ESRI User Conference Technical Report

Report Title: Use of GIS for pedestrian space maintenance of welfare society

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- Synopsis: Reviews the effectiveness and problems of using a GIS to establish a pedestrian network plan as part of a roading improvement project in Matsuyama City in order to establish measures for creating barrier-free pedestrian spaces with the aim of creating a people-friendly local environment.

- Text: See following pages

- References

    ・Guidelines on creating a people-friendly town environment (1994, Ehime Prefecture)
    ・General plan for creating an town environment friendly to the disabled and elderly (1997, Matsuyama City)
    ・Matsuyama City plan for the disabled (1999, Matsuyama City)
    ・Guidelines on creating a network of barrier-free pedestrian spaces (2001, Ministry of Land, Infrastructure and Transport)

- About the author

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Introduction

With the increasing aging of society that has occurred in recent times, ensuring the elderly can maintain their independence and continue to participate in society is an essential part of creating a society that is healthy and active. Accordingly, public utilities need to take active steps to respond to the aging society.

Recent years have also seen a trend towards the concept of normalization whereby it is possible for the disabled to have a lifestyle and a level of activity that is similar to the non-disabled. In other words, a strong need has emerged for the disabled to be able to receive services and to live and work alongside the non-disabled.

For these reasons, creating a society in which people such as the independent elderly and those with physical disabilities can live and work has become a priority in Japan today and there is an immediate requirement to start rearranging our living environment to meet these needs.

Travel by public transport is one aspect of this which is very important if the elderly and physically disabled are to participate in society. Making public transport easier to use is a significant part of achieving such a welfare society.

In Matsuyama City, the location discussed in this report, policies are in place that are in line with these social trends and there is a requirement for specific measures to "create an environment where people can go about their lives on foot" which can be enjoyed equally by all people. Of particular importance was how barrier-free roads can be promoted.

Against this background, this report, " Use of GIS for pedestrian space maintenance of welfare society ", describes the establishment and future direction of a pedestrian network plan that promotes efficient infrastructure development with the aim of determining the regional priority of measures to create barrier-free pedestrian access. The work uses a geographic information system (hereafter GIS) able to present clear information from a variety of perspectives to ensure the accountability of the pedestrian facilities.

1. Overview of the footpath network plan

The footpath network is reviewed based on the following flow. The details of each item are described in the following sections.

① Current situation and issues facing barrier-free access (understanding roading requirements)
② Investigation into a basic strategy for making pedestrian spaces barrier-free（Establishing the basic policy for constructing the basic network for the pedestrian space）
③ Collecting information relating to work on pedestrian spaces（Establishing the basic network）
④ Clarifying the conditions GIS utilization
⑤ Concept for Constructing the basic network
⑥ Pedestrian network analysis (Utilizing spatial information：Primary analysis, Secondary analysis)
⑦ Steps towards implementing a program of work to achieve barrier-free pedestrian spaces

Implementing the seven items above could solidify the effectiveness of the usage of GIS for achieving the pedestrian spaces for the welfare society.

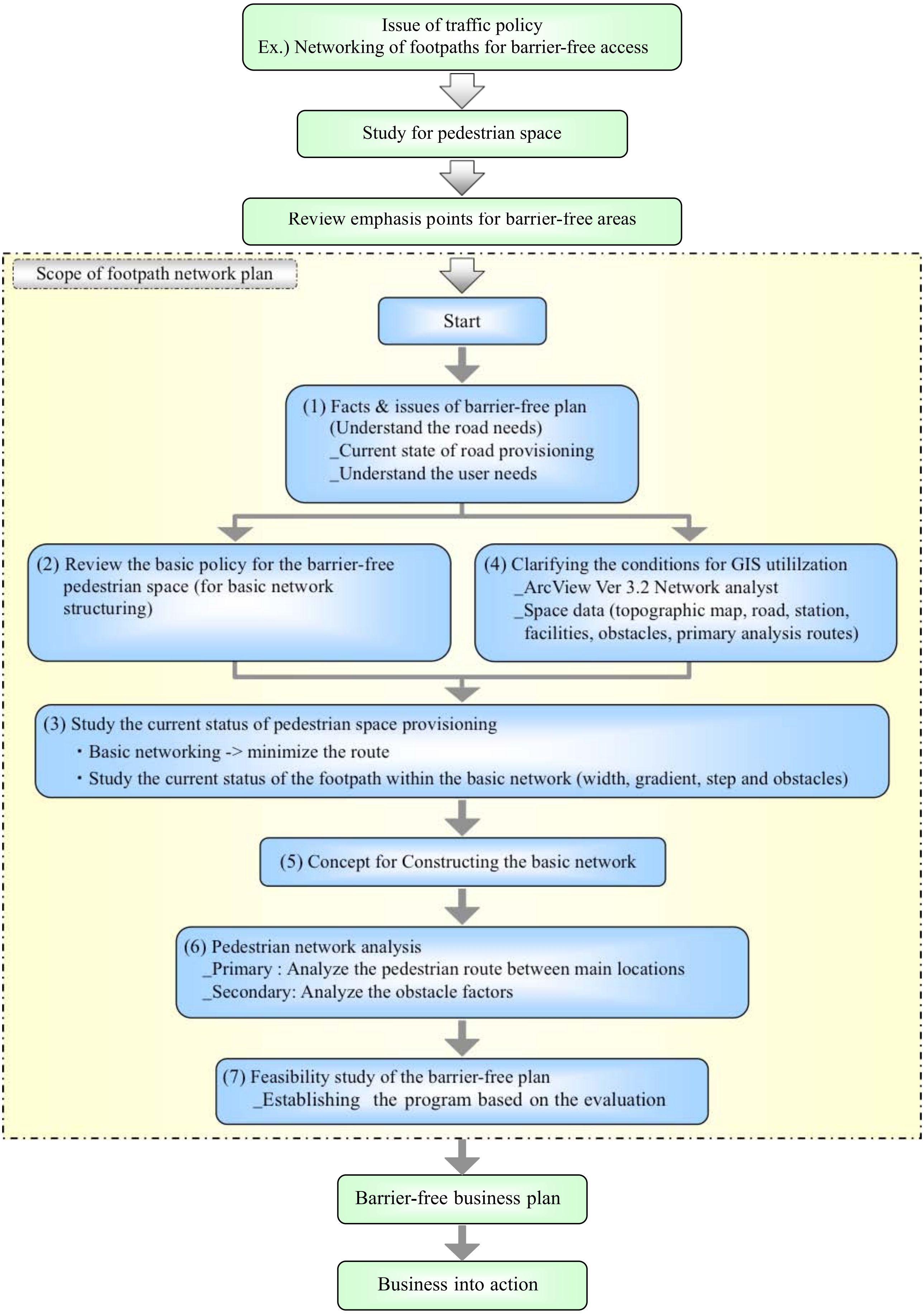


Figure 1-1 Footpath provisioning plan flow

2. Overview of Matsuyama City

This section gives an overview of Matsuyama City, the location discussed in this report.

Matsuyama City is a city with an area of 289.35km^2 located (at longitude 132 east, latitude 33 north) roughly at the center of Ehime Prefecture on Shikoku Island, Japan. To the east, the city is enclosed by the Shikoku mountain range which includes Mt. Ishizuchi, the highest peak in West Japan. The city is located in the northeast section of the warm Matsuyama plain which looks out over Japan's Inland Sea to the west.

