Emirates Journal for Engineering Research

Volume 25 | Issue 1

Article 4

12-5-2019

Identifying the Suitable Areas for Establishment of Agricultural Machinery Repair Center Using GIS in Rudsar

Maedeh Shoaei
University of Mohaghegh Ardabili, Iran, shoaieemaedeh@yahoo.com

Razieh Pourdarbani
University of Mohaghegh Ardabili, Iran, r_pourdarbani@uma.ac.ir

Mir Sadegh Fazel Dolat-abad
University of Mohaghegh Ardabili, Iran, sadeghfazel@yahoo.com

Follow this and additional works at: https://scholarworks.uaeu.ac.ae/ejer

🟡 Part of the Agricultural and Resource Economics Commons, and the Geographic Information Sciences Commons

Recommended Citation

IDENTIFYING THE SUITABLE AREAS FOR ESTABLISHMENT OF AGRICULTURAL MACHINERY REPAIR CENTER USING GIS IN RUDSAR

Maedeh Shoaei [1], Razieh Pourdarbani [2,*], Mir Sadegh Fazel Dolat-abad [3]

[1] MS student, University of Mohaghegh Ardabili, Faculty of Agriculture, Dept. of Biosystem Engineering
shoaieemaedeh@yahoo.com
[2]* University of Mohaghegh Ardabili, Faculty of Agriculture, Dept. of Biosystem Engineering *r_pourdarbani@uma.ac.ir*
[3] University of Mohaghegh Ardabil, Dept. of Geography *sadeghfazel@yahoo.com*

تحديد المناطق المناسبة لإنشاء مركز إصلاح الآلات الزراعية باستخدام نظم المعلومات الجغرافية في رودسر

ملخص

مع الزيادة في الميكنة ، تزداد الحاجة إلى مراكز إصلاح الآلات الزراعية. ومع ذلك ، لا يوجد سوى عدد محدود من مراكز إصلاح الجرارات في رودسر. وجود مراكز إصلاح سيزيد من عمر المعدات ؛ من ناحية أخرى ، فإن وجود مصلحي الآلات سيؤدي إلى تحديد سريع لموقع الدقة من الفشل وإصلاح في الوقت المناسب. كان الغرض من هذه الدراسة هو تحديد المواقع المناسبة لإنشاء إصلاح الآلات والمساعدة في تلبية احتياجات المزارعين في منطقة رودسر. لذلك ، تم جمع المعلومات المكانية من مختلف المنظمات ذات الصلة ، بما في ذلك منظمة رسم الخرائط في البلاد ، وإدارة نظم المعلومات الجغرافية في وزارة الداخلية ، ومنظمة الزراعة. تم توفير معلومات وصفية أيضًا من تقرير التعداد ، والإحصاءات ، والوثائق ، والدراسات الميدانية ، وما إلى ذلك ، وتسجيلها وتخزينها في الجداول ذات الصلة. لإعداد قاعدة البيانات ، أولاً ، تم إدخال الخرائط والبيانات الرقمية في برنامج GIS. ثم تم تخزين البيانات الوصفية المجمعة رقميًا وتوصيلها بالبيانات المكانية. بعد إدخال المعلومات في الكمبيوتر وتخزينها في طبقات مختلفة في قاعدة بيانات نظم المعلومات الجغرافية ، تم استخراج المعلومات كخريطة. وفقًا لنتائج الخريطة النهائية ، يعد جزء من رودسر وجزءًا صغيرًا من كلاچای و چابک سر وجزءًا من چینی جان مناسبًا لإنشاء محلات تصليح.

Abstract

With the increase in mechanization, the need for the agricultural machinery repair centers is increasing. However, there are only a limited number of tractor repair centers in Rudsar. The existence of repair centers will increase the life of the equipment; on the other hand, the presence of machinery repairmen will lead to quick determination of the precision location of the failure and timely repair. The purpose of this study was to determine suitable locations for the establishment of machinery repair and helping to meet the needs of farmers in the Rudsar district. Therefore, spatial information was collected from various relevant organizations, including the Mapping Organization of the country, the GIS Department of the Ministry of Interior, the Agriculture Organization. Descriptive information was also provided from the census report, statistics, documents, field studies, etc., and recorded and stored in the relevant tables. To prepare the database, first, maps and digitalized data were entered into the GIS software. The collected descriptive data was then digitally stored and connected to spatial data. After entering the information into the computer and storing in different layers in the GIS database, information was extracted as a map. According to the results of the final map, a part of Rudsar, small part of Kelachay and Chaboksar and part of the Chini Jan, are suitable for the establishment of repair shops.

