines, edge of carriageway lines, prohibitory lines/no overtaking lines, safety lines, stop lines, channelizing and central median island markings, arrow markings, pedestrian crossings, and approaches to railway crossings (Figure 4).
- Hazard Markers: (Figure 4) [1]
  - Road edge markers posts: are effective aids for night driving. Markers posts are to be considered as guide markings rather than warning devices and should never be substituted by a proper warning sign.
  - Marking of objects within the roadway: bridge piers and abutments within 2m of the pavement edge should be marked. The marking can be used either for low structures, narrow structures, and low and narrow structures.
  - Marking of objects adjacent to the roadway: the reflectorized hazard marker should be used to mark structure limits which are within 50 cm of the borderland of the road. This marker shall be used in all cases where the narrow structure sign is erected ahead of the structure. The hazard markers should also be used to mark trees, rocks, curbs, approaching ends of sections with guardrails etc.

Figure 4. Examples of road markings [4].

3. Intellient Signs (VMS): Concept and Classifications

VMS “Variable Message Sign” shall mean a device to display a variety of text messages to motorists traveling through the city. It is a traffic control device that typically suggests motorists alter their driving in some manner and take appropriate actions [8]. VMS messaging promotes the management of traffic and timely delivery of traveller information. VMS is mainly used to control traffic, manage congestion, information about vehicle parking and availability, unusual accidents, provide notification of current and expected road conditions, and regulate access to specific lanes or sections of the road or an entire system Roads. [7]. (Figure 5 & 6)
3.1 VMS Characteristics:

- **Functions of VMS**: VMS is utilised for real-time communication with drivers. Messages broadcasted by the VMS should cover current events on the road by being dynamic, precise, punctual and easy to understand. In the case of having a number of message requests to post via VMS at the same time, messages would be published according to this order of importance: 1. Accident management/public city. 2. Traffic concentration / Drivers direction, 3. Construction work and maintenance. 4. Special occasions 5. Environmental. 6. Law enforcement message, and 7. Public services campaign. VMS messages will undergo a monitoring process to insure the time efficacy and accuracy of broadcasted messages to prevent safety issues and to ensure the effectiveness of the displayed messages in aiding traffic control issues [10].

- **Legal authority**: The operation Center is responsible for operating VMS devices on a daily basis. This center is represented by a member, contractor, consultant or a concessionaire to represent a regional operations group. These bodies broadcast messages via VMS systems for the Authority pursuant abiding by the specific conditions outlined with authority policies, operations, carried out partnership agreement(s), and/or contracts agreed to by the Authority [10].

- **Standardisation**: message content broadcasted on VMS shall abide by the following general standards:
  - In the absence of a message, display panels will be blank.
  - Must be clear and accurate.
  - A single though must be conveyed per panel.
  - The information displayed must be specific. Vagueness and ambiguity must be avoided.
  - Messages must be on time, current and high in accuracy.
  - Letters in the English language must be capitalized, numerals and characters should be displayed in a single color, and be displayed in one font throughout the whole message.
  - Must give drivers a time period to fully read the displayed message two times.
  - The display period of each message should be 1.5-2.5 seconds for each panel.
  - The displayed message on VMS regarding road state or restrictions shall be removed at once when the state or restriction no longer imposes an issue on roadways.

- **Visibility considerations**: visibility refers to the range at which a driver is able to discover VMS on the road. The visibility components for VMS are as follows:
  - How to make VMS more visible than the rest of the features on the highway. Can the sign be discovered and how well it attracts the attention of drivers. The prompt detection that VMS is displayed plays a vital role in the driver’s ability to react to the displayed message.
Placing the message in a position to ensure that structures, curves, other road signs will not affect its visibility (Target Value);

The message can be seen (Brightness);

The message can be read (Legibility); and

The message can be read from an angle (Cone of Visibility). [7]

- **Material and colour:** for sign technology used LED, fibre-optic technology, and electromechanical. VMS use inverted colours, meaning that the background of it is black and the characters (figures) are light [11].