The history of Matsuyama City starts in 1602 (Keicho 7) with the construction by Yoshiaki Kato of "Matsuyama Castle" in Katsuyama, thereby giving the town its name. The town continued to prosper as the Gamou and Matsudaira castle town, which formed the basis of today's city.

In 1889 (Meiji 22), the town was established as the first "shi" (city) in Ehime Prefecture and has continued to grow since then. Matsuyama City has had particularly strong growth during the post-war era, becoming the first city in Shikoku to reach a population of 400,000 in 1980 (Showa 55).

The town boasts a range of historical and cultural features including the Dogo hot spring, reputed to be the oldest in Japan, and Matsuyama Castle, and being home to haiku poet Masaoka Shiki and author Natsume Soseki. Its reputation has grown as the "spa, castle, and cultural town" and "international tourist hot spring and cultural city", and in the 21st century the city aims to develop even further with the motto "proud to be the best city in Japan".

Figure 2-1 Location of Matsuyama City

However, even a town such as Matsuyama City cannot escape the problems of a rapidly aging society and the population of elderly in the town has increased steadily since 1985 (Showa 60). The proportion of the total population reached approximately 19% in 1995 (Heisei 7), which means that about one in five of the town's people are elderly. Along with the nationwide trend towards an aging population, the aging of Matsuyama City is expected to continue into the future.

Table 2-1 Trend in Population of Elderly in Matsuyama City

	1985		1990		1995	
	Population (No. people)	Proportion (%)	Population (No. people)	Proportion (%)	Population (No. people)	Proportion (%)
Total population	426,658	100%	443,322	100%	460,968	100%
Population for 65 years and older	58,364	13.7%	72,769	16.4%	87,121	18.9%

3. Current situation and issues facing barrier-free access (understanding roading requirements)

In regional society, there are a number of barriers (obstacles) to the elderly and disabled enjoying a normal life. A regional environment is needed that meets the diverse needs of its residents and in which everyone cam move about fairly and easily.

In Japan, the "barrier-free transport law" was enacted in May 2000 (Heisei 12). This law deals with the establishment of transport facilities to suit an aging society and there are high expectations that the law will help with barrier-free roading and public transport facilities.

In Matsuyama City, a "survey into a transportation plan to suit Matsuyama" was conducted (survey conducted from June 28 to July 31, 2000, published on Matsuyama City web site) against the background of an increasingly elderly population. One of the results of the survey was that approximately 50% of city residents use a car or bicycle on a daily basis.

The opinions of residents regarding future transportation facilities can be summarized as follows.

- □ Between 60% and 70% of both the elderly and disabled go out on a daily basis and many people use bicycles, walking (including wheelchairs), and similar as their means of transport. The most common purposes for going out were shopping and going to a medical facility and this showed that there is a demand for pedestrian facilities that link transport hubs to shopping centers and hospitals.
- □ Regarding roads and footpaths, there was a wish to eliminate steps and similar obstacles as well as to provide pedestrian-only facilities and to widen footpaths.
- □ From the perspective of the pedestrian network, there is a need to link footpaths together via pedestrian crossings, traffic signals, and similar. This was evident from the opinions expressed about the inconvenience of intersections that do not have traffic signals.

These results show that future transport policies must give consideration to making facilities easy to use for all city residents. In particular, making footpaths barrier-free is an important policy issue from the perspective of residents' needs and is an issue that must be resolved.

However, as central Matsuyama City has become more urbanized, historically roading facilities have already been established closely intertwined with resident's needs and obtaining the space needed for widening or other improvement is very difficult.

On the other hand, the objective of social welfare policies is that all city residents, including the elderly and disabled, be able to participate in society throughout their life and, in this respect, improving pedestrian facilities, including making them barrier-free, should be one of the objectives of roading work.

This environment requires that progress be made in creating a network that responds to the growth of the city, with priority placed on the necessary policies and the promotion of barrier-free policies that reduce costs and are compatible with a multi-modal transport system*.

When considering this background, establishing various policies aimed at making pedestrian spaces barrier-free and creating a people-friendly local environment from the perspective of roading improvement work enables the needs of the aging society to be met and improves people's daily lives.

Accordingly, investigations into a "pedestrian network work plan" were carried out with the aim of providing a mechanism for understanding the current state of the region and promoting efficient work.

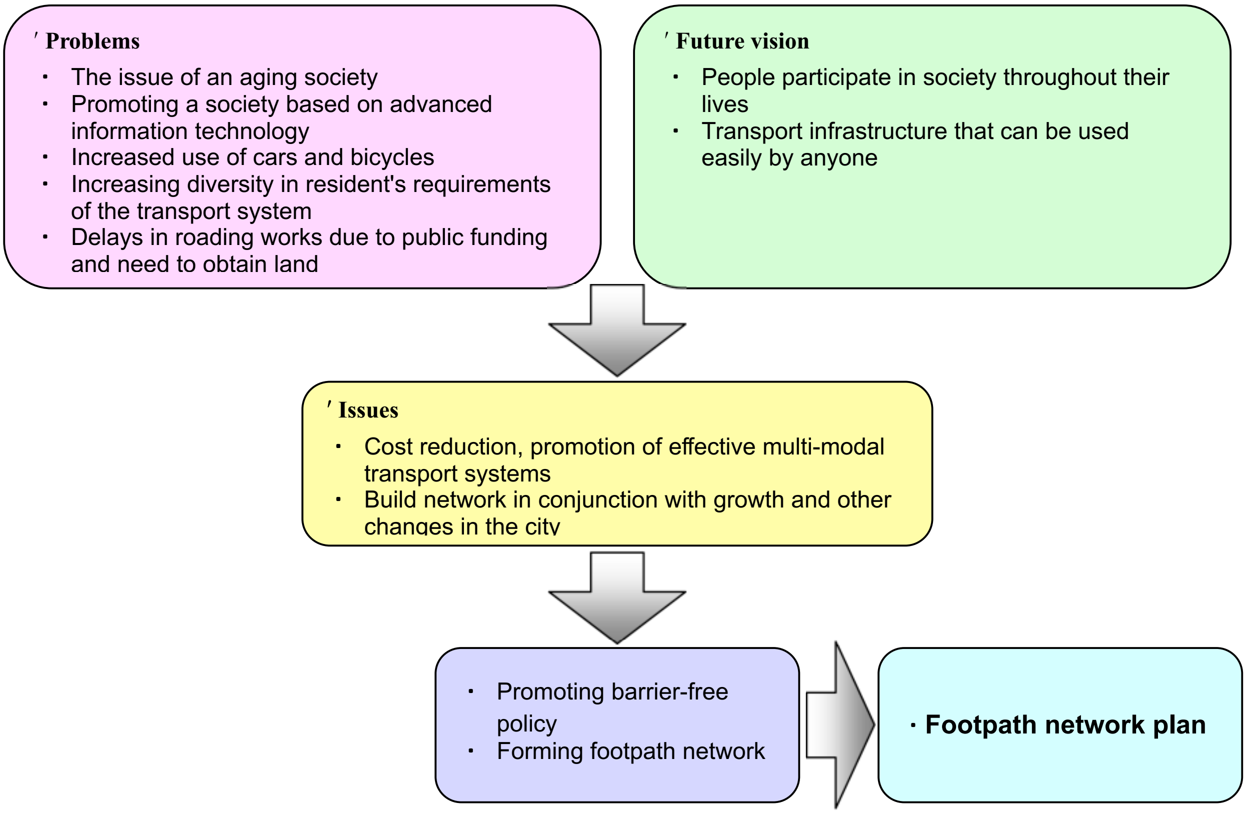


Figure 3-1 Barrier-free facilities: its problems and issues

* What is a "multi-modal transport policy"?
An integrated transport policy that links multiple modes of transportation such as road, air, sea, waterway, and railway to establish an efficient transport system that meets the needs of users.

