



Cyprus
University of
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Faculty of Engineering
and Technology

Doctoral Dissertation

**Critical Investigation of Novel Computational Techniques for
Automated Valuations of Real Estate Properties in Cyprus**

Ph.D. Thesis: Thomas Dimopoulos

Limassol, April 2020

CYPRUS UNIVERSITY OF TECHNOLOGY
FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING AND GEOMATICS

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Approval Form

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Presented by Thomas Dimopoulos

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Cyprus University of Technology

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The approval of the dissertation by the Department of Civil Engineering and Geomatics does not imply necessarily the approval by the Department of the views of the writer.

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ABSTRACT

Keywords: CAMA, AVM, Mass Appraisals, Valuation, Property taxation

Mass appraisals for valuation purposes using automated systems have gained a lot of traction in recent years, a fact which is highlighted when viewing the large amount of corresponding literature that has become available over the past decade. The main valuation governing bodies (IAAO, RICS, IVS, TEGOVA, national authorities, etc.) have all produced papers and articles referring to the models and systems that are used for mass valuations (Computer Assisted Mass Appraisals - CAMA, Automated Valuation Models - AVM, etc.) and how their application could be revolutionary within the sector. While automated systems are already being used in many countries and jurisdictions for taxation purposes, the demand for mass appraisals is growing as a result of the financial globalization process. Issues regarding ethics, licensing and responsibility of the valuations produced by automated systems remain pending but are being addressed constantly, as well as their importance and impact on the broader environment of valuation practice and the Real Estate industry.

The aim of this PhD thesis is to provide a rigorous and accurate analysis of the mass appraisal procedure, to highlight the relevant techniques and methodologies, and to propose innovative methods to advance the currently used mass appraisal system in Cyprus through worked case studies based also from the literature review findings. A global history of mass appraisals, as well as definitions, methodologies and models' specifications, calibration and adjustments are presented and the most common applications of mass appraisals are discussed. The models implemented by the Cyprus Department of Lands and Surveys (DLS) for taxation purposes are analyzed and the strengths and weaknesses of current systems are presented and assessed. The author uses an enhanced apartments' database to analyze the dependence on their deviation on the other parameters influencing a property's value (covered area, location, etc.). The results of the case studies that were carried out in Nicosia (Cyprus) and Thessaloniki (Greece) using Geographically Weighted Regression, Ordinary Least Squares, Random Forests as well as other mathematical techniques are presented, scrutinized and interpreted. The author provides novel recommendations for the improvement of the models and how their application could be implemented in the wider market. Finally, he provides a critical

judgment of the models' accuracy, by utilizing both his significant professional experience (with more than 15,000 valuations conducted throughout a 15-year career) on specific test cases and real valuation practice, with a focus on outliers and observations with high errors.

The main outcome of this Ph.D. is its contribution to the appropriateness of utilization of automated systems in the valuation procedure and in the broader property valuation environment based on the critical evaluation of the existing techniques and their implementation within the Cyprus region. Although the AMVs have many advantages and can be used in several sectors, they also present limitations on the real-world application. However, the use of AVMs can improve the quality of the valuation precision and lead to a higher achieved accuracy ratio per valuation, which could, in turn, create higher profits for any valuer, stakeholder and to the broader industry as well. In conclusion, mass appraisals are cost and time effective and a positive contribution to the sustainability of the broader economic and financial environment.

ΠΕΡΙΛΗΨΗ

Λέξεις-κλειδιά: CAMA, AVM, Μαζικές Εκτιμήσεις, Εκτίμηση, Φορολογία Ακινήτων

Οι μαζικές εκτιμήσεις με τη χρήση αυτοματοποιημένων μοντέλων, αποτελούν πόλο ερευνητικού ενδιαφέροντος τα τελευταία έτη, γεγονός το οποίο επιβεβαιώνεται μέσα από το μεγάλο όγκο σχετικής βιβλιογραφίας και των εργασιών που έχουν δημοσιευτεί τα τελευταία χρόνια. Οι κύριοι εκτιμητικοί φορείς (ΙΑΑΟ, RICS, IVS, TEGOVA, Εθνικές Υπηρεσίες, κ.λπ.) έχουν διεκπεραιώσει μελέτες και άρθρα σχετικά με τα μοντέλα και τα συστήματα τα οποία χρησιμοποιούνται στις μαζικές εκτιμήσεις (Computer Assisted Mass Appraisals - CAMA, Automated Valuation Models - AVM, κ.λπ.) και τον τρόπο με τον οποίο η εφαρμογή τους θα μπορούσε να αποφέρει σημαντικές στις ως σήμερα γνωστές διαδικασίες. Ενώ τα αυτοματοποιημένα συστήματα χρησιμοποιούνται ήδη σε πολλές χώρες και για φορολογικούς σκοπούς, η ζήτηση για μαζικές εκτιμήσεις αυξάνεται ως αποτέλεσμα της διαδικασίας της οικονομικής παγκοσμιοποίησης. Τα ζητήματα που αφορούν την ηθική, την αδειοδότηση και την ευθύνη των εκτιμήσεων που παράγονται από τα αυτοματοποιημένα συστήματα, καθώς επίσης και η σημασία και το αντίκτυπο που έχουν στο ευρύτερο εκτιμητικό περιβάλλον και στη βιομηχανία των ακινήτων, προβληματίζουν την εκτιμητική κοινότητα. Τα αυτοματοποιημένα μοντέλα, ωστόσο, προσαρμόζονται και βελτιώνονται συνεχώς με μεγάλη επιτυχία.