Keywords: Agricultural machinery; GIS software; Repair center; Rudsar.

1. INTRODUCTION

The importance of service and repair and its role in increasing the efficiency and useful life of machinery is obvious. Repeated failures due to machine failure are greatly reduced and as a result, delay in operation is minimized. Thus, identifying the right location to establishment of repair center will help meet the needs of local farmers.

Weber [1] formally began studying on theory of the location since 1909. Studies by Hakimi [2] were more formalized by attempting to locate alternate centers in the communication network and police stations on the roads. Since the mid-1960s, the problem of location has grown in the form of studies. Most of the basic issues of locating resources and centers were formulated in a static and dynamic form.

In recent years, studies have been conducted on the location of service centers using GIS, which can be exemplified by the following:
Parhizkar [3] proved the ability of GIS compared to other models while studying location methods and patterns, such as central location theory, numerical taxonomy model, Lari model and random models, with a case study on the location of firefighting centers in Tabriz,. Babajani et al. [4] investigated the importance of locationing the processing industry for garden products using combination criteria and GIS in Kermanshah. Yonca [5] proposed the creation of a GIS-based methodology for assessing proposed areas for establishing a hybrid wind and solar power plant using a fuzzy multi-criteria decision-making system. Zangyabadi [6] introduced the important centers of Kerman based on urban planning criteria by analyzing spatial distribution of public libraries. Moradi et al. [7] identified the appropriate locations for establishing health centers in Isfahan. Fazelnia et al. [8] conducted a research on locationing of suitable sports spaces in Zanjan using a AHP and GIS analysis model. Muller and Kofi [9] conducted a survey using map and GIS to model health service centers at a village. Giannikes [10] presented a multi-objective model for hazardous landfill location and did not use maps in their work. Amini [11] designed a model for determining the optimum capacity of dairy factories in Kermanshah using mathematical modeling techniques to locationing of dairy industries in this province. Hosseini Dastjerdi et al. studied on the establishment of agricultural machinery repair centers in Karaj using GIS and AHP. Govind Kharat et al [12] prioritize the landfill site selection criteria obtain the critical factors for selection of landfill sites using GIS. Gimpel et al [13] assessed indicators cover economic, environmental and social effects to select the aquaculture sites using GIS-based integrative tools.

2.) Methodology

2.1) Geo-location of the study area

Rudsar is a city in the province of Gilan in Iran; its center is Rudsar, and its latitudinal coordinates are 37.13761 and longitude is 50.288. Rudsar leads from the north to the Caspian Sea, from the south to the mountains of Alborz, from the east to Ramsar, from the provinces of Mazandaran, and from the west to Amol and Langroud. The mountainous part of Rudsar is a chilly and cool climate. The northern part of the city, which lies on the southern margin of the Caspian Sea and the plain area, is wet. The Polrud River, with branches of Kiarud and Shirarud, flows in this city. Since Rudsar is a fertile and rain-fed, the main occupation of the city is agriculture in plain areas of and horticulture and animal husbandry at high altitudes. By increasing of mechanization, the need for special centers for repairing agricultural machinery and equipment is increasing that determines the necessity of present research.

2.2) Method of Research

The present study was applied and descriptive. A questionnaire was prepared based on Likert scale and distributed among the farmers and employees of the Ministry of Agriculture Jihad of Rudsar. The statistical population consisted of 30 people. In this research, based on the sample size set by Krejci and Morgan, and using the Cochran formula, 30 individuals were calculated as sample size.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left[\frac{z^2 pq}{d^2} - 1\right]} \tag{1}$$

n: Sample size

N: Size of Statistical Society

z: Acceptable random error

P: Ratio of success

q: Failure ratio

d: Degree of accuracy
The descriptive criteria of the questionnaire included: the location of the repair shop relative to the villages (A), motorized courier service (B), Availability of bank facilities (C), Overhead repair costs (D), Available spare parts stores (E), the possibility of repair in the area (F), the population density (G), number of expert repairers (H), size of land for establishment (I), traffic load (J) (Table 1). The variables of the research were gender and age; the gender variable was nominal and non-decimal.