4. Investigation into a basic strategy for making pedestrian spaces barrier-free

In establishing the basic strategy for making pedestrian spaces barrier-free, giving priority to pedestrians is a basic principle. Also, it is important to consider the needs of the elderly and disabled when undertaking footpath improvement work. Achieving the aim of "pedestrians first" requires planning for pleasant pedestrian spaces through measures such as clearly separating roads and footpaths, and ensuring footpaths are wide enough. To actually identify measures that will achieve the desired effect, it is necessary to place an emphasis on the extent to which routes are barrier-free when selecting routes.

Selecting routes with an emphasis on the extent to which they are barrier-free involves determining the shortest routes linking the main facilities in the area and establishing a basic network that consists of these routes. This work requires accurate analysis of the large volume and many different forms of spatial data such as the information on routes and footpath conditions that has been collected and collated, together with analysis that can easily be understood visually.

Accordingly, it was decided to use a GIS to provide the functions needed for this analysis and to establish a basic network for the pedestrian spaces in the target areas.

<Basic strategy for creating a basic network of pedestrian spaces>

③ The approach taken to the basic network of pedestrian spaces is to use a GIS as a tool to analyze the network.
✿ Determine the shortest route between the major facilities and transport hubs in an area.
♣ This enables accurate analysis using large volumes of data such as route information and the condition of footpaths, and presents the information visually so it can be easily understood.

5. Collecting information relating to work on pedestrian spaces

In order to establish a basic network of pedestrian spaces and to make these barrier-free, a study was undertaken to collect actual information from the eight areas that were covered by the study. The intention is to use this information to guide future work. The collected information covered flatness and related features including effective width, gradient, steps, footpath construction, obstacles, and pavement material.

☐ Establishing a basic network

③ Commercial districts

The basic network is established by selecting the shortest of the available routes between the locations of major facilities.

✿ Residential districts

The basic network is established by selecting the shortest routes between the major facilities in each residential district.

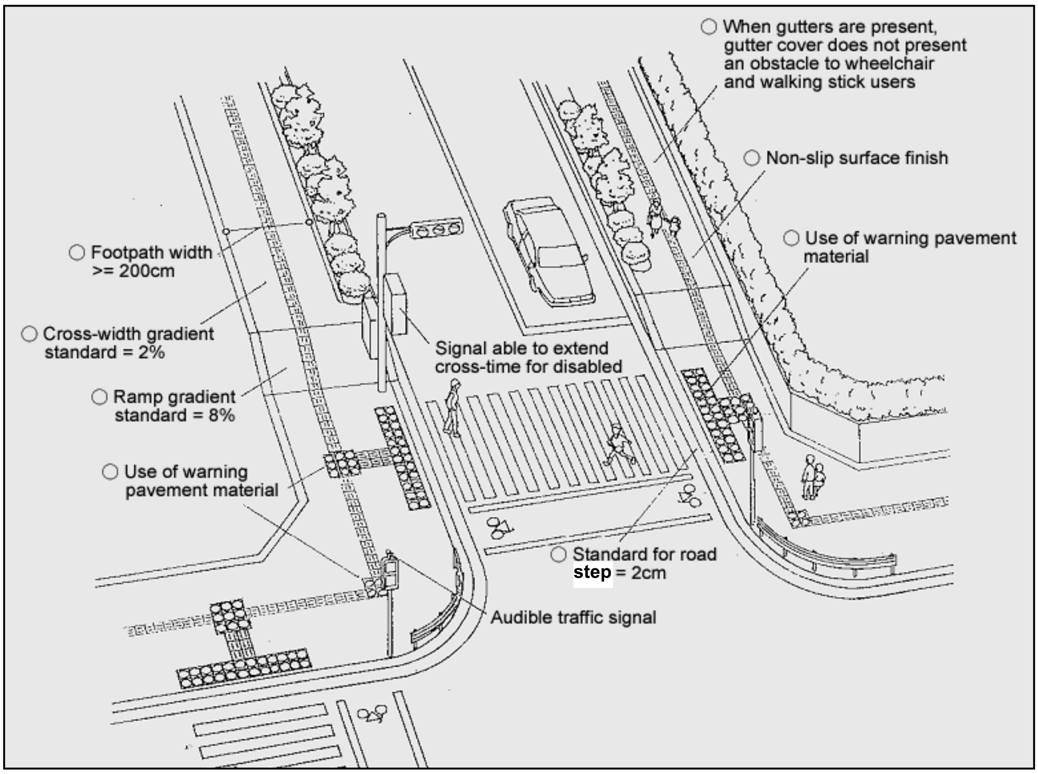
To establish a basic policy strategy, the Ministry of Land, Infrastructure and Transport undertook the "investigation of pedestrian space infrastructure" to formulate the above plans for all prefectures, towns, and cities between 1996 (Heisei 8) and 2000 (Heisei 12). In Matsuyama City, the regions studied for barrier-free access were split into two groups for commercial districts (*1) and residential districts (*2) respectively and a total of eight different areas were established as a base for the investigations into formulating the "pedestrian network facilities plan".

*1 Commercial districts → Areas where major facilities are concentrated, particularly those that fall under the definition of commercial districts in town planning law.

*2 Residential districts → Areas other than commercial districts that do not fall under the definition of industrial districts in town planning law. Includes light industrial districts and fringe commercial districts.

Table 5-1 List of areas covered by study

Commercial Districts	Residential Districts	
1. Aratama, Misake	3. Shimizu	4. Yasaka, Shinonome
2. Shinonome Ropeway	5. Ishii	6. Sanetsu
7. Mitsuhama	8. Furumitsu	



6. Clarifying the conditions for GIS utilization

This section describes the conditions for using a GIS.

Given the requirement that data in the integrated city GIS (G-XML and shape data) be able to be read from and written to, "ArcView version 3.2" was selected as the base GIS engine to use for analysis of pedestrian space networks and a network analyst was used for the analysis. Key factors in this decision were the ability for the final system to easily integrate into the LAN operated by the city government, and support for shape files and G-XML format data which are used by integrated GIS systems that are entering widespread use.

Next, it is possible to use DM data from the roading register for the base map. This is spatial data that is used in the background. In practice, however, the roading register drawings were not up to date and features such as the recently constructed Matsuyama ring line were not included. Accordingly, city plan drawings (1/25,000) were scanned and used instead. As this is raster data, its visual appearance when enlarged to a scale of 1/500 was poor but it was adequate for maintaining the location information for the footpath survey data. We expect to convert the data when the upcoming update of the roading register is complete.

