

Task 2 – Week 5

6-7-2024

Prepared by:
Eng. Adel Hammas
242001104

Research Issues 1



(MGM811)



Article

Integrated Approach to Achieve a Sustainable Organic Waste Management System in Saudi Arabia

Nibras Abdullah ^{1,2,3}, Ola A. Al-wesabi ^{3,4,*}, Badiea Abdulkarem Mohammed ^{1,3}, Zeyad Ghaleb Al-Mekhlafi ⁵, Meshari Alazmi ⁵, Mohammad Alsaffar ⁵, Mohammed Anbar ² and Putra Sumari ⁴

¹ Department of Computer Engineering, College of Computer Science and Engineering, University of Ha'il, Ha'il 81481, Saudi Arabia; neprasf@gmail.com (N.A.); b.alshabari@uoh.edu.sa (B.A.M.)
² National Advanced IPv6 Centre, Universiti Sains Malaysia (USM), Penang 11800, Malaysia; anbar@usm.my
³ Faculty of Computer Science and Engineering, Hodeidah University, Hodeidah P.O. Box 3114, Yemen
⁴ School of Computer Sciences, Universiti Sains Malaysia (USM), Penang 11800, Malaysia; putras@usm.my
⁵ Department of Information and Computer Science, College of Computer Science and Engineering, University of Ha'il, Ha'il 81481, Saudi Arabia; ziadgh2003@hotmail.com (Z.G.A.-M.); m.alazmi@uoh.edu.sa (M.A.); m.alsaffar@uoh.edu.sa (M.A.)
* Correspondence: ola.wesabi@gmail.com; Tel: +60-11-2947-4750



Citation: Abdullah, N.; Al-wesabi, O.A.; Mohammed, B.A.; Al-Mekhlafi, Z.G.; Alazmi, M.; Alsaffar, M.; Anbar, M.; Sumari, P. Integrated Approach to Achieve a Sustainable Organic Waste Management System in Saudi Arabia. *Foods* 2022, 11, 1214. <https://doi.org/10.3390/foods11091214>

Academic Editors: Hanna Dudek, Joanna Myszkowska-Rydzik, Ariun Ishdorj and Mazena Jezewska-Zychowicz

Received: 16 March 2022
Accepted: 30 April 2022
Published: 22 April 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: Organic waste management (OWM) has always been a fundamental aspect of human populations. Approaches to OWM must be matched to the characteristics of a certain population. In this consideration, the Kingdom of Saudi Arabia (KSA) is no exception. Organizations are being aligned to focus on sustainability matters sharing significant features with universal trends, especially the integration of 3Rs (reducing waste, reusing, and recycling resources). However, the degree and nature of advancement in the direction of sustainability vary depending on the economic level of a state. High-income economies can afford to pay a higher price to integrate 3Rs technologies. Most recent endeavors have focused on achieving 'Zero Waste', which is costly for low-income developing countries. The expectations of OWM systems in KSA must be estimated. In this work, the situations in KSA and other countries are analyzed, and pertinent aspects are explored. Matters relating to the sustainability of OWM are conceptually assessed. This study proposes an integrated method for an organic waste management system to achieve sustainable OWM in the context of state policy and appropriate frameworks, suitable technology, institutional order, operational and monetary administration, and people consciousness and involvement. A genetic-based waste collection transportation algorithm that enhances the efficiency of waste collection truck management is presented in line with this technology. The selected routes based on the R_p and IP_p are the most efficient among those available for the examined smart bin destinations. The minimum R_p of selected routes is less than the maximum R_p of available routes by 2.63%. Also, the minimum IP_p of selected routes is less than the maximum IP_p of available routes by 27.08%. The proposed integrated approach, including the waste collection transportation algorithm, would be beneficial across a variety of country-specific layouts.

Keywords: genetic-based waste collection; IoT; truck waste collection management; Zero Waste

1. Introduction

Millions of Muslims visit the Kingdom of Saudi Arabia (KSA) every year to do Pilgrimage (Hajj) and Umrah. Muslims visit holy areas of worship, such as the holy mosques al Haramayn (Makkah and Medina) and Al-Masha'ir (Arafat, Mina and Muzdalifah) [1]. The number of pilgrims arriving in KSA for Hajj (the 12th month of the Islamic lunar calendar) and Umrah has significantly increased in recent decades due to the ongoing expansion of the holy mosques, enhanced transportation services and safety, and decreased aggregate cost and time, with an annual increase of 1.15% from 1993 to 2014 [1–3]. The KSA

Introduction

- Research paper published by MDPI – Food cate, on 22 April 2022.