The age variable was also a nominal and there was no need to define the range because the age of the farmers was variable. To analyze the questionnaire, SPSS statistical software was used. Using Cronbach's alpha factor (Eq. 1), validity and reliability of questionnaires were determined which yielded a reliability of 0.776. Subsequently, using the Expert Choice software, the descriptive measures of the questionnaire were prioritized using pairwise comparisons (Table 1). Then the weight of each criterion was calculated by the

software (Table 2). To calculate the incompatibility index, equation (2) was used.

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K}\sigma_i^2}{\sigma^2}\right) \tag{1}$$

Here; K is the number of questions; σi^2 is the variance of each question and σ^2 is the variance of all questions.

Table 1: Matrix of Paired Comparisons of Criteria

Criteria	A	B	C	D	E	F	G	H	I	J
A	1	8.00	2.00	2.00	2.00	1.00	1	3	3	1
B	0.13	1	0.14	0.50	0.50	0.11	0.11	0.50	0.20	0.11
C	0.50	2	1	2	0.33	0.14	0.50	0.50	0.50	0.50
D	0.50	2	0.50	1	0.50	0.17	1	2	1	0.33
E	0.50	2	3	2	1	0.20	0.50	1	0.50	0.33
F	1	9	7	6	5	1	1	5	2	5
G	1.00	9	2	1	2	1.00	1	3	1	2
H	0.33	2	2	0.50	1.00	0.20	0.33	1	0.50	0.50
I	0.33	5	2	1	2	0.50	1	2	1	2
J	1	9	2	3	3	0.20	0.50	2	0.50	1

Table 2: The weight of each criterion

A^γ	B^γ	C^γ	D^γ	E^γ	F^γ	G^γ	H^γ	I^γ	J^γ	max^γ
12.515	11.69	11.64	12.369	12.355	12.133	11.763	11.684	12.776	10.204	11.914

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{2}$$

Here n is the number of criterion. If the inconsistency rate is less than 0.1, then the calculations are correct and acceptable to the experts. In this research, the inconsistency rate was 0.064478.

The proximity of the repair shop to the village was foremost important, and after that, the

possibility of repair in the site was in the second stage. Similarly, the criteria ranked one after the other from the most important criterion to the least important (Fig. 1). After calculating the final weight of the criteria by Expert choice software, the layers of each of the criteria were created using the GIS based on the scale of 1: 25000 (in DWG format). Then, by overlaying these layers, the proper places were determined to establishment agricultural repair shop.
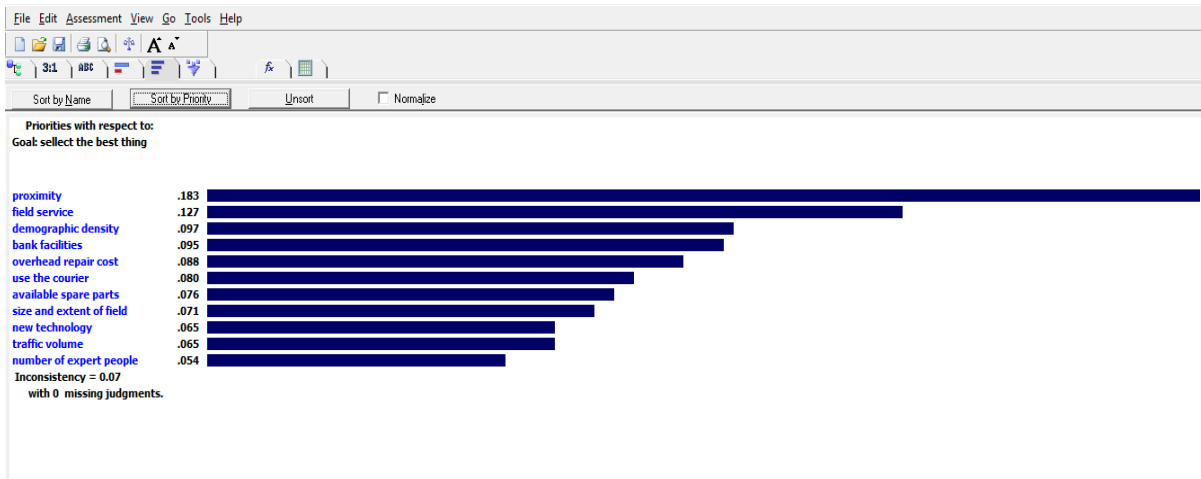
Figure1. The result of ranking the questionnaire's criteria by Expert Choice software