The table below lists the spatial data used for analysis in the study

Table 6-1 Spatial Data List

No.	Name	Graphic Data	Attribute Data
1	Topographic map (base map)	1/25,000 city plan drawings	-
2	Matsuyama City	City boundary	-
3	Applicable areas	1/25,000 city plan drawings	Applicable regions
4	Main roads	National, prefectural, and city roads	Route name, road type, road length
5	City plan roads	1/25,000 road network plans	City plan road number, name, category (in use, planned)
6	Plan roads	City roading development plan routes	-
7	Railway lines	JR, Iyo Railway suburban lines, local lines	Line name, length
8	Stations, tram stops	JR, Iyo Railway suburban lines, local lines	Station, stop name
9	Bus stop		Bus stop name
10	Survey target area	Survey target area	Area number, area name
11	Survey target route	City road with footpath work complete	Route name, construction, pavement surface, width, max. step, max. gradient, improvement priority
12	Area facilities	Hub facilities	Name, area number, facility type
13	Barrier-free route	Barrier-free plan route	Type of work
14	Model area region	Area identified in town development plan	-
15	Photograph of location	Photograph location	Photograph number, content
16	Number of points on route	Route determined in primary analysis	Route name, road type, extent of route duplication , area name, route length, number of obstacles
17	Network route	Route determined in primary analysis	Route name, construction, pavement surface, width, max. step, max. gradient
18	Obstacle (damage)	Obstacle location	Type, nature of obstacle, manager
19	Obstacle (subsidence)	Obstacle location	Type, nature of obstacle, manager
20	Obstacle (effective width)	Obstacle location	Type, nature of obstacle, manager
21	Obstacle (step)	Obstacle location	Type, nature of obstacle, manager
22	Obstacle (gradient)	Obstacle location	Type, nature of obstacle, manager
23	Region 1 analysis result	Primary analysis route	Name of transport hub, travel distance
24	Region 2 analysis result	Primary analysis route	Name of transport hub, travel distance
25	Region 3 analysis result	Primary analysis route	Name of transport hub, travel distance
26	Region 4 analysis result	Primary analysis route	Name of transport hub, travel distance
27	Region 5 analysis result	Primary analysis route	Name of transport hub, travel distance
28	Region 6 analysis result	Primary analysis route	Name of transport hub, travel distance
29	Region 7 analysis result	Primary analysis route	Name of transport hub, travel distance
30	Region 8 analysis result	Primary analysis route	Name of transport hub, travel distance

7. Concept for constructing the basic network

The basic network is constructed by selecting the route (national highway, prefectural highway, or city road for which footpath upgrading is complete) between each main location in the areas being studied that is judged to be the shortest. Amongst main facilities, the shortest routes from transport hubs to all main facilities are selected. (See figure below)

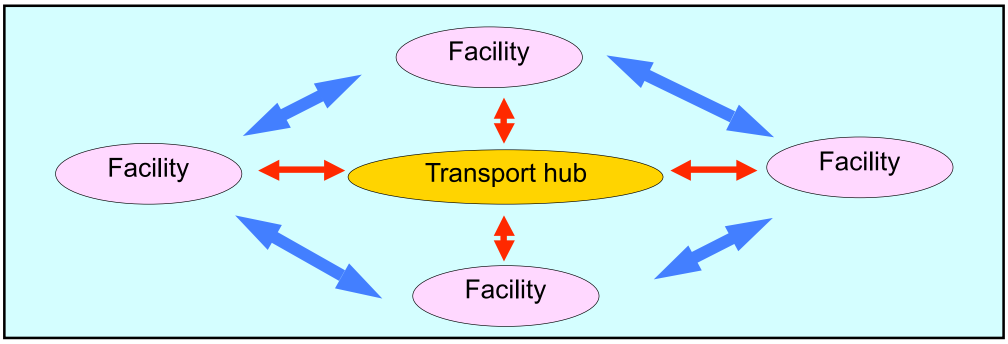


Figure 7-1 Concept of network linking facilities together

In cases when the network linking the locations cannot be constructed using only national highways, prefectural highways, or city roads for which footpath upgrading is complete, the network is formed by selecting the direct route to the facility. In the case when a road at the boundary between areas being studied is selected as the shortest route, the investigation treats the road as being included in both areas.

* "Main facilities" are divided into seven categories: social welfare facilities, health and medical facilities, government administrative facilities, educational facilities, shopping centers, transport hubs, and other public facilities. Public facilities and facilities with a strong public aspect in the area being studied are designated as "main facilities" and these are further categorized into "important facilities" or "other facilities" depending on their size and the organization that manages them.

8. Pedestrian network analysis (Utilizing spatial information)

Analysis of the pedestrian network was performed as follows: ① Primary analysis was performed to determine the pedestrian route between main locations using footpaths included in the study (network analysis). ② Secondary analysis was performed using the maintenance status of existing footpaths, particularly those associated with city roads, to determine the obstacles that existed in the basic network identified by the primary analysis. This was used to prioritize footpath maintenance and improvements.

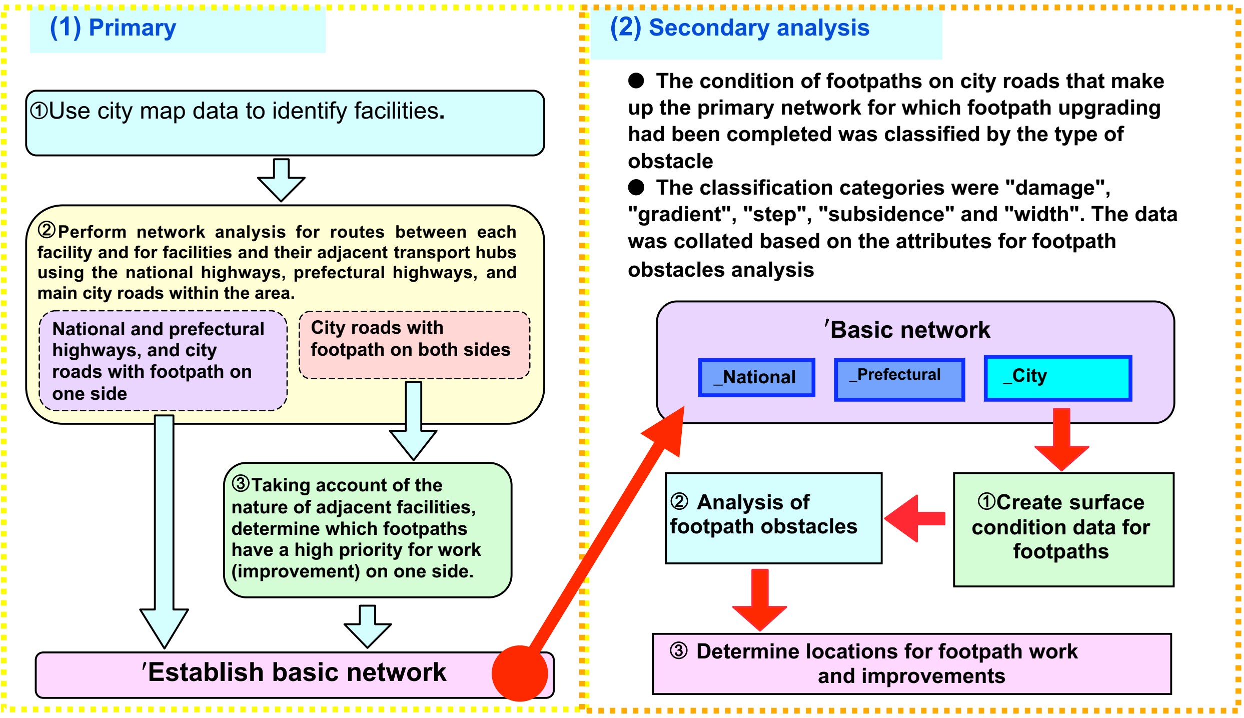


Figure 8-1 Concept of analysis

1) Primary analysis

In accordance with the base strategy, spatial information as commercially available maps was used to determine the main facilities located in each area, and a GIS was used to plot these on top of the base map. Next, the pedestrian routes between these facilities using footpaths included in the study were determined for each of the areas under study (network analysis). The basic network was identified from the routes identified by this step by considering the status of adjacent facilities, particularly for city roads with footpaths on both sides and determining which footpaths had the highest priority for maintenance or improvement work.

