

## A STUDY ON THE GPS TRACKING ANALYSIS FOR INFORMATION MANAGEMENT ON HERITAGE SITE

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### ABSTRACT:

Depending on the concept of 'heritage interpretation', the significance of visitors and their behaviors on heritage site has been emphasized in recent days. The role of visitors should be redefined not only for immediate management issues of heritage site but also for long-term conservation of heritage site. This paper investigates visitors' behaviors on Gyeongbokgung Palace using GPS to record accurate data of their spatial pattern. During the process of research, GPS logger was used to track the spatial data of 100 visitor groups. As a result, 4 typical spatial patterns (Axis, Circulation, Hybrid, Front) of visitors were derived from GPS data. By statistical analysis, visiting time and spatial pattern have no relationship with destination familiarity of the visitor, composition of travelling party, or purposes of visit. Because of the spatial characteristics of the heritage site, visitors are easily confronted with 'ants-trail'. On the contrary, the spatial pattern of visitors can be explained by the level of provided information about buildings in Gyeongbokgung. The results of research will be applied to actual process of information management on the heritage sites. In conclusion, the structure and content of information about heritage site are the most important factors which can affect the visitor's spatial pattern and experience. This paper suggests information system in purpose of providing contextual information to visitors and providing more meaningful experiences to each visitor.

## 1. INTRODUCTION

### 1.1 Definition of Heritage and Heritage Site

Heritage is one of the most controversial concepts since heritage revealed itself as a various functioning role in our society; identity of citizens, history of region, as well as important destination of tourism industry, means of community development. These versatile, such as social, historical, touristic and economical perspectives toward heritage sites hinder defining what heritage is and what it should mean to the public. Under these circumstances, many heritage practitioners simply leave the definition as broad and malleable as possible. (Harvey, 2001) Concurrently, Larkham defines heritage as "all thing to all people". (Larkham, 1995) Lowenthal sees that "heritage is today all but defies definition". (Lowenthal, 1998) Lastly UNESCO World Heritage Program defines heritage as "our legacy from the past, what we live with today and what we pass on to future generations". In addition heritage site is "the works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from historical, aesthetic, ethnological or anthropological point of view". Heritage is not substantial object which can be classified by the absolute rules irrespective of time change, but on the other hand, it is essentially accompanied with communicative process within stakeholders in society. So, Heritage refers to "value-loaded concept", and the value is always changing within social changes. (Hardy, 1988)

The definition of heritage is simple but still ambiguous. Heritage studies nevertheless should imply any actual, concrete

conceptual background which can be used for heritage practitioners for the purpose of management. If we only emphasize unsystemized and heterogeneous side of heritage definition, heritage studies would be confronted with "morass of case studies". (Harvey, 2001)

### 1.2 Heritage Interpretation as Communication

ICOMOS Charters give practical guidelines to preserve, conserve, research on heritage sites. In the Charter of Venice (1964), "It is essential that the principles guiding the reservation and restoration of ancient buildings should be agreed and be laid down on an international basis, with each country being responsible for applying the plan within the framework of its own culture and traditions." Consecutive ICOMOS charters emphasize the significance of public communication to heritage, including interpretation and presentation process. Interpretation particularly refers to the full range of potential activities intended to heighten public awareness and enhance understanding of cultural heritage site. Tilden insisted that heritage interpretation is more than to interchange of information between interpretation provider and receiver. It rather inspires and provokes the receivers of information, like citizens, foreign tourists, and potential visitors. The scope of interpretation is complex, but Tilden suggests six fundamental principles of interpretation. (Tilden, 1977)

- Any interpretation that does not somehow relate to what is being displayed or described to something within the personality or experience of the visitor will be sterile.

- Information, as such, is not interpretation. Interpretation is revelation based upon information, but they are entirely different things. However, all interpretations include information.
- Interpretation is an art, which combines many arts, whether the materials presented are scientific, historical or architectural.
- The chief aim of interpretation is not instruction, but provocation.
- Interpretation should aim to present a whole rather than a part, and must address itself to the whole man rather than any phase.
- Interpretation addressed to different visitor segments should follow a fundamentally different approach.

### 1.3 Antecedents

The concept of heritage interpretation implies that heritage site needs such information system which is based on visitor's behaviors and experience. This information system should give a new phase of personal experience and emotional provocation to visitors.