Nibras Abdullah, Ola A. Al-wesabi , Badiea Abdulkarem Mohammed, Zeyad Ghaleb Al-Mekhlafi , Meshari Alazmi, Mohammad Alsaffar, Mohammed Anbar, and Putra Sumari

- Research Title :**
Integrated Approach to Achieve a Sustainable Organic Waste Management System in Saudi Arabia.

العنوان

عنوان الورقة البحثية : النهج المتكامل لتحقيق نظام إدارة النفايات العضوية المستدام في المملكة العربية السعودية.

العنوان مقبول الى حد ما، ولكنه لا يعكس تفاصيل الدراسة المذكورة والنتائج المرجوة من البحث، ويظهر متغيرين فقط وهم المنهجية المتكاملة والمستدامة كمتغير مستقل والآخر نظام إدارة النفايات العضوية كمتغير تابع، ولم يحدد المكان بشكل دقيق بحيث يفضل ذكر المدينة أو المنطقة أو النطاق البلدي المستهدف بالدراسة. وعلى الرغم ذلك فإن العنوان تطرق لتطبيق وتأثير المنهجية المستدامة على نظام إدارة النفايات العضوية في السعودية.

المستخلص، الكلمات الدالة، المقدمة

Nibras Abdullah ^{1,2,3}, Ola A. Al-wesabi ^{3,4,*}, Badiea Abdulkarem Mohammed ^{1,3},
Zeyad Ghaleb Al-Mekhlafi ⁵, Meshari Alazmi ⁵, Mohammad Alsaffar ⁵, Mohammed Anbar ²
and Putra Sumari ⁴

- ¹ Department of Computer Engineering, College of Computer Science and Engineering, University of Ha'il, Ha'il 81481, Saudi Arabia; nepras@gmail.com (N.A.); b.alshaitani@uoh.edu.sa (B.A.M.)
- ² National Advanced IPv6 Centre, Universiti Sains Malaysia (USM), Penang 11800, Malaysia; anbar@usm.my
- ³ Faculty of Computer Science and Engineering, Hodeidah University, Hodeidah P.O. Box 3114, Yemen
- ⁴ School of Computer Sciences, Universiti Sains Malaysia (USM), Penang 11800, Malaysia; putras@usm.my
- ⁵ Department of Information and Computer Science, College of Computer Science and Engineering, University of Ha'il, Ha'il 81481, Saudi Arabia; ziadgh2003@hotmail.com (Z.G.A.-M.); ms.alazmi@uoh.edu.sa (M.A.); m.alsaffar@uoh.edu.sa (M.A.)
- * Correspondence: ola.wesabi@gmail.com; Tel.: +60-11-2847-4750

Abstract: Organic waste management (OWM) has always been a fundamental aspect of human populations. Approaches to OWM must be matched to the characteristics of a certain population. In this consideration, the Kingdom of Saudi Arabia (KSA) is no exception. Organizations are being aligned to focus on sustainability matters sharing significant features with universal trends, especially the integration of 3Rs (reducing waste, reusing, and recycling resources). However, the degree and nature of advancement in the direction of sustainability vary depending on the economic level of a state. High-income economies can afford to pay a higher price to integrate 3Rs technologies. Most recent endeavors have focused on achieving 'Zero Waste', which is costly for low-income developing countries. The expectations of OWM systems in KSA must be estimated. In this work, the situations in KSA and other countries are analyzed, and pertinent aspects are explored. Matters relating to the sustainability of OWM are conceptually assessed. This study proposes an integrated method for an organic waste management system to achieve sustainable OWM in the context of state policy and appropriate frameworks, suitable technology, institutional order, operational and monetary administration, and people consciousness and involvement. A genetic-based waste collection transportation algorithm that enhances the efficiency of waste collection truck management is presented in line with this technology. The selected routes based on the R_p and IP_p are the most efficient among those available for the examined smart bin destinations. The minimum R_p of selected routes is less than the maximum R_p of available routes by 2.63%. Also, the minimum IP_p of selected routes is less than the maximum IP_p of available routes by 27.08%. The proposed integrated approach, including the waste collection transportation algorithm, would be beneficial across a variety of country-specific layouts.