2.3 Criteria used for the preparation and analysis of map

2.3.1. Coastline

This criterion has been considered due to factors such as tide and environmental damage. The distance between the repair shops and coastline was considered at least 500 meters.

2.3.2. Population centers

This criterion is considered due to the importance of the city and the surrounding countryside and their easier access to the repair shop. The repair distance from these areas is considered to be a maximum of 5 km.

2.3.3. Communication lines

The farmer and the owner of the machinery, in order to transfer his faulty device to the repair centers, need to have safe and convenient access to the roads and lines of communication. In this study, the optimal distance of the repair shop was considered to be a maximum of 1 km.

2.3.4. Spare parts stores

Spare parts stores are very effective in choosing the proper place to establish a repair shop because repair and replacement of parts require new spare parts. Therefore accessing to spare parts stores is one of the main criteria. In this research, due to the low number of spare parts stores for agricultural equipment in Rudsar, the optimal repair distance was considered to be a maximum of 10 km.

2.3.5. Existing repair center

Another important criterion is the repair center of agricultural machinery. The new repair center should have enough distance from the existing centers in order to be efficient, and also to not to stop the existing repair shops from getting earn. At present, there are 4 repair shops for agricultural machinery in Rudsar, so the distance from the new location was considered at least 2 Km.

2.3.6 Rivers

Rudsar is famous for having many rivers. Therefore, considering this criterion is important. Therefore the optimal distance of river from the new location was considered at least 1000 m.

2.3.7. Health centers

The selection of medical centers as a criterion was important for two reasons; a: The noise of repairs and sound of agricultural equipment should not interfere with the health centers; and b: Considering the possibility of an accident for a repair worker and immediate access to this centers, it should not be far, so the optimal distance from these centers was at least 500 meters.

2.3.8. Educational Centers

Due to the noise caused by repair, the repair centers should be established at an ideal distance from the educational centers in order to not to disturb. The optimal distance for this criterion was considered at least 500 m.

2.3.9. Slope

Slope, depending on the direction and percentage, can affect many of the costs of the establishment of repair center. In this study, the maximum slope was 30 degrees.

2.3.10. Elevation above sea level

The elevation should be such that the transport of equipment, especially for agricultural machinery, become with no problem. They should transport easily and the route should be fairly smooth. The elevation above sea level should not exceed 2,000 m.

3. Results and Discussion

Layer of each criterion, mentioned in Section 2.3, were extracted. Figure 2 illustrates a classified layer of elevation. The higher the elevation is, the more difficult will be the establishment of a repair center. The map was classified into two classes using the Boolean logic (zero and one), zero class representing unacceptable and class one representing acceptable zones. It should be noted that this layer can be related to the criteria of size of the land and the availability of the repair center, mentioned in the questionnaire. The priority of these two criteria in the questionnaire was ranked 8th and 1st respectively.

Figure2. The layer of elevation in terms of limitation for the establishment of a repair center in Rudsar

Figure 3 illustrates the layer of slope. The more slope it will be, the harder it will be to establish a maintenance center
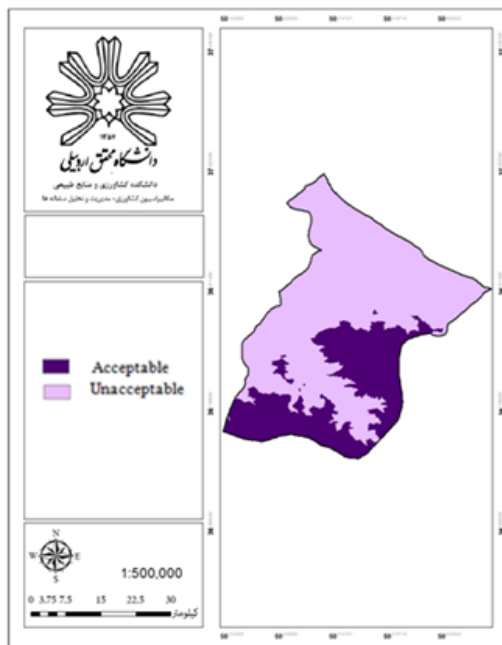

