A Hierarchical Evaluation for Success Factors of the Mobile-Assisted Language Learning Using AHP

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ABSTRACT

With tremendous advancement of information and communication technologies, mobile learning systems have been widely adopted in language learning contexts, and several frameworks have been developed for identifying and categorizing different factors of mobile-assisted language learning (MALL). However, pre-existing frameworks have limitations when evaluating the importance level of criteria. The purpose of this study is to develop a comprehensive hierarchical framework for identifying and categorizing success factors of MALL and prioritizing them according to the importance level. To do that, AHP method is used to quantitatively estimate weight values of MALL criteria. Results reveal that the priority of MALL criteria is ordered as follows: content, system, learner, language learning. Local weights of each criterion are also analyzed; for example, usefulness, accuracy, and authenticity are critical factors for improving MALL contents. Ease of use and mobility of MALL systems are also considered more critical than other systematic factors. In addition, availability of immediate feedback and self-directness has the highest weight values of importance. The findings of the study are discussed regarding hierarchical orders of MALL criteria and conclude that successful MALL implementation may be achieved if related elements are diversely measured and evaluated. Pedagogical implications and suggestions for further research are also presented.

1. INTRODUCTION

In recent years, the impressive development of information and communication technologies (ICTs) and wireless internet systems led to the production of powerful mobile devices and the expansion of social and interactive communication tools. As a result, a new form of learning was emerged, namely mobile learning (m-learning), and has widely spread in many educational contexts. Likewise, this new technology-enhanced learning trend was adopted in the field of language teaching and learning, and therefore, mobile-assisted language learning (MALL), which provided learners with anytime and anywhere learning environment, became important trends in language teaching and learning.

The concept of MALL was first appeared in the late 1990s. Ever since it appeared, a number of studies have investigated the convenience and usability of mobile devices as instructional delivery tools in order to provide authentic and meaningful learning resources and multimedia (such as animation, video, and sound) for language learning [1], [2]. In addition, mobile devices, with the use of wireless internet technologies, are suited to supporting social contacts and collaborative learning, and therefore, MALL goes beyond language teaching and learning to the delivery of time-and-location-free communication and interaction to improve language performance [3]. The benefits of MALL, therefore, are summarized as timely contents, flexible accessibility, enhanced communication and responsiveness, and providing learner-centered learning contexts.

However, technology is not enough to make MALL possible, and many factors such as the need and purpose of using MALL, improved teaching-learning strategies, administrative process, management, and teacher-and-student's confidence to use technology should be considered in the

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process of design and implementation of MALL. Additionally, in order to make a decision of whether or not to adapt MALL in language teaching and learning, a lot of information needs to be collected to understand circumstances. However, not all information is useful for improving decisions, but some information is critical to make MALL successful.

From this point of view, many researchers in the field of language teaching and learning have suggested some principles of using MALL over the last two decades and proposed system frameworks for MALL to help with identifying critical successful factors of MALL implementation and categorizing its components [4]-[6]. Nevertheless, most of these frameworks have some limitations for evaluating the success factors of MALL criteria and do not support quantitative evaluation to prioritize or rank the factors in a more systematic way.

For this reason, this study focuses on the identification and prioritization of success factors for MALL implementation according to their importance and relevancy in particular criteria. To do so, the present study employs the analytic hierarchy process (AHP) method, one of the powerful, flexible, and widely used methods that decomposes decision-making problems into a hierarchy structure and considers the numeric values and priorities for the measurement of quantitative and qualitative performances [7].

Therefore, the aims of the study are 1) to identify possible criteria for MALL implementation by conducting a focused group interview from language teaching and ICT experts, 2) to formulate a hierarchical framework with these criteria, and 3) to establish the weights of each criterion, and finally 4) to provide the answers to a questions: which criteria are more important in making MALL successful than any other?

2. LITERATURE REVIEW

2.1 Mobile-Assisted Language Learning (MALL)

The increased penetration and evolution of mobile technologies have granted the ownership of various mobile devices worldwide, and particularly in Korea, 84.6% of population own smartphones [8]. The development and usability of various interactive mobile devices make the learning process easier and more effective in many contexts. As a result, m-learning has changed educational trends and now is widely used inside and outside the classroom environment.