2) Results and evaluation of primary analysis

The route overlap level indicates the extent to which footpath routes overlap between footpath intersections and between facilities (basic network). The table below lists the routes between facilities that were identified as having a route overlap of four or more in the primary analysis.

The result was that the basic network for all areas being studied contained 223 routes, including national highways. Of these 159 routes were city roads (71%).

Of the 35 routes with a high level of overlap (4 or higher), 24 routes were city roads (69%) indicating that the frequency of city road use is high. This shows the importance for Matsuyama City of city road maintenance in constructing a network in each area.

The city road with the highest route overlap level was the Funayamachi Gokoku Shrine route ⑤. Eight different pedestrian routes between facilities within the area and between facilities and adjacent transport hubs overlap on this route. This route was identified as the route with the greatest need of footpath upgrading.

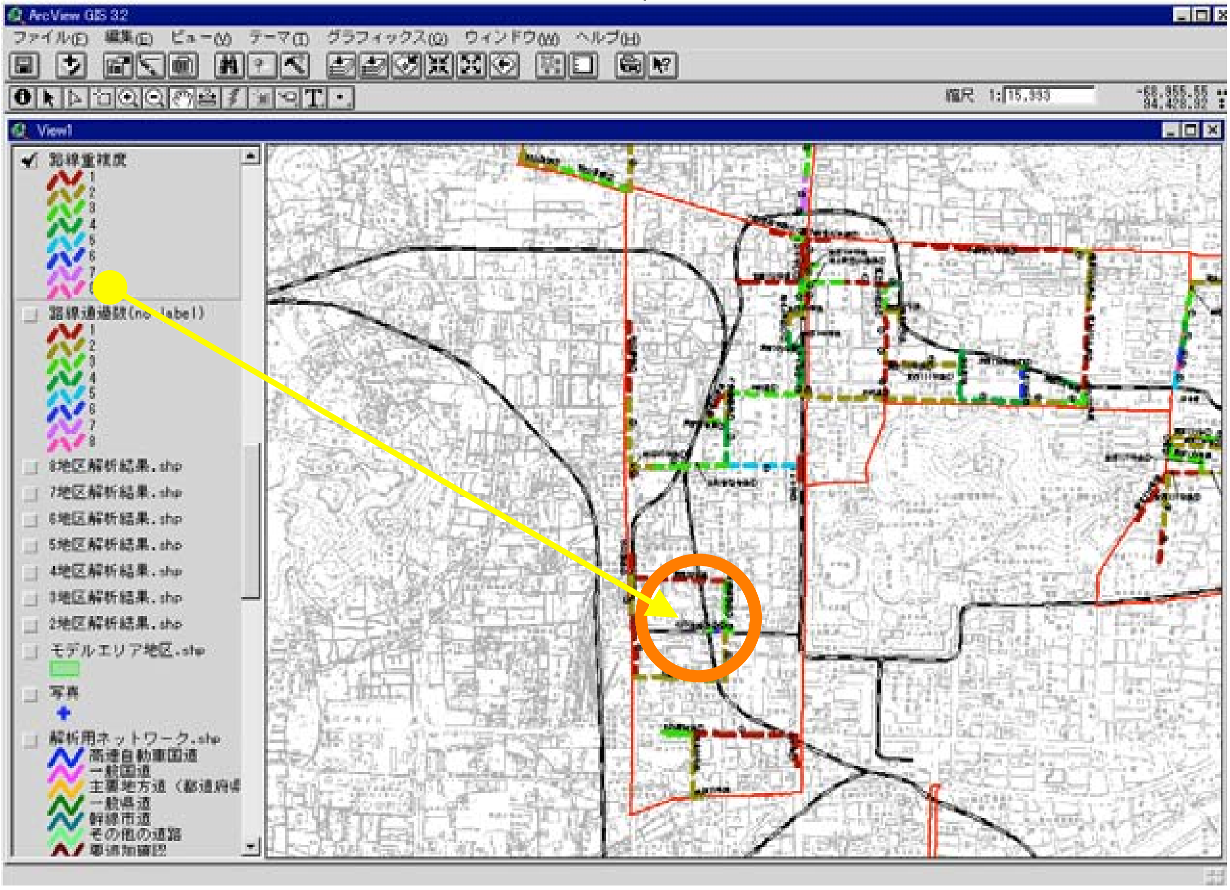
Table 8-1 Route Overlap

Area	Road Type	Name	Route Overlap	Length (m)	Priority Footpath
1	Main regional highway	Matsuyama Kosen ♠	8	29.18	
2	City road	Funayamachi Gokoku Jinja-sen ❡	8	32.29	East side
6	Ordinary national highway	Route 196 ❡	7	127.55	
1	Main regional highway	Matsuyama Kosen ✿	6	24.01	
2	City road	Funayamachi Gokoku Jinja-sen ➻	6	41.47	East side
3	City road	North-south route 198	6	123.99	
4	City road	Dogo route 44 ③	6	203.94	
1	City road	Honmachi Hodoji-sen ✿	5	256.06	Both sides
2	City road	Funayamachi Gokoku Jinja-sen ⑥	5	15.49	East side
2	City road	Funayamachi Gokoku Jinja-sen ⑥	5	51.44	
4	Ordinary prefectural highway	Dogo Koen-sen ♣	5	124.32	
4	Ordinary prefectural highway	Dogo Koen-sen ➻	5	125.37	
5	Ordinary prefectural highway	Kumehabu-sen ③	5	23.15	
1	City road	North-south route 4 ✿	4	47.80	
1	City road	East-west route 109	4	44.52	
1	Ordinary national highway	Route 196 ♣	4	25.75	
1	City road	Oguri Oyo-sen ✿	4	154.87	East side
2	City road	Funayamachi Gokoku Jinja-sen♣	4	86.66	East side
2	City road	Funayamachi Gokoku Jinja-sen ✿	4	18.76	East side
3	City road	East-west route 121	4	65.47	
3	City road	Shimizu-machi Matsuyama Kosen ♣	4	50.94	
3	City road	Shimizu-machi-sen	4	176.44	West side
3	City road	East-west route 110 ✿	4	6.29	
3	City road	Heiwa-dori ♣	4	215.84	
4	City road	Shinonome route 47 ③	4	207.45	
4	City road	Shinonome route 47 ♣	4	106.19	
4	Ordinary prefectural highway	Dogo Koen-sen ⑥	4	99.16	
5	City road	Ishii route 43 ❡	4	178.89	West side
6	Ordinary national highway	Route 196 ⑥	4	13.60	
6	City road	Hisae route 202 ✿	4	33.67	South side
6	City road	Shimizu route 19 ✿	4	356.91	
7	City road	Mitsuhama route 42	4	153.40	
7	City road	Mitsuhama route 5	4	381.38	
8	Ordinary national highway	Route 437 ✿	4	88.65	
8	Ordinary prefectural highway	Mitsuhama Teisha-jo-sen ♣	4	17.87	