Keywords: genetic-based waste collection; IoT; truck waste collection management; Zero Waste

1. Introduction

Millions of Muslims visit the Kingdom of Saudi Arabia (KSA) every year to do Pilgrimage (Haji) and Umrah. Muslims visit holy areas of worship, such as the holy mosques al Haremeyn (Makkah and Medina) and Al-Masha'ir (Arafat, Mina and Muzdalifah) [1]. The number of pilgrims arrive in KSA for Hajj (the 12th month of the Islamic lunar

أوجز الباحث في المستخلص تعريف النفايات العضوية ومدى خطورتها في التخلص السليم، كما أشار الى موقع الدراسة وذكر أهمية الدراسة ومشكلتها والطريق الى حلول هذه المشكلة من خلال ادخال المنهجية المتكاملة والمستدامة بتطبيق أحدث التقنيات.

استخدم الباحث 5 مصطلحات للدراسة وتم وضعها في موقعها المناسب للبحث العلمي، وجميعها تدل على عنوان البحث وقضية الدراسة. على الرغم انه كان بالإمكان زيادة بعض المصطلحات والتي تعود الى حدود الدراسة وموقعها.

أسهب الباحث من خلال المقدمة في طرح مشكلة الدراسة وأهميتها وأهدافها واستخدم الجداول والأرقام والاحصائيات التي تم الحصول عليها من الدراسات السابقة، كمات تم ربط المتغيرات المذكورة بالعنوان وماهي العلاقات بينهم.



Citation: Abdullah, N.; Al-wesabi, O.A.; Mohammed, B.A.; Al-Mekhlafi, Z.G.; Alazmi, M.; Alsaffar, M.; Anbar, M.; Sumari, P. Integrated Approach to Achieve a Sustainable Organic Waste Management System in Saudi Arabia. *Foods* **2022**, *11*, 1214. <https://doi.org/10.3390/foods11091214>

Academic Editors: Hanna Dasik, Joanna Myszkowska-Rydzik, Ariun Ishdorj and Marzena Jezewska-Zychowicz

Received: 16 March 2022
Accepted: 20 April 2022
Published: 22 April 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

مشكلة الدراسة

الموضوع

03

2. Food Waste Is a Problem

According to the World Bank report in 2020, more than two billion tons of MSW were produced annually, with at least 33% of this being ecologically harmful. On a global scale, the average amount of waste produced per individual each day is 0.74 kg. These values range from 0.11 kg to 4.54 kg. Despite accounting for just 16% of the world's population, high-income exports account for approximately 34% or 683 million tons of global waste [12,13].

Waste generation has enormously increased across the world in the last decades, and there is no indication of it decelerating down. Global MSW generation is expected to have increased by 70% to 3.4 billion metric tons by 2050. This situation is a result of a number of factors, such as world population growth, urban expansion, economic evolution and consumer shopping behavior. People generate millions of tons of waste each year, and this is rapidly becoming a worldwide problem. The necessity for authorities to provide appropriate waste remediation and disposal facilities has become ever more significant with the massive quantities of waste accumulating. However, less than 20% of waste is recycled each year, with massive aggregates still transmitted to landfills. Waste is frequently disposed of in hazardous open tips, particularly in developing countries. High-income countries produce more waste than low-income poorer countries, but they often have better waste management systems to help address these issues [14].

Waste generation statistics by billions of metric tons are presented in Figure 2. These statistics clarify the amount of MSW produced globally in 2016, with projections for 2030 and 2050. According to estimates, approximately 3.4 billion metric tons of MSW will be produced globally.