### 3.2 Types of VMS [10]

- **“Permanent VMS (also known as stationary VMS):** Permanent VMS are typically mounted on overhead structures either spanning the roadway, cantilevered out over a portion of the highway, or off the highway, and are used to influence motorists for traffic control purposes. Their messages can be electromechanically changed to provide motorists with information about traffic congestion, traffic crashes, maintenance operations, adverse weather conditions, roadway conditions, organized events, or other highway features. A benefit of permanent VMS is that they can support a longer, more detailed message and afford the greatest exposure time for motorists to comprehend messages before arriving at a decision point”.

- **“Portable VMS (PVMS):** are typically trailer mounted; self-powered, easily moved and placed near the decision point on the highway right-of-way. PVMS messages can be changed by either manual, mechanical or electromechanical means to provide motorists with information about traffic congestion, traffic crashes, maintenance operations, adverse weather conditions, roadway conditions, organized events, or other highway features”.

- **“Boards:** Also known as arrow boards, arrow panels, speed boards, changeable speed signs, extinguishable message signs, and radar boards. A special type of VMS used for other applications, such as to advise motorists of information about traffic congestion, traffic crashes, maintenance operations, adverse weather conditions, roadway conditions, organized events, or other highway features. (e.g., arrow boards/panels used to display advisory text information verses a flashing graphic arrow).

### 3.3 Standardization of Application

The following factors should be considered when installing variable message signs (VMS) [5]:

- “VMS should be located sufficiently upstream of known bottlenecks and high crash locations to enable road users to select an alternate route or take other appropriate action in response to a recurring condition”.

- “VMS should be located sufficiently upstream of major diversion decision points, such as interchanges, to provide adequate distance over which road users can change lanes to reach one destination or the other”.

- “VMS should not be located within an interchange except for toll plazas or managed lanes”.

- “VMS should not be positioned at locations where the information load on drivers is already high because of guide signs and other types of information”.

- “VMS should not be located in areas where drivers frequently perform lane-changing manoeuvres in response to static guide sign information CCTV Closed-Circuit Television Station, or because of merging or weaving condition.

### 3.4 Criteria Installation of VMS

To install VMS you should have one or more of the following options on the site: [12]

- There are at least two hours of delay during travel time, with traffic flows exceeding (1,100 vehicles per hour) in each lane.

- The level of service (LOS) on the road is C or lower during most of the day.

- Threshold (AADT) for the road is not less than:
  - For two-lane roads, (16800) vehicles per day.
  - For roads with (4) lanes, (33600) vehicles per day.
  - For roads with (6) lanes, (50400) vehicles per day.
Roads with (8) lanes or more, (67200) vehicles per day.

4. Practical Study Material and Methods
To distribute VMS in the study area, a number of statistics must be done, they are traffic volume, level of services (LOS), free flow speed, and average annual daily traffic (AADT).

4.1 Tools Materials

4.1.1 HCS Programs:
Used to measure service at roads and intersections, there are several versions of it. The HCS (2010) program carries out the procedures outlined in the Transport Research Council (TRB) Capacities Highway Guide (HCM) 2010. HCS (2010) was used to complete the LOS study requirements. Data is entered in two types:
- Engineering data: It is obtained by direct observation and measurement at the site or by measuring the engineering drawings with the required accuracy.
- Traffic data: Is the information obtained by direct census by conventional methods in the field, where the process of enumeration of cars in each cubit every (15 minutes) to determine the volume of traffic in rush hour.

A number of windows that allow data entry assesses Level of Services (LOS). The first window concerns speed: free flow speed, median type, lane width (LW), lateral clearance and access points. The second window concerns traffic volumes: peak hour factor (PHF), peak 15-minute volume (V15), number of lanes, trucks and buses %, recreational vehicles, and driver population.