Figure3. The layer of slope in terms of limitation for the establishment of a repair center in Rudsar

As Rudsar leads to the Caspian Sea from the north, the distance from the coastline should be increased due to the tidal of sea (Fig4).
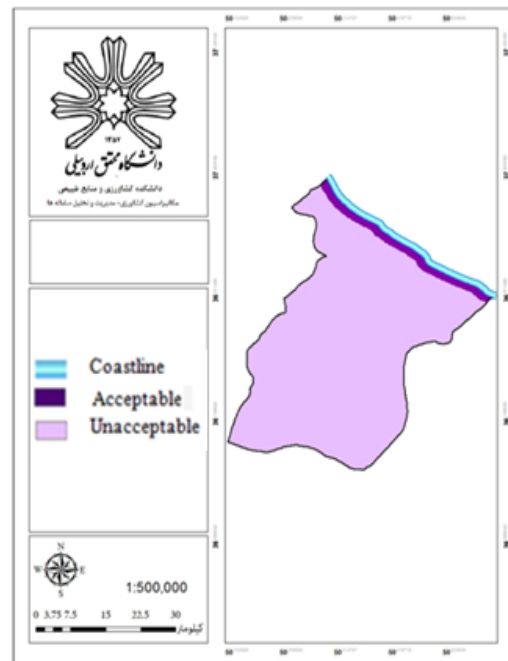

Figure4. The layer of coastline in terms of limitation for the establishment of a repair center in Rudsar

Regarding hydrographic networks or rivers, it is important to note that Rudsar may be at risk of flooding, especially in the rainy season; hence, the

construction of any repair center requires observance of the river boundary (Fig 5).
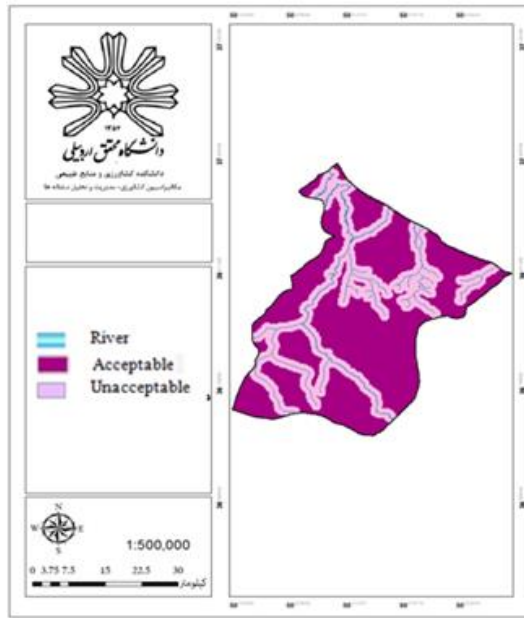

Figure5. The layer of hydrographic networks for the establishment of a repair center in Rudsar

The Rudser communication lines can be related to the traffic load criterion, as well as the criteria for using the motorized courier (mentioned in the questionnaire). The traffic load is directly related to urban and interurban routes, and the use of motorized courier requires the availability of appropriate communication lines to reach the repair centers. As the distance from communication lines increases, the conditions for construction of the repair center will become inappropriate (Fig6).
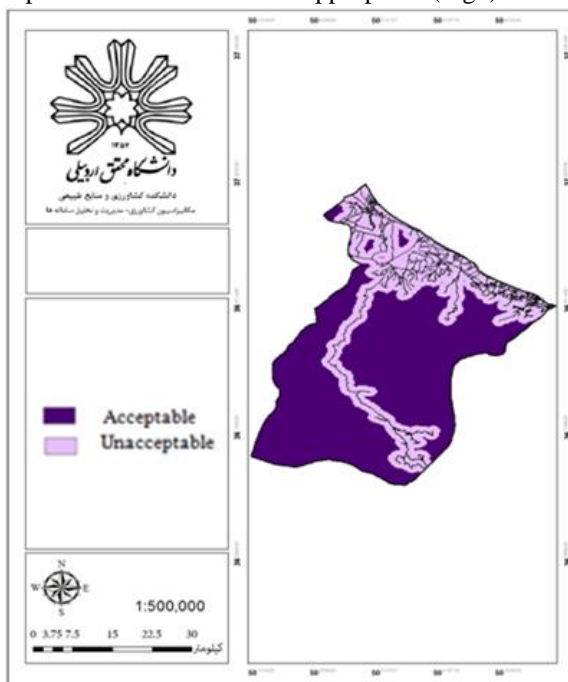