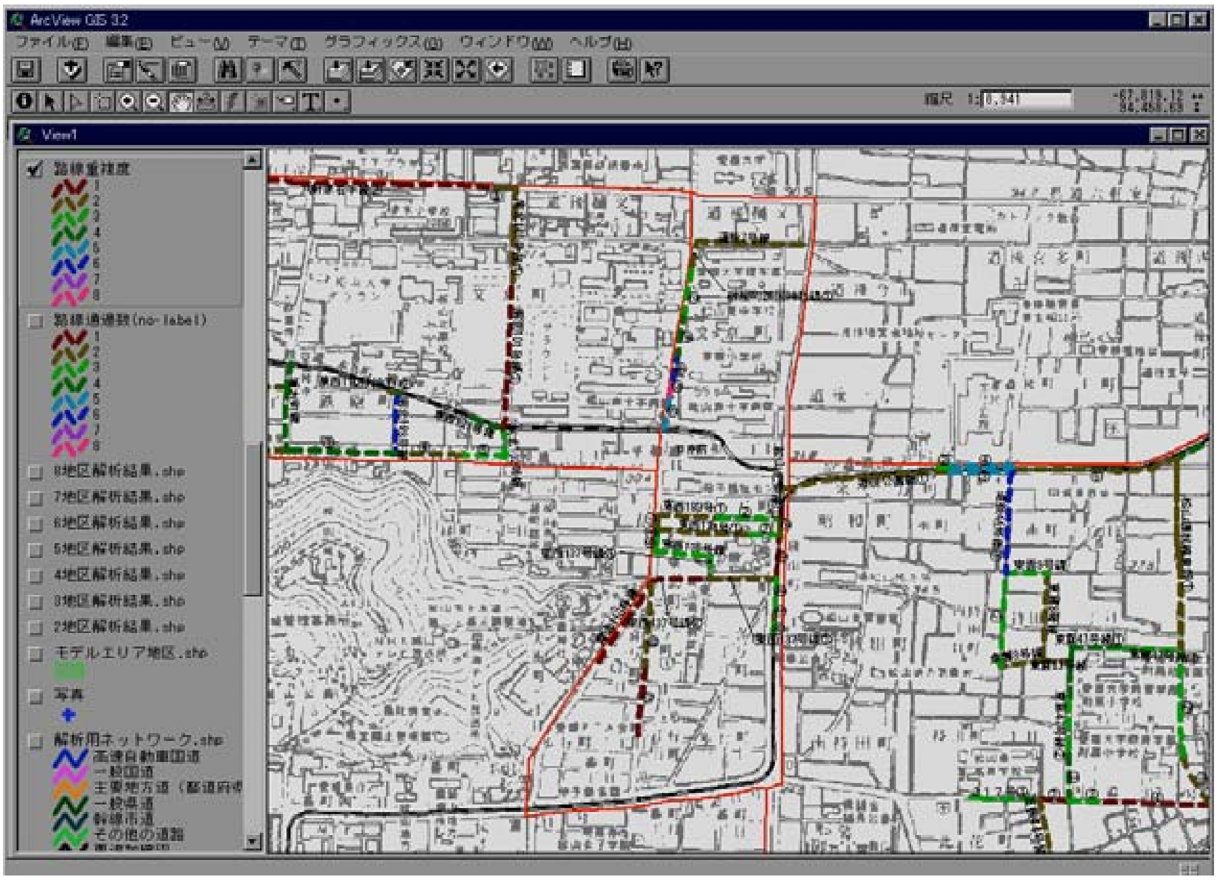
Indicates city road for which footpath upgrading complete.

The figures below show the results of primary analysis for the two main areas (③Aratama/Misake area, ✿ Shinonome Ropeway area)

<③ Basic network routes and overlap level for Aratama/Misake area>



<✿ Basic network routes and overlap level for Shinonome Ropeway area>



3) Secondary analysis (Locations for footpath maintenance and improvement)

Uses the maintenance status of existing footpaths, particularly those associated with city roads, to determine the obstacles that exist in the basic network identified by the primary analysis.

The condition of those footpaths associated with the city roads that make up the primary network for which footpath upgrading had been completed was classified by the type of obstacle. The classification categories were "damage", "gradient", "step", "subsidence" and "effective width". The data was collated based on the attributes shown in the table below and the footpath obstacles were analyzed using the GIS.

Table 8-2 Obstacle Type List

Attribute (1)	Attribute (2)	Attribute (3)						Obstacle
Effective Width	Power pole	Traffic signal	NTT pole	Power pole	Power feeder line			Numeric value W < 1.5 W < 2.0
	Sign	Legally required sign	Direction sign	Guide sign	Warning sign	Information sign	Fire safety sign	
	Safety feature	Reflector	Lighting	Pedestrian bridge	Subway			
	Fire hydrant							
	Bus stop							
	Post box							
	Telephone box							
	Private property	Tree	Commercial sign					
Step	Stone border							Numeric value Δt > 2 cm
	Sewage facility	Manhole cover	Sewage cover					
	Stormwater cover	Grating cover	Concrete cover	Iron cover	Stormwater cover			
	Water supply	Stop valve	Water valve	Air valve				
	Fire hydrant							
	Gas supply							
Damage	Pavement	Standard asphalt	Interlocking	Color pavement	Concrete	Concrete slab	Slab	
	Stone border							
	Guide block							
	Gutter							
	Stormwater cover	No cover	Rainwater measure	Grating cover				
Gradient	Ramp gradient							Numeric value
	Crossing gradient							Numeric value
	Intersection gradient							Numeric value
Subsidence	Pavement	Asphalt	Interlocking	Color asphalt	Concrete	Concrete slab		Numeric value
	Sewage facility	Manhole cover	Sewage measure					Numeric value

4) Secondary analysis results and evaluation

The most common obstacles over all the areas under study were gradients and steps. A total of 508 locations across the 8 areas did not meet the gradient criteria. Amongst these, intersection gradients were particularly numerous with 292 locations across the 8 areas not meeting the criteria.