The term m-learning has been defined by many researchers in different notions; however, there is no universal definition for it. Generally speaking, m-learning refers to the mobile nature of the devices and the aspect of mobility of the learners. From this perspective, MALL is broadly defined as language learning through various mobile devices (e.g., laptop, notebooks, mobile phones, smartphones, tablet PCs, etc.), which allows learners to access learning contents anytime, anywhere with relatively small-size, low-weight, and time-and-location independent devices [3].

The concept of MALL, since it appeared in the field of language education, has developed with the emphasis of constructivist, collaborative, and learner-centric approaches [9]. Many researchers have attempted to identify and categorize MALL components for the past two decades. Some researchers

have attempted to adopt the system frameworks of m-learning or distance learning [4], [7], [10], and other researchers presented the principles of using MALL or tried to propose the conceptual framework in order to identify success factors of MALL [5], [6].

Among these previous studies, [10] identified four m-learning design requirements: 1) generic mobile environment, 2) m-learning context, 3) learning experience, and 4) learning objective. Their framework was based on a combination of a game metaphor and m-learning contexts and applied it to teaching and learning environments that had differing characteristics. On the other hand, [4] proposed the systematic framework consisting of three major dimensions of m-learning success factors: 1) mobile device, 2) quality, and 3) learner requirement. Using these dimensions, they reviewed previous conceptual and empirical studies and identified 17 distinct factors that influence m-learning and organized them according to the dimensions of the taxonomy.

In Korea, [7] suggested a conceptual framework which contributed to the success of e-learning systems, and it consisted of four categories of important challenges: 1) individuals, 2) courses, 3) contexts, and 4) technologies. Each category has several sub-group challenges; for instance, individual (students' motivation, academic confidence, technical confidence, etc.), courses (curriculum, subject content, learning activities, etc.), contexts (training for teachers, attitudes towards e-learning, rules and regulations, etc.), and technologies (accessibility, cost, interface design, etc.).

In the field of language teaching and learning, there have been several attempts to identify the critical factors of MALL and propose the conceptual frameworks for MALL [3], [5], [6]. According to them, main factors of the MALL include mobile technologies, mobile devices, wireless protocols, wireless applications, and language learning materials, and these factors allow MALL applications to be developed and implemented. From this point of view, [6] developed a conceptual framework based on pedagogical, technological and usability perspectives. According to them, the framework for MALL system consists of five major components: 1) mobile devices (user infrastructure), 2) mobile applications (installed in the mobile device), 3) mobile middleware, 4) wireless network infrastructure (4G/3G/Wi-Fi), and 5) back end system (hosting LMS application and services).

In addition, [11] asserted that the features of MALL were represented as cost-effectiveness, enhanced communications to interact, timely contents, flexible accessibility, and providing extended and enriched learning opportunities. Reference [12], on the other hand, reviewed previous literature and summarized that the successful design, development, and implementation of MALL applications could be featured by several factors such as openness to society, engaging interaction, communication and collaboration, personalization, time-critical nature, portability, easy delivery, aural and/or alternative medium, and informal and lifelong learning. He also stated that MALL activities were featured by behaviorist activity (immediate feedback), constructivist learning activity (immersive experiences), situated activity (authentic context), collaborative activity (communication and sharing information), and coordination of learning and resources.

2.2 Analytic Hierarchy Process (AHP)

AHP is one of the multiple criteria decision-making methods that have been used in various contexts relating to decision-making [9], [13]. It was originally developed by [14] and has accepted as a powerful and flexible method for solving the problems and making judgements. Based on previous studies that adapted the AHP method as problem-solving and decision-making procedures, AHP could be used in a complex situation where intangibles are involved or in a questionable practice when objectivity is the norm. Therefore, the most important characteristics of AHP are collecting information to derive tangible values from intangibles and combining knowledge, experience, individual opinions, and foresight in a systematic way [7].