Figure6. The layer of communication lines for the establishment of a repair center in Rudsar

Population centers are always the habitat of people, and when building a repair shop, it should be careful not to disturb the population centers. According to the distributed questionnaire, all of experts believed that the proximity of the repair shop to the villages was desirable more. Also the probability of machine failure on site is much higher. Hence, as the distance from the population centers increases, the conditions for construction of the repair center will be inappropriate (Fig7).
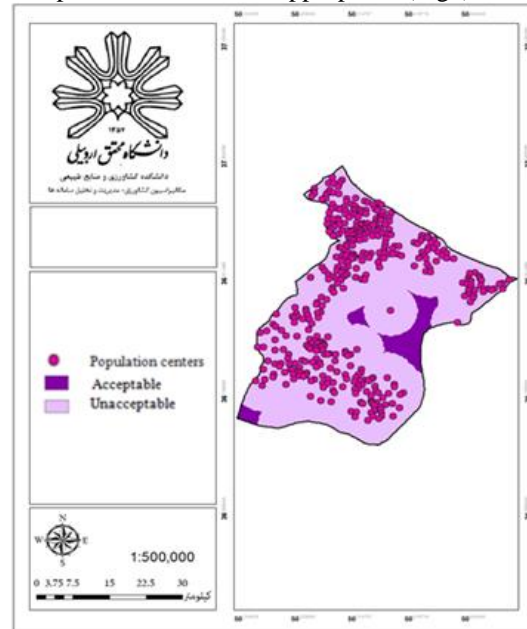

Figure7. The layer of population center for the establishment of a repair center in Rudsar

The existence of a new repair center near other repair centers will, on the one hand, hinder the business of old centers and, on the other hand, may lead to a loss of human capital; therefore, as the distance from the existing centers increases, the conditions for the construction new one will be more appropriate (Fig8).
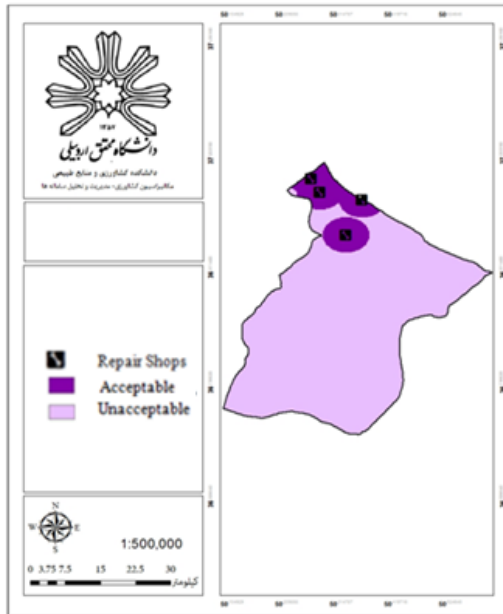
Figure8. The layer of repair center criterion for the establishment of a repair center in Rudsar

The availability of spare parts near the repair shop is of great importance in terms of easy access to parts needed. As the distance from the spare parts store increases, the conditions for the maintenance center will be worse (Fig9).
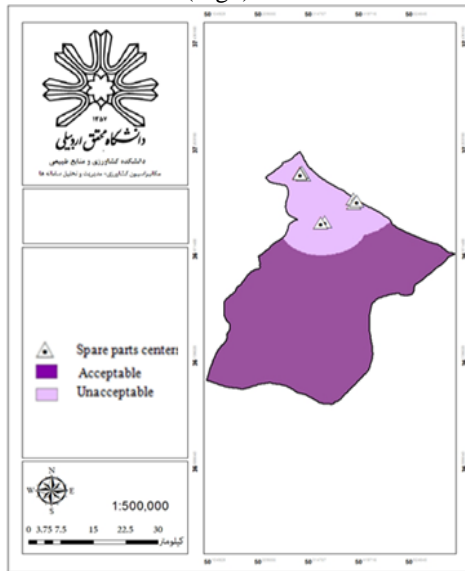