4.1.2 Surveys as Follows:
Survey of Traffic volume: calculate the traffic volume in the morning and evening peak hours by counting traffic to achieve the first demand of the criteria installation of VMS.
Level of service (LOS): it was determined by the levels (A, B, C, D, E, and F) of the streets in the study area to achieve the second demand of the criteria installation of VMS.
Average annual daily traffic (AADT): it was extracted using the coefficient value (K= 0.14) according to urban standards. It was determined after studying different criteria and selecting a value (0.14) that best fits the traffic volumes of the actual hours of movement of the study area using the specialized program HCS2010 to evaluate the performance of streets. This point achieves the third demand of the criteria installation of VMS.
Survey of traditional traffic signs: it achieves a survey of traditional traffic signs in study area and compare the results with international criteria.

4.2 Practical Aspects

4.2.1 Study Area
The boundary of the research was the intersection of Maysaloun, located in Al-Ghadeer municipality, located in the eastern part of Baghdad city on the side of Rusafa, as it is bordered to the north by Diyala province, to the east by the new Baghdad municipality, to the south by the Karrada and Rusafa municipalities, and to the west by Al-Sadr municipality and center of Rusafa municipalities.
The study area (Maysaloun intersection) was selected because it meets the VMS installation criteria.
The intersection connects four main areas, the first road east of the intersection of the municipality’s area, a two-way road for traffic. The second road to the west connects the intersection with the Al-Ghadeer Bridge, a two-way road for traffic. The third road leads to the new Baghdad Municipality towards the south of the intersection, and the fourth road leads to the intersection of Palestine Street, a two-way road for traffic (Figure 7 & 8). In the study area, there are malls.
Figure 7. The study area within Baghdad area (Researchers based on [13])

Figure 8. Photo map illustrate the roads (name and directions), in the study area [Researchers]
4.2.2 Survey
Survey of Traffic volume: Measurement of traffic volume for all roads leading to (Maysaloun intersection) in the morning and evening peak hours by counting traffic to achieve the first demand of the criteria installation of VMS.

The survey was conducted for the period (November 2017 - September 2018) and for the morning and peak periods (8-10 am) and evening (1-3 pm). The statistics of traffic volumes surveys were conducted for all roads leading to Maysaloun intersections by traffic counting. The results were arranged in tables showing the results of traffic volumes with classification of mode of transport from large, medium and small, and all types of vehicles were converted equivalent to a small vehicle by using the PCU conversion factor (Table 1).

| No. | Vehicle type          | PCU |
|-----|-----------------------|-----|
| 1.  | Bicycle               | 0.5 |
| 2.  | Motor cycle           | 0.5 |
| 3.  | Vehicle (small)       | 1.00|
| 4.  | Bus (small)           | 2.00|
| 5.  | Truck (small)         | 1.25|
| 6.  | Truck (big)           | 3.00|
| 7.  | Bus (large)           | 3.00|

5. Results and discussion

5.1 Surveys concern intelligent traffic signs (VMS)
After achieving surveys and traffic statistics in the study area, it was found that traffic flows in each lane exceed 1100 vehicles / hour in each lane (Table 2 & 3)

| Direction | Time   | Small vehicle (vph) | Kia (vph) | Small truck (vph) | Big truck (vph) |
|-----------|--------|---------------------|-----------|-------------------|-----------------|
| St."1"/ Dir."1" | 7-8 M.rush | 2160 | 708 | 192 | 24 |
|           | 2-3 Ev.rush | 2232 | 704 | 324 | 36 |
| St.1/ Dir. 2 | 7-8 M.rush | 1716 | 96  | 252 | 24 |
|           | 2-3 Ev.rush | 1788 | 144 | 168 | 12 |
| St.2/ Dir. 1 | 7-8 M.rush | 2616 | 276 | 480 | 24 |
|           | 2-3 Ev.rush | 1956 | 228 | 204 | 48 |
| St.2/ Dir. 2 | 7-8 M.rush | 1992 | 276 | 276 | 12 |
|           | 2-3 Ev.rush | 2136 | 216 | 276 | 48 |
The results of LOS, using the HCS program, are below C, and this meets VMS installation criteria, which state that the service level must be C or lower (Table 4). AADT results showed that the two-lane roads had at least 16,800 vehicles per day, and this meets VMS installation criteria (Table 4).