The advent of new technology has given an opportunity to researchers to model new media for visitor's information system, like PDA, Cellular Phone, etc. However, convergence between information technology and tourism industry often neglect the side of information users. There have been so many technological inventions for information system, but detailed knowledge of the basis of actual visitor behavior is lacking in designing the information system. (Nielsen, 2004) It impedes the system to be successful. Therefore, practical visitor studies need to be executed for establishing user-centric methodological framework in heritage information system.

Recent visitor studies were based on consumer behavior theory in the field of management, and attempted to explain visitor behavior by visitor behavior model. Visitor behavior is affected by situational influences, product characteristics, and individual differences. Situational influences of visitor is determined by nature of decision making, or composition of travelling party; family, friend or lovers. Product Characteristics are determined by purpose of trip and mode of travel. Family life cycle and socio-economic status influence individual difference. (Fodness and Murray, 1999) The satisfaction process of visitor also could be measured by theoretical model that explains the interrelationships between attitudes, prior beliefs, post-experience assessments. (del Bosque and Martin, 2008) The number of visiting sites also affects visitor behavior model. (Tideswell and Faulkner, 1999) However, limitation of theoretical behavior model lies in its methodology. The data which were derived from survey or questionnaire data, easily fail to describe the actual, spatial features of visitor behavior and these models remain at only theoretical level. (Mazanec, 2007)

Gareth Shaw insisted that research on spatial pattern of visitors has been neglected, though spatial concentration of visitors is the phenomena in tourism recently. (Shaw and Williams, 2002) Depending on the new technology, visitor behavior could be observed and analyzed. In national park, managers are confronted to organize the flux of visitors. They used ALGE system, which is used for athletic sports, to track the spatial pattern of visitors. (O'Connor and Zerger and Itami, 2005) In Akko, heritage site in Israel, 3 methods (GPS, Cellular Phone, Land Based TDOA) were experimented in tracking visitors. (Shoval, 2007) Engineers also developed computer algorithm that extract route of visitors from GPS data, and cluster groups by similar spatial pattern automatically. (Asakura and Iryo, 2007) VR and personal image, mental maps are combined to

GIS recently. (Bishop and Gimblett, 2000) This kind of research is interdisciplinary approach of heritage studies.

### 1.4 Aim of Study

- To record spatial data of visitor on heritage site
- To analyze characteristics of visitor behavior in heritage site compared to other tour sites.
- To set guidelines for building interpretation system on heritage site based on visitor's experience.

## 2. METHODS

### 2.1 Gyeongbokgung Palace

Gyeongbokgung, built in 1395 (the fourth year of King Taejo), is the historical site No.117 of Korea, and was the main palace of the Joseon Dynasty. It is the foremost palace of the five royal residences in Seoul, the capital of the Joseon Dynasty; Gyeongbokgung, Changdeokgung, Changgyeonggung, Gyeonghuigung and Deoksugung. The restoration project of Gyeongbokgung is in progress. As a result, the scenery of Gyeongbokgung will look differently from what it is at the current moment. However, there has been no research to observe the visitor's spatial pattern and analyze their experience on Gyeongbokgung. The results of study must be applied to new information system of Gyeongbokgung, as it will be restored for the next few years.

### 2.2 Methods

We used 2 methods to track the visitors in Gyeongbokgung; first, non-participatory tracking by trained researcher to record behavior of visitors, second, GPS tracking by GPS Logger to record more quantitative data of visitor's spatial pattern. These 2 methods function reciprocally. Finding only geometrical pattern from GPS data is hard to give implications about visitor's experience. The geometrical pattern itself does not tell why visitor has stopped at specific point and what visitor did at that moment. In contrast, non-participatory tracking depends on subjective decision of researchers. Therefore, a large amount of data must be recorded by GPS logger in objective way. Non-participatory tracking is process to examine "Spatial Behavior", and GPS tracking is process to examine "Behavior in Space". (Werlen, 2000)

We executed non-participatory tracking for 7 days, and 19 groups of visitor were analyzed. GPS tracking was carried out for 7 days, and 100 groups of visitor were analyzed. We used GPS740 Model (<http://www.ascen.co.kr>) for tracking visitors.



Figure 1. GPS Logger

To supplement GPS data, we also executed 2 times of survey; before visiting and after visiting Gyeongbokgung. In prior survey, questions were 'purpose of visit', 'composition of travelling party', 'first visit or prior visit experience'. In posterior survey, 'impressive spot', 'used information source

(brochure, signage, personal guide, none)' were asked to visitors. To control the environmental features, we carried out GPS tracking only on weekends during pm 12:00 ~ pm 4:00. For the same reason, the cloudy or rainy days were excluded.