Σκοπός της παρούσας διδακτορικής διατριβής είναι να παρέχει μια αντικειμενική ανάλυση της διαδικασίας των μαζικών εκτιμήσεων, να επισημάνει τις σχετικές τεχνικές και μεθοδολογίες και να προτείνει καινοτόμες μεθόδους με σκοπό τη βελτίωση του συστήματος μαζικής εκτίμησης που χρησιμοποιείται σήμερα στην Κύπρο, μέσω μελετών που βασίζονται επίσης στα ευρήματα από τη βιβλιογραφική ανασκόπηση. Παρουσιάζεται η ιστορία των μαζικών εκτιμήσεων, καθώς επίσης και ορισμοί, μεθοδολογίες, προδιαγραφές των μοντέλων, η βαθμονόμηση και οι προσαρμογές τους, ενώ παρατίθενται και οι πιο γνωστές εφαρμογές των μαζικών εκτιμήσεων σε παγκόσμια κλίμακα. Αναλύονται τα μοντέλα που εφαρμόστηκαν από το Τμήμα Κτηματολογίου και Χωρομετρίας της Κύπρου για σκοπούς φορολογίας έως σήμερα, ενώ εντοπίζονται και αξιολογούνται παράλληλα τα πλεονεκτήματα και τις αδυναμίες τους. Ο συγγραφέας χρησιμοποιεί μια βάση δεδομένων για διαμερίσματα και αναλύσει τις παραμέτρους που

επιηρεάζουν την αξία ενός ακινήτου (εμβαδό κλειστών χώρων, τοποθεσία κ.λπ.) καθώς και τις μεταξύ τους συσχετίσεις. Παρουσιάζονται, αναλύονται και ερμηνεύονται τα αποτελέσματα τα οποία προέκυψαν μέσα από μελέτες που πραγματοποιήθηκαν για την περιοχή της Λευκωσίας (Κύπρος) και της Θεσσαλονίκης (Ελλάδα) με τη χρήση της Γεωγραφικά Σταθμισμένης Παλινδρόμησης (GWR), της Μεθόδου των Ελαχίστων Τετραγώνων (OLS), της τεχνικής μηχανικής μάθησης Random Forest, καθώς επίσης και άλλων υπολογιστικών τεχνικών και μοντέλων. Ο συγγραφέας παρέχει καινοτόμες προτάσεις για τη βελτίωση των μοντέλων και τον τρόπο εφαρμογής τους στην ευρύτερη αγορά. Τέλος, ο συγγραφέας πραγματοποιεί κριτική σχετικά με την ακρίβεια των μοντέλων, αξιοποιώντας τα με βάση τη σημαντική επαγγελματική του πείρα (η οποία περιλαμβάνει περισσότερες από 15,000 εκτιμήσεις που διεξήχθησαν σε μια 15-ετή καριέρα) δίνοντας έμφαση στις ακραίες τιμές και τα μεγάλα σφάλματα.

Το σημαντικότερο αποτέλεσμα της παρούσας διδακτορικής διατριβής είναι η συμβολή της στην εφαρμογή και τη χρήση των αυτοματοποιημένων συστημάτων εντός της εκτιμητικής διαδικασίας αλλά και στο ευρύτερο οικονομικό περιβάλλον και βασίζεται στην κριτική αξιολόγηση των υφιστάμενων τεχνικών και την εφαρμογή τους στην Κύπρο. Παρόλο που τα Αυτοματοποιημένα Εκτιμητικά Μοντέλα έχουν σημαντικά πλεονεκτήματα και μπορούν να χρησιμοποιηθούν από διάφορους τομείς, παρουσιάζουν ωστόσο περιορισμούς στη δια ταύτα εφαρμογή τους. Παρ' όλα αυτά, η χρήση των AVMs μπορεί να βελτιώσει την ποιότητα της ακρίβειας των εκτιμήσεων και να οδηγήσει σε υψηλότερη αναλογία ακρίβειας ανά εκτίμηση, γεγονός που θα μπορούσε, με τη σειρά του, να επιφέρει σημαντικά οφέλη στους εκτιμητές, τους άμεσα ενδιαφερόμενους, αλλά και γενικότερα στην ευρύτερη βιομηχανία των ακινήτων. Συμπερασματικά, οι μαζικές εκτιμήσεις πλεονεκτούν ως προς το κόστος και τον χρόνο που απαιτείται, και συνεισφέρουν θετικά στη βιωσιμότητα του ευρύτερου οικονομικού και χρηματοοικονομικού περιβάλλοντος.