A Decision Support Tool for Buying Farm Tractors

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Tractors are the most important equipment for most of the farmers. Data science can help farmers when making a decision about tractor purchase. Buying a tractor represents a big investment for farmers, and price is one of their main concerns. This study presents the development of a web-based decision support tool (DST) that calculate the price of new and second-hand tractors, for the purpose of providing the decision-maker some information that will lead him to the final decision. The tool makes use of different algorithms based on predictive analytics methodologies.

Keywords: farm tractors ; data science ; data economy ; decision support tool

1. Introduction

Tractors are essential for farming as they provide machine power for performing farm applications. Tractors are capable of performing the most important operations in farming, like plowing, planting, cultivating, fertilizing, and harvesting crops [1][2].

1.1. Data Science

Data Science is an interdisciplinary field that involves scientific methods, processes, and systems to extract knowledge or a better understanding of data in its different forms, whether structured or unstructured. It includes some data analytics fields such as statistics, data mining, machine learning, and predictive analytics [3][4].

The use of data science methods and tools creates new opportunities for organizations to use data to produce new market-changing products and better public services in the data economy [3][4].

1.2. Data Economy

Data Economy can be defined as the set of initiatives, activities, and/or projects whose business model is based on the exploration and exploitation of existing database structures (traditional and from new sources) to identify opportunities for the generation of products and services.

Data are new resource considered by many as “the new oil” [5], which reflect its relevance and increasing dependence on this resource. They have also been defined as an infrastructure resource [6], as they can be used by an unlimited number of agents for an infinite number of applications to produce goods and services, considered the basic equipment and structure necessary for a country, a region, or an organization to function properly [7].

1.3. Decision Support Tools

According to Shim et al., 2002, a decision support tool (DST) is a computational system with the purpose of helping decision-makers by analyzing information and identifying solutions. Their goal is to link strictly computational attributes of a management information system to the judgement ability of the decision-maker [8].

A DST consists of three fundamental characteristics: a database that can store and manage internal and external information, algorithms necessary for the analysis, and an interface for communication with the user [9].

Stakeholders and farmers may encounter difficulties in making proper decisions about agricultural management in topics where there is a huge amount of information available (e.g., environmental, crop-related, and economic data) [10]. It is challenging for them to transfer these data into practical knowledge. Thus, DST can assist them in making evidence-based and precise decisions.

DST have been developed in agriculture for disease prevention [11][12], optimizing crop rotation [13], assessing the climate regulation potential of agricultural soils [14], visualizing *E. coli* risk on agricultural land [15], field-specific nutrient

management [16], and many other applications [17]. There are studies about the development of decision support tools in other fields like medicine [18][19][20][21], supply chain management [22], cement industry [23], sewage sludge treatment [24], marine spatial planning [25], or ecosystem services quantification and valuation [26].

1.4. Tractor Cost Studies

Al-Suhaibani and Wahby 2017 studied the work order for 40 tractors, investigating the relationship between tractor age and power on repair and maintenance costs, finding that repair cost ratio and maintenance cost ratio were directly related to tractor working life (age) and tractor power [27]. Asfarnia et al., 2014 studied the effect of failure rate on repair and maintenance costs of just four agricultural tractor models [28]. Lorencowicz and Uziak, 2015 studied the repair cost of tractors and agricultural machines in family farms in Poland. They found that specific circumstances of Polish agriculture, with small sizes of the farms and old tractors and agricultural machines, highly affect the repair costs [29].

2. Decision Support Tool

The decision support tool is available and fully operative at: https://www.tractoresymaquinas.com/calculadora-precios-tractores/ . It is an open and free tool, very easy to use. It is done in a web environment, but it can be also implemented in a smartphone APP for Android or IOS. It is in Spanish because it is implemented in a Spanish site dedicated to tractors and other farm machinery. The number of fields and options were reduced to a minimum, with the idea of making the tool as simple as possible.

In the first place, the user must choose between new and used. If he chooses “new” then he will have to select brand and power. The power selector uses CV for power units, because it is the most commonly used unit by the farmers in Spain. Pressing the button of calculate price, one will get an estimation of the price of the tractor based on the mathematical models developed here. For each brand, there is a specific range of power.

If one chooses second-hand, the user can also select year of manufacture or operating hours. For each brand, there are also specific ranges of year of manufacture and operating hours.

The interface includes a disclaimer and information about the authorship of the tool, in order to build user confidence. Moreover, each time the tool is used, the inputs and the output are saved in a database. This gives feedback about the performance of the models and the search needs of the users.

3. Findings through DST

The DST developed here has the three fundamental characteristics that any DST should have: a database that can store and manage internal and external information, algorithms necessary for the analysis, and an interface for communication with the user [9].

The present DST fulfills the eight core factors that influence the uptake and use of DST by farmers, established by Rose et al., 2016. These factors are performance expectancy, easy to use, peer recommendation, trust, cost, habit, relevance to user and farmer-adviser compatibility [17].

Regarding performance, this DST works efficiently, provides up-to-date information, give accurate predictions or information, and enable better decision-making. DST is very easy to use because it provides information in a quick, user-friendly way, works in any browser, has a clear and simple design with only few options for the inputs and one clear output. The peer recommendation is not extensive because it is a DST that has just been launched. But if the DST performs well, the peer recommendation will come.

Regarding trust, farmers and advisers are keen to use tools from trusted sources. For this reason, there is a text in the bottom of the DST saying that it is a neutral decision support tool based on algorithm done by a public university, not a farm machinery manufacturer, dealer, or distributor. Thus, it is something that farmers can trust. This DST is also free to use. Users do not have to pay and can use the DST for an unlimited number of times.

In the case of habit, younger farmers are used to using computers and smartphones. They will seamlessly start to use a decision support tool delivered in the form of software or apps. Following this approach, the present DST can be used in any smartphone, tablet, or computer. It works in a www secured environment.

Regarding the relevance to user, this DST is sufficiently flexible to serve the needs of an individual but it is also generic. It gives specific results for the most popular brands, but also has general models that can be applied to any brand.

In this DST the farmer-adviser compatibility is guaranteed, because it is accessible for both and is compatible with any browser or Internet device.

4. Conclusions

With the parametric models developed here, a calculator for estimating new and used tractor prices was developed, implemented, test, and validated. This calculator is currently used as a decision support tool for buying and selling tractors. This tool can lead users through clear steps and suggest optimal decision paths in the process of buying farm tractors.

This tool saves time and money to farmers and machine dealers. In the case of new tractors, the farmer does not need to visit several stores to get a price information. He just can use the tool and get many different price estimations in a short time. For the machine dealers, it is a very easy way to compare tractor prices of different brands. In the case of second-hand tractors, the tool summarizes and condenses the information of thousands of tractors models with different characteristics, operating hours, and age (year of manufacture).

Moreover, the DST has other benefits. To the buyer, the farmer, it allows to detect fraudulent offers, suspicious for being too cheap or too expensive. The seller or tractor owner can estimate the remaining value of his tractor or the selling price in the market. The seller does not need to be an expert appraiser to know how much to sell his used tractors for.

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