Figure 2. Process of GPS Tracking

### 2.3 Data Analysis

To analyze raw data from GPS Logger, we developed 2 algorithms. One is called Zone analysis. In Gyeongbokgung, there are 20 Zones to visit, including King's Garden, Pavilion, Hall, and Queen's room, etc. The outer rectangle in figure 3 shows area for the Throne hall compound. The inner rectangle shows Geunjeongjeon hall. Point A was recorded at 2009/03/28 13:08:19 and Point B was recorded at 2009/03/28 13:33:39. The differences between A and B refer to time of the visitors staying in the Throne hall compound. The developed algorithm calculated the visiting time of 100 groups in 20 zones automatically.

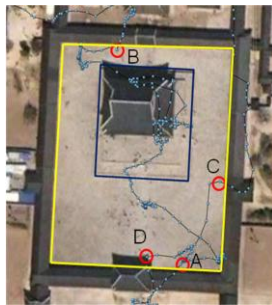


Figure 3. Zone Analysis

Zone analysis is useful only for observing behavior in zones, but Grid analysis is useful for observing the whole area of Gyeongbokgung irrespective of zones. We separated Gyeongbokgung by 5183 grids. And the developed algorithm extracts the grid where visitors stayed more than 5 minutes. By Grid analysis, we found the spot where visitors spent the most of time.

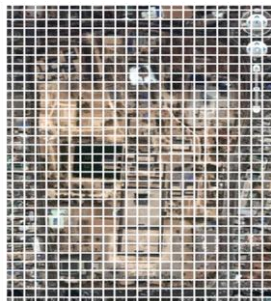


Figure 4. Grid Analysis

### 2.4 Result

The spatial pattern of visitors in Gyeongbokgung could be classified under 4 patterns; Axis, Circulation, Front, Hybrid. Axis pattern is for visitor who walked straight from entrance and only visited buildings which are on axis line. Visitors who walk in Circulation pattern doesn't move by axis line. They

rather walk about Gyeongbokgung in clockwise or counter-clockwise rotation. Front pattern is for visitors who only stayed in front of Gyeongbokgung. They usually visited only 3 or 4 buildings. Hybrid pattern is the combination of Axis pattern and Circulation pattern.

	N	%
Axis	29	29.0
Circulation	22	22.0
Hybrid	33	33.0
Front	16	16.0
Total	100	100.0

Table 5. Spatial Patterns



Figure 6. 4 Patterns Mapping on Google Earth  
From left Axis, Circulation, Front, Hybrid

By cross-tabulation analysis, 'information source' which media visitor used in Gyeongbokgung has correlation with the spatial pattern. Each information source, like brochure, personal guide, and signage, offers particular ways for visiting the site. And also 'desire of information' makes difference in visiting time. Visitors who want more information about heritage site or want to access information system tend to stay longer. Otherwise 'purpose of visit', 'composition of travelling party', and 'first visit or prior visit experience' do not indicate any statistical relationships with the spatial pattern or the total visiting time.

H1. Purpose of Visit	Different Purpose of Visit makes different pattern.	Rejected
H2. Prior Visit Experience	Number of Prior Visit makes different pattern.	Rejected
H3. Composition of Travelling Party	Different Travelling Party(Friend, Family, etc) makes different pattern.	Rejected
H4. Information Source	Different Information Source makes different pattern.	<b>Accepted</b>
H5. Destination Familiarity	Repeat visitors will spend more time in site	Rejected
H6. Heterogeneity of preferences	The larger the travel party size, the more time will be spent	Rejected
H7. Risk and Uncertainty reduction	The further the visitors' city of origin, the more time will be spent	Rejected
H8. Desire of Information	Desire of Information will make difference in visiting time	<b>Accepted</b>

Table 7. Hypothesis Verification

Spatial pattern of visitors is not only affected by the visitors themselves but also by the Supply-side. Supply-side includes the information system which heritage managers offer, and proximity of buildings. (Tideswell and Faulkner, 1999 and Shoval and Isaacson, 2007) As a result, we illustrated by GPS data which zone is the most frequently visited and which zone is not.