Reference [15] defines AHP as a theory of measurement, which relies on the judgement of experts to derive priority scales through pair-wise comparisons. The scales measure intangibles in relative terms, and the comparisons are made using a scale of absolute judgements that represents how much more one element is important or dominant over another element with respect to which they are compared. Then, the ratings for each decision are replaced with alternative for each criterion. It allows respondents to choose a value between 1 and 9, which asks the respondents to rate the strength of the relationship between criteria, and establishes the pair-wise comparison matrix for each criterion. After that, the resulting matrix is normalized, and the values in each row are averaging to get the corresponding ratings. In this way, the AHP method obtains objectivity from a standard scale, and as a result, is capable of achieving goals and making decisions that hardly modeling or quantifying [16].

Ever since it was initially presented by [14], AHP has been widely utilized in different fields of research, such as business and e-commerce [17], [18], social sciences [19], ICTs and e-learning systems [7], [20], [21]. Based on these studies, AHP is concluded to be a tool or technique for providing measures of judgment consistency, deriving priorities among criteria and alternatives, and simplifying preference ratings among decision criteria using pair-wise comparisons.

In the current study, AHP method was adapted in order to analyze how Korean university students, who have actually experienced MALL, perceived the effectiveness of MALL and its criteria as well as their relative values and ranks to make decisions of using MALL. However, since there has been not much research done in the field of language education in regard to the MALL and hierarchy process, the current study employed the original AHP method as an analytic technique, but did not use any other statistical techniques such as Fuzzy or TOPSIS.

To operate the AHP procedures, the most important step is to develop a hierarchical framework, and the structure of hierarchy is proposed with following standards, which are:

1) The overall goal or objective of analysis is laid at the first level of the hierarchy;
2) The multi-criteria that consist of several criterions are gathered at the second level;
3) The sub-criteria for each of the second level criteria are located in sub-criteria;
4) The last level contains the alternative choices [22].

After that, the pair-wise comparisons are made among the criterions in the hierarchy in order to establish priorities of the elements. The next procedure is to synthesize judgements to obtain the set of overall or weights for achieving the goals, and at this point, the consistency of judgements needs to be checked. According to [13], the pair-wise comparisons are required and should either be homogeneous or close with respect to the common attribute; otherwise, substantial errors may occur in the measurement process. Therefore, when the elements are compared by the respondents, it is essential to produce consistency so that it could be confirmed if the original preference ratings were consistent. Based on previous literature, it is recommended that a consistency ratio of less than or equal to 0.10 is acceptable [16], [22].

3. Methodology

In this section, the procedures to design the research framework are firstly described, and data collection and analysis procedures are introduced by following the general AHP procedures.

3.1 Research Framework Design

There are a number of criteria (components, requirements, and constraints) that may influence the design and implementation of MALL. The conceptual framework of the current study is designed on a basis of the previous literature that has discussed success factors of m-learning, major features of MALL, and its components. The detailed steps are as follows.

Two educational experts, one working in the field of ICT and the other working in the second language teaching field, met and conducted the focused group interview. Above all, they listed all the possible elements that could be related to the previously classified MALL factors through the literature reviews and brainstorming process. Then, they composed synonymous elements and eliminated week and ambiguous elements that were inappropriate in MALL contexts. After that, they finally identified all criteria that influenced the efficiency and performance of MALL. Each criterion was grouped into four representative categories, and the categories were structured to construct a hierarchical framework for the critical MALL challenges. In order to determine the importance level of criteria associated with MALL, the elements were decomposed into sub-criteria of the hierarchy structure. Fig. 1 illustrates the research framework that is finally proposed for the current study.
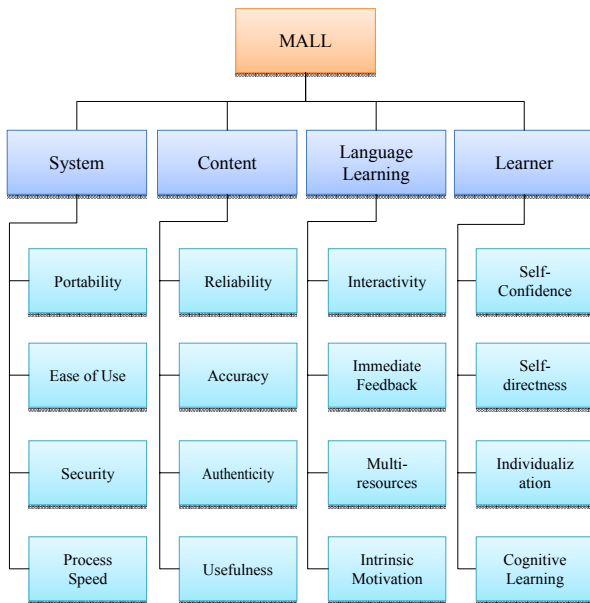
Fig. 1. The Research Framework