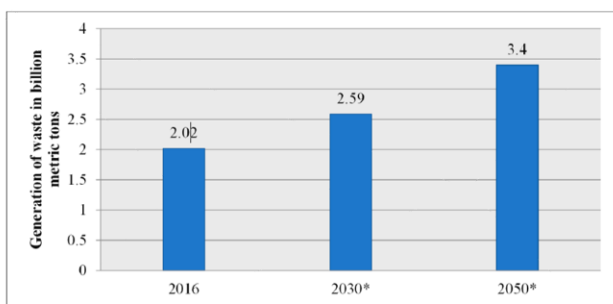
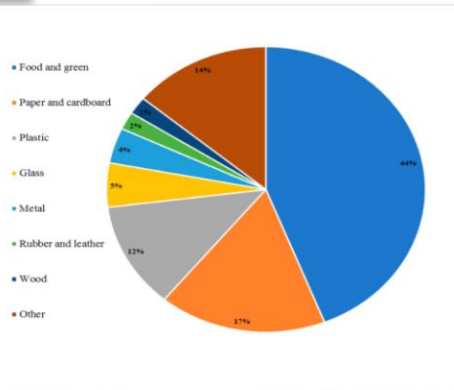


Figure 2. Worldwide municipal solid waste generation planning (2016–2050) [15]. *: Prediction values.



ذكر الباحث خلال سرد قضية الدراسة المشاكل الناتجة من نفايات الطعام والكميات التي تنتج يوميا من مختلف القطاعات وكيفية جمعها ونقلها وطرق التخلص منها. وذكر انها مشكلة تعاني منها جميع الدول بالعالم. كما أشار الى بعض الدراسات السابقة في طرح قضايا مشابهة وكيفية التعامل معها. وأخيرا ذكر بالتفصيل عن منطقة الدراسة وهي السعودية وماهي الأرقام الاحصائيات الحالية للتعامل مع هذه المشكلة، وقدم مثال عن موسم الحج عند استقبال السعودية لملايين الزوار سنوياً، وماهي الطرق المتبعة لإدارة النفايات العضوية خلال مواسم الحج والعمرة.

منهجية الدراسة

الموضوع

04

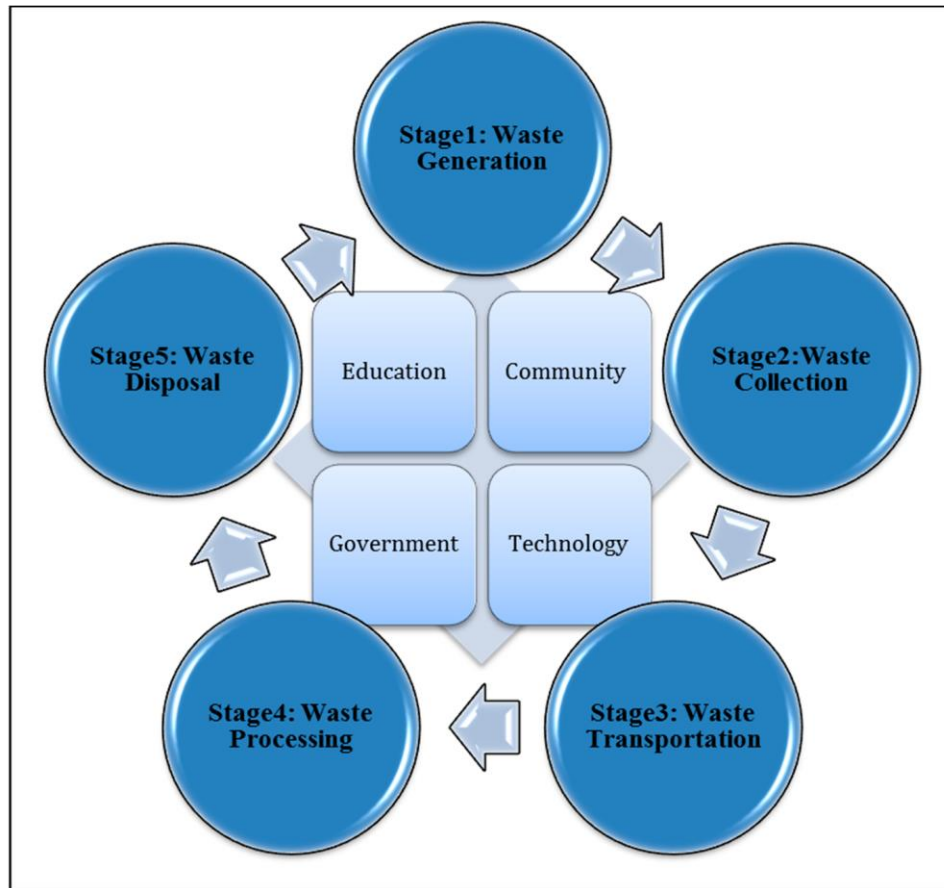


Figure 5. Integrated approach for organic waste management.