Figure9. The layer of spare parts stores criterion for the establishment of a repair center in Rudsar

The location of a new repair center should be at an optimum distance from the health centers, in order to of quick access to the health centers at the time of the incident and on the other hand does not disturb.
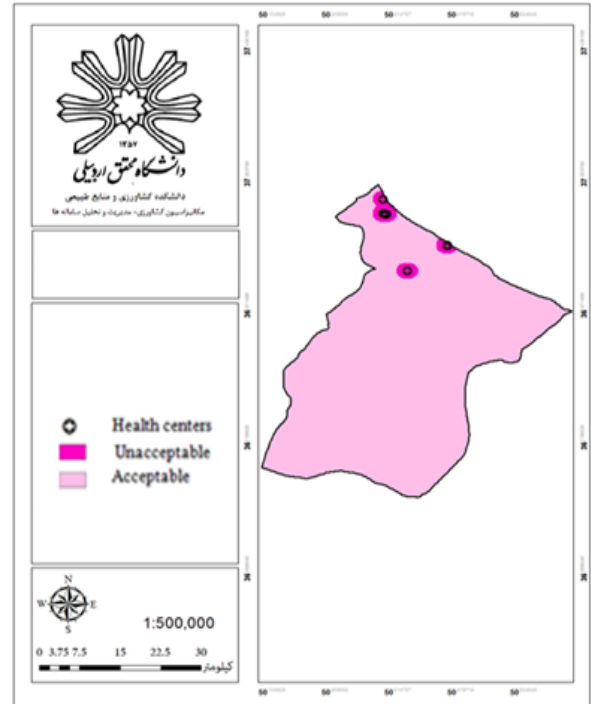

Figure10. The layer of health centers for the establishment of a repair center in Rudsar

Figure 11 illustrates the layer of educational centers criterion for the locating the repair center in Rudsar.
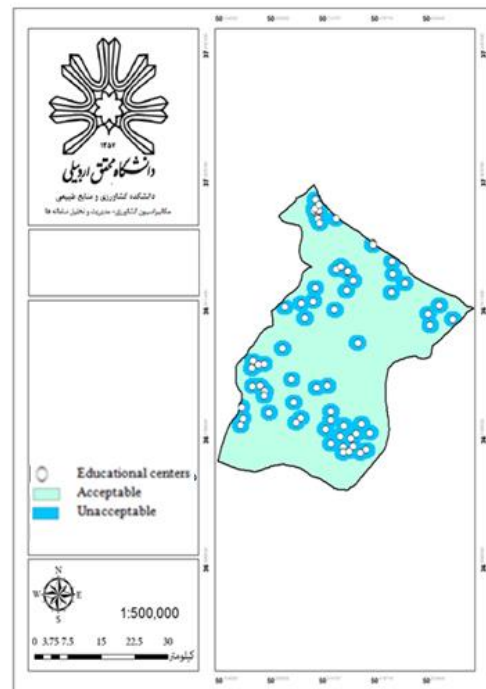

Figure11. The layer of educational centers for the establishment of a repair center in Rudsar

In the end, after integrating the layers and multiplying them in each other, the desired and undesirable parts were separated. Finally, it can be said that the small parts of the Kelachay and Chaboksar, and part of the chini Jan were suitable for the establishment of agricultural machinery repair centers (Fig 12).
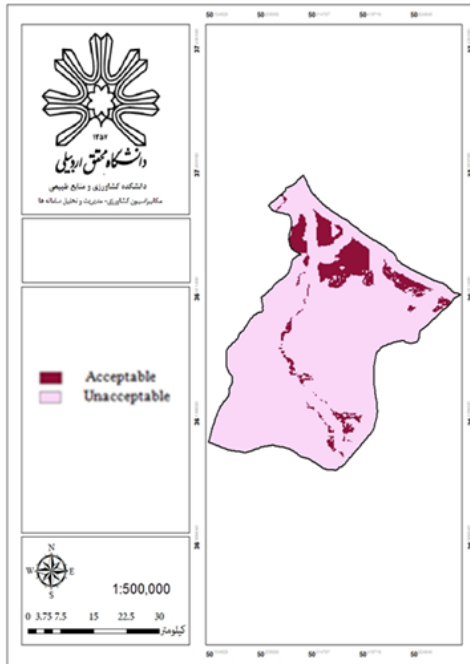