A structure of hierarchy consists of three levels of interrelated elements that describe the criteria. As illustrated in Fig. 1, the overall goal or objective, which is the use of mobile devices for language learning, is laid at the first level of the hierarchy. Four main criteria that may contribute to the successful use of MALL are placed at the second level, which are system, content, language learning, and learner. The sub-criteria for each of the second level criteria are located in the third level of hierarchy, and each criterion includes four sub-criteria [17], [21].

3.2 Participants

Once the research framework was completely set up, the AHP questionnaire was designed with pair-wise comparison questions in line with elements of criteria and sub-criteria. The questionnaire was distributed to the participants, a group of students who were enrolled in smart technology-enhanced English language courses at one university located in Chungbuk area. The survey was originally distributed to twenty-five students, and 23 responses were completely done. Among them, eight responses were removed due to high inconsistency ratio. Therefore, 15 participants who reached the appropriate consistency ratio were finally selected, and their responses to the AHP questionnaires were collected for analysis.

In fact, it is important to understand whether or not the respondents have a logical consistency in the process of AHP. Based on previous research, AHP finds statistical significance by a small number of participants (experts), and unlike other survey questionnaires, it is important to make sure how the respondents are aware of the field, logically and consistently, rather than the number of participants [23], [24]. Therefore, when making decisions through the AHP method, the respondents' expertise is more important than the size of the participants.

For this reason, the participants of this study were considered as an expert group of students due to their

prior/current situations. All of them had at least two years of MALL experiences and were utilizing various MALL materials and activities at the time of the survey. Their ages were ranged from 18 to 22, and six were male and nine were female. Table 1 displays brief information of the participants.

Table 1. Detailed Information of the Participants

Characteristics		# (%)
Age	18~22	9 (60.0)
	23~26	6 (40.0)
Gender	Male	6 (40.0)
	Female	9 (60.0)
Major	Art & Humanity	4 (26.7)
	Social Science	5 (33.3)
	Science & Engineering	4 (26.7)
	Medical Fields	2 (13.3)
Years of MALL experience	2 ~ 4	5 (33.3)
	5~7	7 (46.7)
	8~12	3 (20.0)
Types of MALL experience*	Smartphone recording system	8 (53.3)
	Google translator	11 (73.3)
	Youtube video	9 (60.0)
	Pod-cast	4 (26.7)
	Online Community	6 (40.0)
	Online Blogging	2 (13.3)

* The results represent the analysis of multiple responses.

3.3 Data Collection and Analysis

Since the main purpose of this study was to figure out the important factors of MALL and their perceived importance levels and ranks, the question items of the survey asked how much more one element is important than the other. The importance level of each criterion was measured by weighted average of the question items and ranked by their orders. The detailed steps are described as follows.

3.3.1 Pairwise Comparison: The first step of AHP is to make pair-wise comparisons between each criterion. Four main criteria were compared using a nine-point weighting scale and established relations within the structure. For each pair of comparisons, the participants were required to answer a question such as, "Is A more important than B?" The results of the comparisons were used to build up a comparison matrix.

3.3.2 Normalization: Once the pair-wise comparison matrix was completed, the next step was to normalize the matrix. It was done by totaling the numbers of each column and dividing by the column sum to get its normalized score.

3.3.3 Consistency Analysis: Next step was to calculate the consistency ratio and check its value. This was done to make sure whether the comparison matrix was consistent. In this study, a consistency ratio of less than 0.10 was acceptable, so the responses that did not meet the consistency ratio were excluded.

All of this work was to determine the weights for the second-level criteria. The next step was to continue similar pair comparisons for other elements of the sub-criteria. Once the

priorities for all elements in the hierarchy structure were computed, the judgements on all elements were completed. The weights of each criterion and the consistency ratio were calculated by Microsoft Excel 2013.