- من خلال المنهجية تتطرق الباحثة مباشرة الى عدة خطوات وهي :
- استخدام انترنت الأشياء IoT في عمليات أنظمة إدارة النفايات
 - المواد المستخدمة والاساليب المتبعة
 - بناء نظام إدارة النفايات
 - توليد النفايات وتجميعها ونقلها وتخلص السليم منها
 - التعليم
 - المجتمع
 - الحوكمة القوانين والتشريعات
 - التقنيات المناسبة

نتائج التجربة

الموضوع

05

Table 1. Experiment scenarios.

Call from Smart Bin ID	List of Smart Bins in the Route	Residual Free Space %	Importance Priority
11	0 15 11	2	12
	0 31 11	2	33
	0 23 11	11	20
	0 26 11	18	4
	0 27 11	28	16
	0 21 47 22 11	29	16
	0 36 40 11	29	30
	0 6 10 11	30	33
	0 27 16 11	31	21
37	0 23 38 18 16 26 11	49	32
	0 15 37	11	20
	0 14 37	16	26
	0 23 37	22	25
	0 45 37	23	24
	0 19 37	23	25
	0 36 9 37	29	22
	0 35 37	31	21
	0 38 45 37	35	33
41	0 48 34 3 37	44	42
	0 15 41	1	13
	0 31 11 41	13	39
	0 14 41	17	10
	0 27 41	26	11
	0 6 24 41	28	48
	0 26 11 41	29	10
	0 11 41	30	18
	0 26 5 41	30	28
	0 6 41	33	17
	0 15 36 48 41	35	37
	0 32 14 41	38	21

وضع الباحث مجموعة من التجارب في صيغة أرقام إحصائية وبيانات رقمية للخروج بالنتائج المرجوة عند مقارنة المقترحات التقنية المستخدمة لقضية البحث، وتوصل الباحث الى معادلات رقمية أو خوارزمية لاكتشاف أي الحلول الأنسب تطبيقه في عمليات جمع النفايات ونقلها المراد

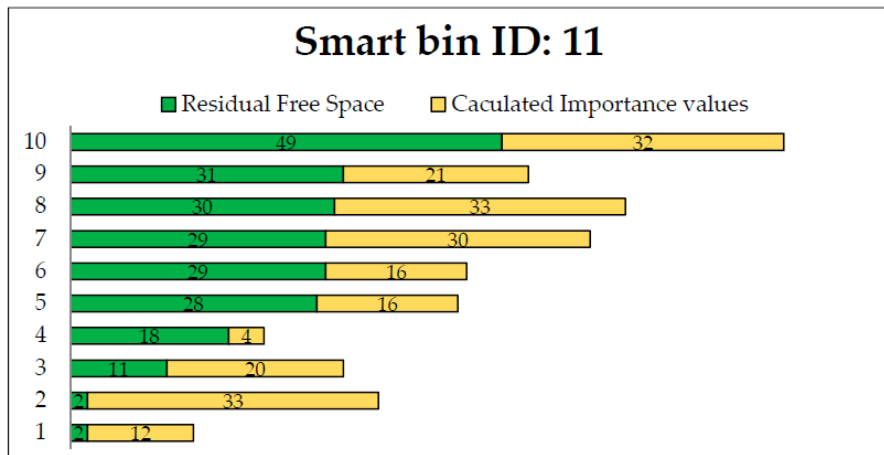


Figure 11. Evaluation routes to smart bin id: 11.

نتائج التجربة

الموضوع

05

Table 2. Efficient route selected.

Smart Bin Target	List of Smart Bins in the Selected Route (R_{fs} Priority)	List of Smart Bins in the Selected Route (Equal Priority)
11	0 15 11	0 15 11
37	0 15 37	0 14 37
41	0 15 41	0 15 41

Table 3. Residual free space R_{fs} , and importance priority value IPv .