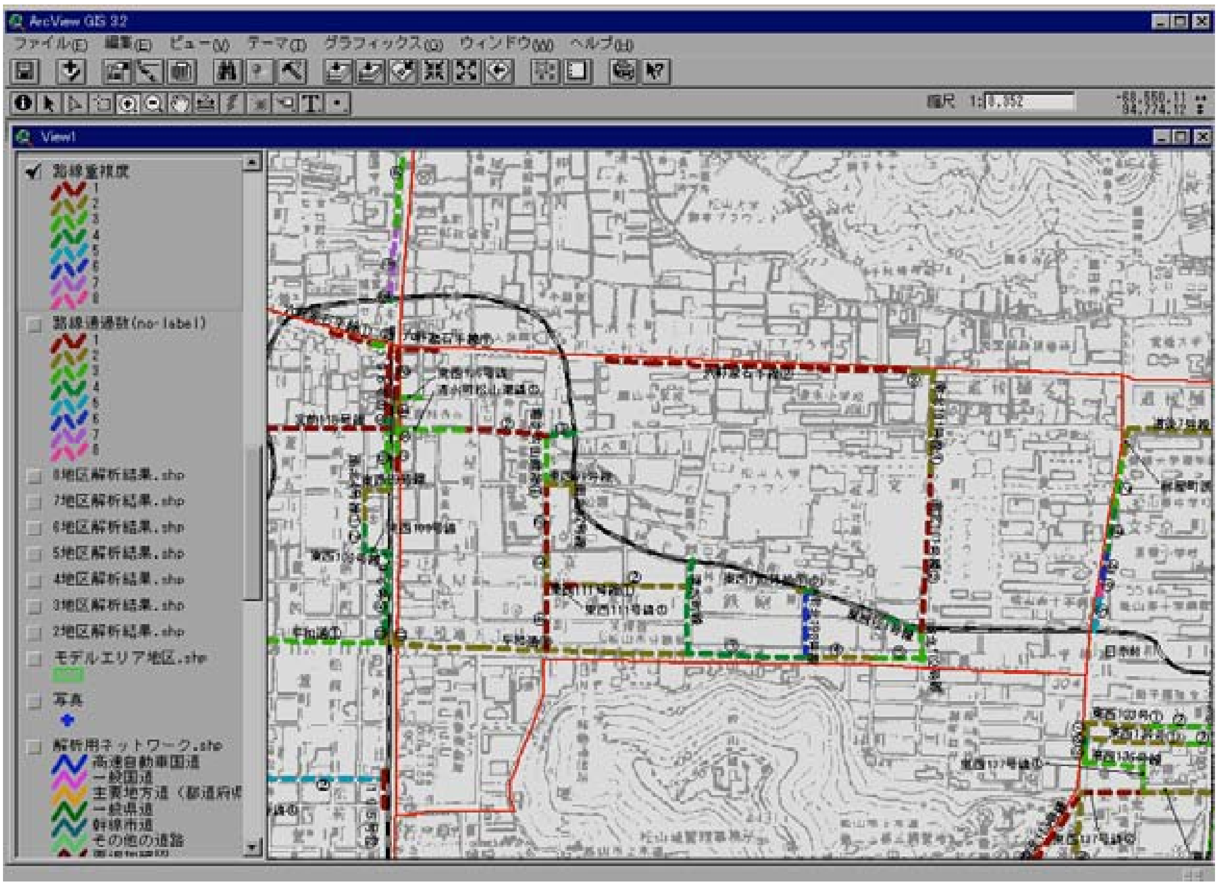
A total of 537 locations across the 8 areas did not meet the criteria for steps, of which most were stone borders with 500 locations (93%) not meeting the criteria.

Most of the obstacles in the width category were caused by power poles. In area 1, the obstacles also included privately owned trees.

The most common causes in the damage category were stone borders and stormwater covers with damage to stormwater covers in 13 locations spread over 5 routes in area 6.

The following figures show the results of secondary analysis for the one main areas (③ Shimizu area).

<♣ Secondary analysis results for the Shimizu area>



5) Overview of prioritization of footpath maintenance (improvement) work

The results of the primary and secondary analysis for constructing the basic network and the prioritization of footpath upgrade work were treated as follows.

First, footpath upgrade work to establish the basic network is a priority for footpaths with a high overlap level (level 4 or higher) and which have not yet been upgraded. Also, routes on which work has already been done need to be given priority for improvement work if they have a high overlap level (level 4 or higher) and a large number of obstacles have been identified.

Accordingly, the following specific points can be made regarding prioritization of footpath work based on pedestrian network analysis.

_ The footpath work priority is high for the north-south route 198 in the Shimizu region [3] and the Dogo 44 route (between the Matsuyama Minamimachi post office and Mochida Kindergarten) in the Yasaka/Shinonome area.

_ Amongst routes for which work has already been done, the priority is high for routes that pass through a large number of locations and which have a large number of obstacles.

_ In addition, although the overlap level is low, work is also needed on the north part of the Matsuyama ring line due to its location (26 step locations and 21 gradient locations).

9. Steps towards implementing a program of work to achieve barrier-free pedestrian spaces

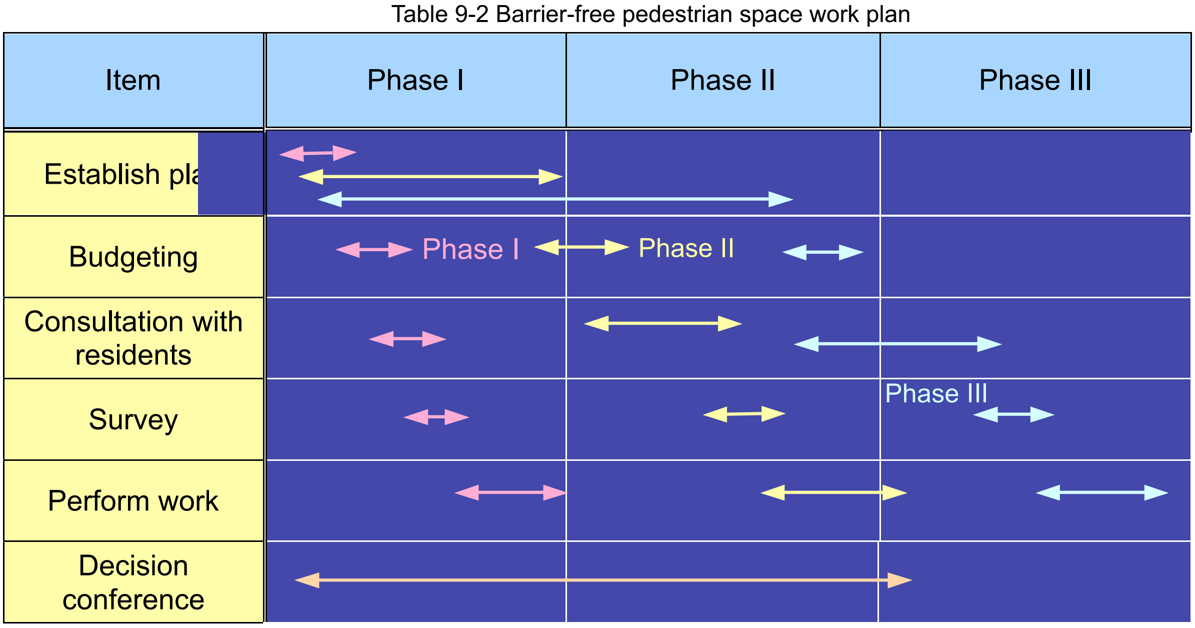
The evaluation from the perspective of barrier-free access was quantified using the items identified from the analysis of the pedestrian network between the roads in the areas being studied.

Further, a program for pedestrian space development work that is conducive to future efficient footpath upgrade work in Matsuyama City was able to be developed by performing an evaluation of making pedestrian spaces barrier-free for the extent of the routes being studied. This was done by considering the following points so as to list up the options for making pedestrian spaces barrier-free and evaluate the practicality of each measure.