4. RESULTS

4.1 Analysis of Four Criteria affecting Successful MALL

In order to identify and prioritize success factors of MALL challenges, the weight values of four criteria at the second level were compared and ranked. The results showed that the order of priority for a successful MALL implementation was as follows: content (0.368), system (0.223), learner (0.219), and language learning (0.191). This indicated that among other things, the content criterion emerged as the most important factor to make MALL successful. However, the participants gave the language learning criterion as the least important factor. The overall weights and ranks of the second-level criteria are displayed in table 2.

Table 2. AHP Weights and Ranks of Four Criteria

Criterion	Weights	Ranks
System	0.223	2
Contents	0.368	1
Language learning	0.191	4
Learner	0.219	3

4.2 Analysis of Local Weights of Sub-Criteria

Following the AHP procedures, the weight of each criterion along with the associated ranks of the respective criterions was calculated.

4.2.1 Analysis of System Criterion: In terms of system criterion, it consisted of four sub-criteria: mobility, ease of use, security, and process speed. As shown in table 3, the weight values of each criterion were ordered as follows: ease of use (0.365), mobility (0.352), process speed (0.195), and security (0.088). The results indicated that two elements, ease of use and mobility, belonging to the system criterion played a major role in establishing a successful MALL system, and both were far more important than the other elements, security and process speed. Therefore, the participants of this study considered the features of easiness and mobility important as the MALL system requirements.

Table 3. AHP Weights and Ranks of System Criterion

Criterion	Weights	Ranks
Mobility	0.3520	2
Ease of Use	0.3650	1
Security	0.0880	4
Process Speed	0.1950	3

4.2.2 Analysis of Content Criterion: The content criterion has four sub-criteria: reliability, accuracy, authenticity, and usefulness. Table 4 shows the order and weight values of content criterion. The order of priority was ranked as usefulness (0.327), accuracy (0.283), authenticity (0.241), and reliability

(0.149). The content criterion showed that usefulness weighed more than other three sub-criteria, and both accuracy and authenticity had a similar importance level in offering successful MALL contents. This indicated that it was critical to provide useful contents in order to implement MALL. In addition, accuracy and authenticity of the contents also play a major role in order to decide whether or not to use MALL contents.

Table 4. AHP Weights and Ranks of Content Criterion

Criterion	Weights	Ranks
Reliability	0.1490	4
Accuracy	0.2830	2
Authenticity	0.2410	3
Usefulness	0.3270	1

4.2.3 Analysis of Language Learning Criterion: The language learning criterion also includes four sub-criteria: interactivity, immeidate feedback, multi-resources, and intrinsic motivation. As shown in table 5, the weight values of each criterion were ordered as follows: immediate feedback (0.339), multi-resources (0.266), interactivity (0.205), and intrinsic motivation (0.190). From this result, the participants perceived that the availability of the immediate feedback better represented the features of MALL and considered it as the most important factor in terms of language learning. In addition, both interactivity and multi-resources were also considered as critical elements when utilizing m-learning for language learning.

Table 5. AHP Weights and Ranks of Language Learning Criterion

criterion	Weights	Ranks
Interactivity	0.2050	3
Immediate Feedback	0.3390	1
Multi-resources	0.2560	2
Intrinsic Motivation	0.1900	4

4.2.4 Analysis of Learner Criterion: The learner criterion had four sub-criteria: confidence, self-directness, individualization, and cognitive learning strategy. Table 6 shows the order of priority of learner criterion, and the weight values of each criterion were as follows: individualization (0.392), self-directness (0.260), cognitive learning strategy (0.224), confidence (0.124). The results indicated that the participants seemed individualized learning as the most important element in learner criterion. In addition, they considered self-directness and cognitive learning strategy as the crucial elements. Therefore, these three elements were appeared as learner requirements when making decisions of MALL implementation.

Table 6. AHP Weights and Ranks of Learner Criterion

Criterion	Weights	Ranks
Confidence	0.1240	4
Self-directness	0.2600	2
Individualization	0.3920	1
Cognitive Learning	0.2240	3

5. DISCUSSION & CONCLUSION

Over the last two decades, MALL has rapidly been gaining importance in the field of language teaching and learning because of the advancement and spread of mobile-technologies and its flexible mode of learning. There are a number of factors to be considered for successfully implementing MALL for university level of students. The current study attempted to investigate not only to identify the success factors of MALL but also to examine their hierarchical evaluation in making decisions of implementing MALL.