Call from Smart Bin ID	Residual Free Space %			Importance Priority		
	Min	Max	Selected	Min	Max	Selected
11	2	49	2	4	33	12
37	11	44	11	21	42	20
41	1	38	1	10	48	13

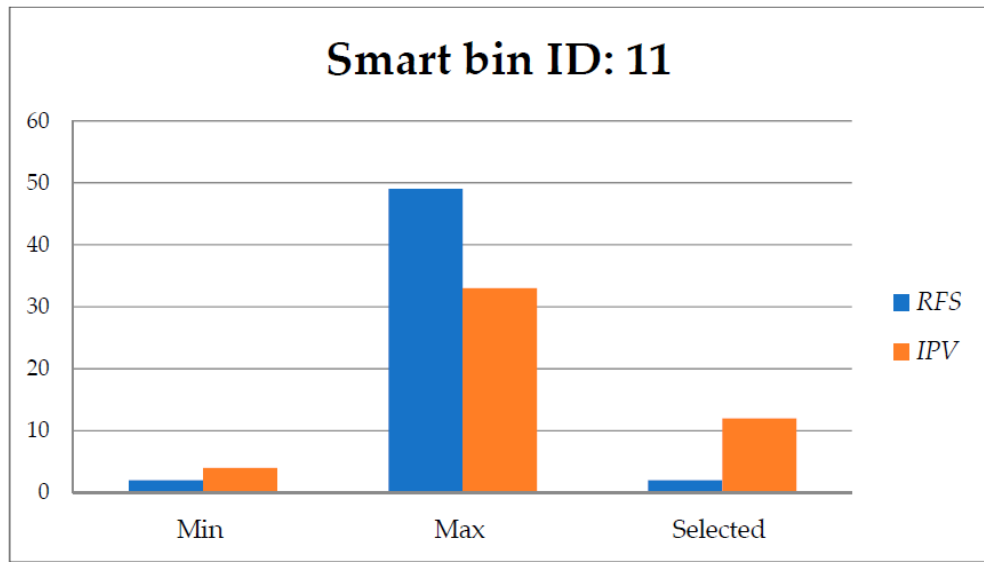


Figure 14. Residual free space R_{fs} , and importance priority value IPv to smart bin id: 11.

الخاتمة

الموضوع

06

النظام الحالي لإدارة النفايات WMS بالسعودية لا يكفي لتقديم مساهمات فعالة خصوصاً مع زيادة معدلات انتاج النفايات العضوية، وبناء على ذلك، فإن إدارة OWM أكثر استدامة ويجب تطويرها من أجل مجتمع مستدام. النفايات العضوية تشكل أكثر من 50% من النفايات الصلبة المحلية العالمية. تنتج منطقة شرق اوروبا معظم النفايات العضوية، وهو ما يمثل حوالي 62%، تليها منطقة الشرق الأوسط وشمال أفريقيا (61%).

الحد من النفايات العالمية هو الهدف الرئيسي للعلماء من خلال طرق البحث المختلفة. عدة توصيات تم تصنييعها للتحكم في النفايات العضوية، بما في ذلك التسميد وصنع الفحم الحيوي والطاقة الحيوية لمستحضرات التجميل والأدوية والمكملات الغذائية.

تعد إدارة النفايات العضوية أمراً مهماً، لنظام توفير الخدمات العامة ويجب تقديمه بفعالية إلى المجتمع للحفاظ على معايير الجمالية والصحة العامة حيث تحتاج الهيئات البلدية إلى تخطيط وإدارة هذه الأنظمة لا سيما عند زيادة النمو السكاني.

ومع ذلك، فإن نهج الدراسة المقترح والذي يشمل جمع ونقل النفايات الخوارزمية، ستكون مفيدة وفعالة عند تنفيذها بالسعودية كما سيتم تنفيذ الحاويات الذكية ودمجها مع وسيلة نقل القمامة المقترحة (خوارزمية).

وينبغي النظر في المزيد من المعايير لاختيار المسار، مثل المسافة والسلامة، حالة خالية من الحوادث، وأي معايير مفيدة أخرى.



مجموعة جامعة
الجميع الذكية
للتعليم القابضة

MIDOCEAN
UNIVERSITY



Thank You