The figure 8 shows that visitors tend to stay more in the zone near the entrance. Point A refers to the main entrance of Gyeongbokgung. Previous studies have shown that a site in a

close distance to others will be more attractive to visitors as it offers more opportunities. (Fotheringham, 1985) This is called the 'law of proximity'.

There are two findings from spatial analysis of Gyeongbokgung. First is the exception of 'law of proximity'. Geoncheonggung Residence locates in northern side of Gyeongbokgung, but 3.34% of total visiting time is recorded. This number is quite high compared to nearby buildings. The reason is that Geoncheonggung has implicit information. Queen Myeongsung, King Gojong's wife, was assassinated here by Japanese. Even though Geoncheonggung is far from entrance, this famous historical event functions as vital information to visitors. The Second one is that visitors tend to stay much time out of zone. 48.62% of total visiting time is being spent out of zone. Heritage managers usually presume that visitors stay in the zone. Moreover, managers concentrated to develop information about zones. However, the fact shows that information about heritage site must contain pathway, resting place, trees, as well as a void space.

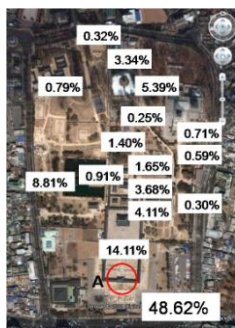


Figure 8. Time Spent in Each Zone

## 2.5 Discussion

The results indicate that visitors' behavior on heritage site are affected by the information system rather than their own features, such as purpose of visit, composition of travelling party. Previous studies showed the same results. Visitor behavior model has concentrated on the visitor's experience in macro level, like 2 or 3 days visiting. In micro level, like visiting only one place, visitors are confronted with 'ants-trail'. Individual Preference, purpose of visit play a vital role before visitors arrive at heritage site. But during the visit, they move in same pattern like ants. (Keul and Kuehbergerl, 1997) Therefore, the interpretation system should be designed carefully, since the information affect the visitor's experience directly. To deduct management issues from 'one' heritage site, behavior model and assumptions must be modified depending on particular situation that heritage site faces.

Visitors depend on the information which heritage manager offers. Visitors on heritage site are different from visitors at other tourism site or leisure site. Previous studies have shown that visitors on heritage site have a desire for leisure experience. (Prentice, 1993) And they also want to do window shopping, rather to get knowledge about heritage. (Markwell, Bennett, and Ravenscroft, 1997) But the result of previous studies was simply deducted, because heritage managers have offered only information for elite. (Bramwell, and Lane, 1993) This kind of heritage information is useless for giving more meaningful experience to visitors. Visitors need experience that is only possible on heritage site, even though they do not need 'to study' about heritage. Visitors have desires to participate, to walk around, to experience. Therefore, heritage interpretation is

more human than researcher assumes. (Mitshe, and et al., 2008)

Contextual information system which emphasizes on the situation of visitors starts with archiving. Tracking data is also a kind of archive. Digital technology could be helpful for archiving. The most important point in archiving is to decide what has to be archived about heritage. Photos, footpath, articles, and mental maps could be examples. The target of archiving is extended from past to present days, and from historical, architectural fact to visitor's memory. Second step is to design the structure of system. The issues derived from the results must be reflected in the structure of system. There is no perfect structure, but there are storytelling methods that functions as a reference for designing structure. (Miller, 2004) Afterwards, information manager establishes strategy for each media; PDA, Kiosk, Web, and also analogue media like paper brochure. The service of media is segmented for various types of visitor.

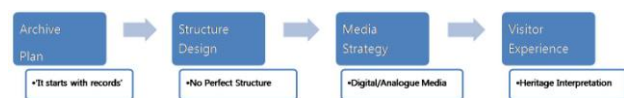


Figure 9. Contextual Information System

## 3. CONCLUSIONS

Contextual information system will be evolving as socio-technical environment changes. It contains not only explicit information but also implicit information such as ideas, experience of people, and events. The information system must be comprehensible by a present visitor as well as a future visitor. (Cameron, and Kenderdine, 2007) Building heritage information system is a lively controversy. At least, information system must be designed according to visitor's desire and their experience. The definition of visitor must be enlarged to people who never visited the heritage site or people of future generation. For such purpose, visitor's need and experience should be observed by studying visitor behavior constantly. This research is the first step for building sustainable heritage interpretation system.

Relationships between nationality and visitor behavior, and differences among heritage sites are neglected on this research. Alongside, actual process of building information system could be the next research area. These all must be the tasks of future work.

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