Figure12. Rudsar's classified map of desirable parts to establish a repair center

Conclusion

The aim was to select site to establishment of repair center in Rudsar, because the existence of repair centers will increase the life of the agricultural equipment. The results showed that only small parts of the city were suitable to establish a repair center; the reasons for this were:

1. The presence of Alborz heights in the southern parts of Rudsar has led to very difficult access to these areas. Also, there are not many residential areas and communication paths in these areas which considered as a disadvantaged region.
2. The slope of the region in mountainous areas is more than the other parts, which does not match the determined criteria in the research, resulting in the unfavorable category.
3. Because of more water paths in the region and also the northern section leading to the sea, most part of Rudsar has been classified as undesirable areas.
4. Having high educational centers and population density in the city have caused many urban areas to be considered for the establishment of an undesirable repair center.

References

1. Weber, A. (1929). *Alfred Weber's Theory of the Location of Industries* . Edited by Carl Joachim Friedrich . Chicago: University of Chicago .

2. Hakimi, S. L. (1964). Optimum Location of Switvhing Centers and the Absolue Centers and medians of a Graph . *Operations Research*. 12, 450-459.

3. Parhizgar, A. (1996). Provide an appropriate pattern of urban utilities location by researching urban models and GIS. *Thesis for PhD*, Tarbiat Modarres University

4. Babajani, A., Kalantari, kh., Rezvanfar, A. and Shabanali, H. (2007). Locating the Gardening Products Processing Industry in Kermanshah Province Using Combined Indicator and GIS.*Thesis for Master Degree*, Campus of Agriculture and Natural Resources of Tehran University.

5. Yonca, Aydin nazli. 2009. GIS-Based site Selection Approach for Wind and Solar Energy System: A case study from western turkey, A Thises submitted to the graduate school of natural and applied sceinces of middle east technical University.

6. Zangi Abadi, M. (2002). Analysis of Spatial Distribution and Location of Public Libraries by Geopraphical Information System in Kerman City, *Thises of Msc*. of Geography Major, tarbiat Modares University. 45-49.

7. Moradi, H. (2010). Competitive Positioning Service Centers: A case study of the location of production and operation management of health centers in Isfahan.

8. Fazel Nia, N. (2010). Optimal Location of Sampling Space Sports Models using AHP and GIS. *Journal of Urbon planning*, 4, 1-20.

9. Muller, S .L. Kufie, G. (2001). Exploiting Available Data Sources: Lication allocation modeling for health Service planning in Rural Ghana. *Danish Journal of geography.4,5-9*

10. Giannikes, L. (1998). A Multi Objective programming Model for Locating treatment sites and routing hazardous wastes *.European Journal of Op. Res*.14, 2-12.

11. Amini, A. (2002). Modeling for Location Allocation and optimum capacity of Dairy Industries in Kermanshah province. *Journal of Urbon planning* , 6(1), 79-102

12. GOVIND KHARAT, M., JAISINGH KAMBLE, S., RAUT, R. AND KAMBLE, A. S. (2016). IDENTIFICATION AND EVALUATION OF LANDFILL SITE SELECTION CRITERIA USING A HYBRID FUZZY DELPHI, FUZZY AHP AND DEMATEL BASED APPROACH. MODELING EARTH SYSTEMS AND ENVIRONMENT, 2 (98)

13. Gimpel, A., SandraTöpsch, V., Gubbins, M., Miller, M., Murillas, A., G.Murray, A., Pınarbaşı, K., Roca, G., Watret, R., (2018). A GIS-based tool for an integrated assessment of spatial planning trade-offs with aquaculture. *Science of The Total Environment, 627: 1644-1655*