Table 3. Traffic volume (PCU) in morning and evening rush hours in the study area.

| Direction | Time | Small vehicle (PCU/vph) | Kia (PCU/vph) | Small truck (PCU/vph) | Big truck (PCU/vph) | Total PCU/vph |
|-----------|------|------------------------|---------------|-----------------------|-------------------|---------------|
| St.3/ Dir. 1 | 7-8 M.rush | 1836 | 384 | 36 | - | 36 |
| 2-3 Ev.rush | 1656 | 228 | 252 | | | |
| St.3/ Dir. 2 | 7-8 M.rush | 1764 | 240 | 60 | 12 | |
| 2-3 Ev.rush | 1956 | 288 | 204 | | | |
| St.4/ Dir. 1 | 7-8 M.rush | 1188 | 348 | 108 | 24 | |
| 2-3 Ev.rush | 1596 | 384 | 144 | | | |

* St.: street
b Dir.: direction
c M.rush: Morning rush
d Ev.rush: Evening rush

Table 4. Comparison of Survey Results with criteria of installation of VMS in Maysaloun Square Intersection.

| Direction | Time | Traffic volume (vph / pcu) | The ratio of large to small cars (vph %) | Level of service LOS | Average Annual Daily Traffic AADT | Achieve the requirement of installation |
|-----------|------|---------------------------|----------------------------------------|---------------------|-------------------------------|---------------------------------------|
| St.1/ Dir. 1 | 7-8 M.rush | 3888 | 1 | F | 27771.4 | Conditions are met |
| 2-3 Ev.rush | 4233 | 2 | F | 30235.7 | |
| St.1/ Dir. 2 | 7-8 M.rush | 2295 | 3 | D | 16392.8 | AADT condition is not met |
| 2-3 Ev.rush | 2322 | 1 | D | 16585.7 | |
| St./Dir. 1 | 7-8 M.rush | 20078.5 | Conditions are met |
|------------|------------|---------|--------------------|
| 2-3 Ev.rush | 27428.5 | Conditions are met |
| St./Dir. 2 | 7-8 M.rush | 20892.8 | Conditions are met |
| 2-3 Ev.rush | 21835.7 | Conditions are met |
| St./Dir. 1 | 7-8 M.rush | 18921.4 | Conditions are met |
| 2-3 Ev.rush | 18107.1 | Conditions are met |
| St./Dir. 2 | 7-8 M.rush | 16821.4 | AADT morning condition is not met |
| 2-3 Ev.rush | 19907.1 | AADT morning condition is not met |
| St./Dir. 1 | 7-8 M.rush | 14935.7 | AADT morning condition is not met |
| 2-3 Ev.rush | 19200 | AADT morning condition is not met |

St.: street  
Dir.: direction  
M.rush: Morning rush  
Ev.rush: Evening rush

So when comparing the results regarding the need for the study area to install VMS, which was extracted from field surveys and office work, with the thresholds that determine the locations of the distribution of VMS on the roads leading to the intersection show that there is a difference in the distribution of traffic by street as well as time. High, medium and few traffic volumes were observed, with the level of service varying from level D to F.

5.2 Surveys concern traditional traffic signs
The field survey of traditional traffic signs in the study area showed a large deficit in their distribution. When comparing the existing of the traffic control devices in the study area with the criteria of the distribution of traditional traffic signs (signs and pavement marking), it was found that a number of streets do not have traffic control devices (pedestrian crossing lines, no parking sign, vehicle speed sign, etc.) (Figure 10). The lack of crossing lines for pedestrians endangers the pedestrian, because of the wide width of the streets in the study area.
6. Conclusions

There is an imbalance in the spatial distribution of traditional traffic signs that have a major role in regulating the movement of transport in the study area.