The research framework of the identified MALL criteria was proposed and evaluated by employing the AHP method and specifying the pair-wise matrix depending on the relative importance of each criterion. The results showed that among four main criteria of the MALL, content had the highest weight score (0.368), followed by system (0.223), learner (0.219), and language learning (0.191). This indicated that the respondents of this study perceived that the most important factor influencing the MALL implementation was providing timely contents, and furthermore, the quality assurance of m-learning system and learner requirements were appeared as the next important factors with the similar significance level.

The emergence of three factors was exactly consistent with the previous literature that considered them as the most important success factors of m-learning [4], [8], [12], [15]. Therefore, the findings of this study suggest that whoever is willing to adapt the MALL environment in their teaching contexts is faced with at least three crucial challenges from four criteria; in other words, content quality, systematic support, and learner requirement significantly influence the implementation of the MALL.

Under the content criterion, four sub-criteria were compared by their weight values. Three elements, usefulness, accuracy, and authenticity, showed similar level of importance, and this result was partially consistent with some previous literature that mentioned the importance of meaningful activities and authentic resources in language learning contexts [8], [12]. Therefore, the findings suggest that if the MALL contents were useful, accurate, and authentic, it could improve the judgements of using MALL.

The system criterion was also emerged as one of the important factors, and by the pair-wise comparison of four sub-criteria, ease of use as well as mobility were appeared as relatively significant factors for the successful MALL system. Based on the information from previous literature, MALL systems are a piece of hardware and software developed for language learning purposes, such as LMS, applications, and network services [11]. Therefore, the findings of this study suggest that the MALL system, whichever is selected as learning activities and tasks, should include easiness, accessibility, and portability and allow learners to connect with learning activities easily and use it in public and/or private space [3], [7].

In addition, learner criterion was deemed as an important factor in the success of MALL, which was consistent with previous studies that found the importance of learner requirements, and his/her interest and willingness played a major role in making m-learning successful [2], [4]. Under the learner criterion, individualization had the highest weight score, and both self-directness and cognitive learning were followed the next. The findings suggest that individual learners, in order to process MALL appropriately, are required to perform individualized and self-directed learning, In addition, the use of certain cognitive learning strategies is also needed when the learners successfully complete the MALL [4], [7].

Interestingly, language learning criterion was considered as the least important factor from the pair-wise comparisons of four criteria. However, two sub-criteria, immediate feedbacks and multi-resources, had relatively high weight values. This result was explained by the previous studies, which insisted that differentiated contents with diverse and dynamic multimedia and quick responses to the user requests are two critical components of MALL [3], [6], [15]. Furthermore, language learning criterion could not be ignored because, if language learning is the fundamental goal, the affordance of mobile devices should be directly connected in a principled way to language learning research and theory [7].

This study aims to present the new and comprehensive framework with relatively critical factors that affect the successful design and implementation of MALL. The main contribution of this study is to propose the hierarchical framework that consists of the criteria and sub-criteria of MALL and evaluate their values by ranking from the one with the highest weight (most important) to the one with the lowest (least important). Therefore, the findings of this study are able to be attended by language learning teachers, school administrators, material designers and developers, researchers, and other related agencies that plan to adapt MALL in diverse educational contexts. The research framework proposed in this study as well as the weights of importance of each criterion can help them not only improve the judgements and make decisions of what to be focused on but also change the educational contexts shifting from traditional teacher-centered to learner-centered MALL environments.

In conclusion, the current study is the first step to build up a systematic model for a successful MALL. The current framework selected some major criteria of MALL and considered the analysis of its hierarchical level of importance; however, it would be more helpful if the criteria selected for this study were compared against the weights of other criteria. Therefore, in the further study, the framework can be extended by adding and removing any other criteria that may affect MALL implementation. In addition, the research methods and techniques of this study can be used as a reference in future work. By applying and modifying the current research methods and findings to various types of educational contexts, future research should be done to investigate differences of components that affect the success of MALL.

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