Table 9-1 Evaluation Criteria for making pedestrian spaces barrier-free

No.	Criterion	Score
③	Distance to transport hub (500m or less)	500m or less 20 points 500m or more 05 points
✿	Distance to major facility (500m or less)	500m or less 20 points 500m or more 05 points
♣	Footpath construction (mound-up or flat)	Mound-up 10 points Flat 05 points
➣	Route type (commercial or residential)	Commercial 10 points Residential 5 points
❡	Footpath width	Less than 1.5m 10 points 1.5m or more 05 points 2.0m or more 03 points
⑥	Number of obstacles (subsidence, steps, etc.)	20-40 location 10 points 10-19 location 05 points 01-09 location 03 points
✿	Number of network points passed	04-08 10 points 01-03 05 points
✿	Feasibility of work	Less than 10,000,000 10 points 10,000,000 or more 05 points 20,000,000 or more 03 points
♠	Evaluation of work viability	000-069 points Phase III 070-079 points Phase II 080-100 points Phase I

Table 9-2 Barrier-free pedestrian space work plan



National and prefectural road administration and city planning policies need to be taken into account in the above evaluation of the routes included in the study. In progressing road works for making pedestrian spaces barrier-free, the work program was established as shown above based on the work evaluation performed via the pedestrian network analysis while simultaneously revising the plan in accordance with key issues including the relevant laws and technical standards.

Also, as shown in the photographs below, we believe that analysis of pedestrian space networks using GIS results in the upgrading and improvement of the current situation in a way that conforms with social welfare needs.

(Before improvement) (After improvement)

Figure 9-1 National Highway Example

Figure 9-2 Ideal Barrier-Free Construction

ʹEvaluation items

③ Distance to transport hub (500m or less)

As these are important facilities where users of public transport congregate, the evaluation criteria was based on identifying pedestrian spaces within approximately 10 minutes walk.

✿ Distance to major facility (500m or less)

As these are important facilities such as welfare centers where users congregate on a daily basis, as above, the evaluation criteria was based on identifying pedestrian spaces within approximately 10 minutes walk.

♣ Footpath construction (mound-up or flat)

This identifies the key structural characteristic from the perspective of creating barrier-free pedestrian spaces. The points were allocated so that mounded-up type footpath construction ranked highest and flat construction ranked lower.

➣ Route type (commercial or residential)

Obviously the functional requirements of a footpath are different depending on the environment through which the route passes, such as whether it is commercial or residential. In order to determine the work priority within the regions being studied, the points were allocated such that residential areas, where the number of users is likely to be limited, ranked lower.

❡ Footpath width

As for the footpath construction criterion, this is a key characteristic from the perspective of creating barrier-free pedestrian spaces. If it is not possible to achieve an effective width, improvements such as widening that require obtaining continuous stretches of land involve long-term work and are not practical. To this extent, it is necessary to give priority to remedying obstacles on routes with narrow widths so as to satisfy the diverse needs of city residents.

⑥ Number of obstacles (subsidence, steps, etc.)

Obstacles such as damage, subsidence, and the kerb between footpaths and roads which were identified for each route by this investigation are a negative factor for making pedestrian spaces barrier-free. To clarify the case for improvements, points were allocated based on the number of obstacles.

✿ Number of network points passed

This criterion is indicative both of footpath usage and of the extent that the routes between facilities identified by network analysis overlap. Naturally, more points were allocated to routes that passed through a greater number of points.

✿ Feasibility of work

Although work cost estimates are generally proportional to the number of obstacles, the work ratio differs depending on the type of work. Accordingly, points were allocated by classifying based on the total work cost. More points are allocated to work that is less expensive as this work is easier to perform.

♠ Evaluation of work viability

Quantitative evaluation was performed using the totals for each route where the sum of criteria ① to ⑧ is 100 points. The stages for undertaking the work were categorized by placing routes with 80 to 100 points in phase I, 70 to 79 points in phase II, and 0 to 69 points in phase III.

10. Conclusion (Necessity of using this GIS system)

For Matsuyama City which aims to "create the best town in Japan" at a time when the financial situation for regional government is tight, the significance of being asked to "create an environment where people can go about their lives on foot" was great. As anyone can appreciate, a society based on the automobile is dangerous for the able bodied as well as for the disabled. Pedestrian bridges, for which there was an active program of construction in the past, have proved to be white elephants, the majority of which are little used. They cannot be used by the elderly and the disabled, so are only used by children. And of course, there are no pedestrian crossings in the vicinity of a pedestrian bridge. As a result, there is the risk of accidents when the elderly attempt dangerous street crossings.

Although the public stance is "pedestrians first", the reality is "cars first". Both in Matsuyama City, which has a high level of car and bicycle usage, and throughout Japan, residents have high expectations of their roads.

For example, "non-step buses" have no step at the passenger doors and a floor height (ground to floor) of 30cm, 23cm lower than for single-step buses (floor height = 53cm), and this can be lowered by an additional 5cm if vehicle height adjustment equipment is fitted. These specifications make it much easier for the elderly, small children, and the disabled to get on and off. Currently, "non-step buses" are used on four city bus routes where the need for barrier-free access is high.

Figure 10-1 Bus Stop Example

In addition to buses, wheelchair-accessible vehicles have been adopted for local trams (low-floor level vehicles) following on from Kumamoto City and Hiroshima City and have attracted much attention in recent times. At some Matsuyama City tram stops located on roads rather than on dedicated tram lines, it is impossible to get on or off, as shown in the photograph on the right below. As at the bus stops described above, this is not a problem even if there is a gap provided that the footpath is wide. However, as there is a busy road on the opposite side to the tram stop in this case, this represents a great danger to the disabled. In other words, the people involved in administering roads and railways need to work together to achieve roads that are safe.

Figure 10-2 Low-Floor Tram and Tram Stop Situation

Based on these quantitative issues, we are able to endorse the effectiveness of using a GIS-based pedestrian space network analysis to evaluate how to achieve barrier-free access.

The pedestrian space network analysis discussed in this report was able to <u>collect and utilize diverse spatial information in a GIS tool</u> and determine a firm direction for a work plan based on the results of analyzing usage, particularly for locations such as transport hubs and social welfare facilities. However, how to encourage the use of the analysis results is an important issue in achieving pedestrian spaces that meet the diverse needs of residents who "get around on foot", including the able-bodied.

Partnership, participation, and cooperation with transport operators, residents and other relevant parties is essential if local authorities are to establish policies and operations for barrier-free pedestrian spaces. As can be seen in various examples from the past, if administrators and designers only take on the concept of barrier-free access as an idea and in fact put their emphasis on design or on ease of implementation, the result does not meet the needs of users. Understanding has increased in recent times as affected parties have taken an active participation with respect to the elderly and disabled.

Currently there is a trend to broadly standardize the policy options adopted for progressing barrier-free pedestrian access, including removing steps, low-floor buses, and installing escalators and elevators.

Considering future developments, analysis results need to be combined with using surveys, public hearings, and similar to obtain the real facts and opinions from users based on a partnership of roading administrators, traffic administrators, and residents.

That is, using GIS to perform analysis of barrier-free pedestrian spaces helps lead towards "creating an environment where people can go about their lives on foot" and enables the actual state of the transport system including public transport and roading to be determined together with the people who actually move about in the city, particularly residents, and is an effective means to solve the problem of achieving barrier-free access in a way that creates a healthy and energetic way of life for the aging society.