Significant deficit in traditional traffic signs in the study area.

LOS is low in the study area (below level C), indicating that VMS can be applied in the study area.

The study area suffers from traffic congestion during the day, especially during the morning and evening peak hours. This indicates that the area lacks traffic control devices.

Most Iraqi cities suffer from problems in the organization and distribution of traffic using traditional traffic signs, as well as the need to install VMS.

The application of VMS systems in any region does not require strong changes in transport infrastructure, and the specifications and standards it requires are available in the study area. As well as the need to determine the control and control sites (secondary and main) for the management of traffic in the city of Baghdad on both sides of Kardh and Rusafa, and for the study area, the location of the main control can be located near the General Traffic Department (near Al-Shaab Stadium), and the secondary center near the Rusafa traffic department.

Regulating traffic using traditional and intelligent traffic signs in areas with traffic problems will contribute to increasing the efficiency of the road network system, as well as reducing these problems (not ending them).

Recommendations

Issuing legislation, laws and traffic controls that help in the application of variable message signs (VMS) in the country.

Using intelligent traffic signs in accordance with planning standards and their applications in a scientific and efficient manner, to be integrated with traditional traffic signs. (figure 11)

Utilization of the methods used in the study (computer programs and types of field survey) to be applied in transport planning in cities.
In order to raise the level of transport services in Baghdad, the Directorate of Traffic must cooperate with the Municipality of Baghdad to form a permanent high authority tasked with the management, planning and guidance of transport services in the city of Baghdad, and thus address traffic problems by applying intelligent and traditional traffic signs. Preferably, this entity is consist of the departments of government, private, academic and service sectors that have to do with transportation and traffic services. Holding scientific seminars in schools and colleges for students to introduce the mechanism of using traditional and intelligent traffic signs, and its contribution in solving many transport and traffic problems, as well as television and radio programs that inform the public of the usefulness and mechanism of their use and the conditions and laws of their application. Using intelligent and traditional traffic signs in the driving license test.

Figure 11. The suggestion of the necessary traditional & intelligent traffic sign in the study area

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References
[1] State organization of roads and bridges, Highway design manual, handbook, (ministry of housing and construction, Iraq, 1982) IV-1- V-2.
[2] Road department, Traffic control devices manual, Handbook, 1 (Abu Dhabi municipality, 2005) 2-1.
[3] U.S. Department of Transportation 2000 MUTCD manual on uniform traffic control devices, millennium edition (Fedral Highway Administration).
[4] Governmental Departments: General Directorate of Traffic/ Iraq Retrieved From http://itp.gov.iq/ar/node/61
[5] Department of transportation 2014 Texas MUTCD manual on uniform traffic control devices (Heathrow: American Automobile Association).
[6] Alberta transportation 2017 Highway pavement marking guide.
[7] Nygardhs S and Helmers G 2007 VMS – Variable Message Signs, A literature review (Sweden: vti, ).
[8] Mesrop S S 2016 *Using the intelligent systems in the transportation planning for Baghdad city*, Center of urban & regional planning for postgraduate, Baghdad, MSc.

[9] Office of traffic, safety, & technology (OTST), *Mn/ Dot intelligent transportation system (ITS) design manual* (Minnesota: Department of transportation, 2010).

[10] Department of maintenance and operations /New Yoruk state Thruway Authority, *Guidelines for use of variable message signs (VMS)* (New Yoruk, 2011).

[11] Rämä P Schirokoff A and Luoma J 2004 Practice and development of variable message signs (VMS) in Viking countries-potential for harmonisation, *Julkaisua saatavana pp14-46.*

[12] Balke K *Warrants & criteria for installing & sunsetting* (TSDOT ITS equipment, January, 2014).

[13] Governmental Departments: Baghdad Municipality/ Urban Planning and GIS Departments and Municipality of Karrada/ GIS Department.

[14] World Transport in United Kingdom [www.eco.logica.co.uk](http://www.eco.logica.co.uk).