EXECUTIVE SUMMARIES

The Executive Summary consists of a brief description of the problem followed by a largely equation-free summary of the progress made and the results obtained by the study group.

VALUE OF DOMESTIC TOURISTS IN TRAVEL AND TOURISM INDUSTRY

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Executive Summary

Severe disruption of global and local economies has occurred since the onset of the COVID-19 pandemic. Restrictive measures have been put in place to curb the spread of the pandemic. International travel has been limited to a large extent due to the travel bans which have been issued by different nations. Due to heavy dependence of the tourism industry on international tourists, revenue generation in this industry has subsided and consequently led to many employees being retrenched. The challenges presented by the pandemic especially on international travel have heightened the need for nations to consider the value of domestic tourism. The Study Group was tasked to investigate how customized packages of tourism products and / or services can be utilized to mitigate the challenge of catering for the domestic market.

Tourism is described as traveling to, and staying in places outside the usual environment for not less than 24 hours and not more than one consecutive year for leisure, business, and other purposes (See e.g, Vanhove, 2015). In efforts to boost economic development while protecting its citizens from COVID-19, the South African Ministry of Tourism opened intra-provincial tourism, followed by inter-tourism. Of the nine provinces in South Africa, there was a concern that in Mpumalanga province there was not much usage of accommodation and tourist attractions during intra-tourism. This necessitated research into the domestic tourist sector of this area. Mpumalanga is one of the most fascinating provinces in South Africa which can be described as a melting pot of cultures. The province lies in the eastern side of South Africa. Also, it is very enriched with flora

and fauna. Tourism is one of the biggest industries in Mpumalanga along with farming and mining. The Study Group reasoned about what would encourage a local person to be a domestic tourist. It was reasoned that we could encourage locals to travel by getting them to spend less. This would encourage larger numbers of local tourists which would in turn result in more revenue for the tourist operator.

The Study Group started by considering a generalist view in solving the problem. For any domestic tourist, four sectors are considered as foremost, these are accommodation, recreation and / or attraction sites, transport, food and beverage. The Study Group modelled the package cost function using the number of tourists as the only independent variable. Season and quality were considered as constant parameters which could scale the costs since they play an important role in the tourism industry. We employed weights to the sectors included in the package cost function. The sum of the weights is required to be equal to unity. The solutions which we obtained should be suitable for application in other provinces and could be utilised across different nations. The Study Group obtained from the studied optimised package cost function that a group which consists of three or four tourists would provide the most cost effective tourism package. The minimum cost occurs for scenarios where accommodation is not the preferred option to be optimised.

Future work would include choosing better cost functions. More realistic independent variables should be considered for a better formulation of the package cost function as an optimisation problem. A concurrent modelling of the revenue of the tourist operator would also be something worthwhile to explore.

References

[1] Vanhove N. Tourism, In: Jafari J, Xiao H (eds), Encyclopedia of Tourism, Springer, Cham., 2015. https://doi.org/10.1007/978-3-319-01669-6$_5 03-2$

DEVELOPING SOUTHERN AFRICAN TOURISM CLIMATE INDEX

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Executive Summary

Over the years Travel and Tourism has managed to be resilient despite the diverse climatic conditions that affect tourists on a global scale. It is also known that tourism is controlled by climate in terms of determining the destination country before a tourist travels. In 2017 Trip Advisor reviews in South Africa showed Durban and Cape Town as destinations for most tourist in the country. In 1985 Mieczkowski developed the Tourism Climate Index (TCI), a method to quantify, classify and compare the climatic suitability of various destinations for tourism and to determine changes in climatic suitability through time. This index was based on expert opinion regarding the climatic factors which are of importance to tourists and the relative weighting thereof. The Study Group proposed a mathematical model for TCIsa. The poroposed model used five climatic variables, maximum temperature, minimum temperature, precipitation, cloud cover and wind speed as the input to estimate the values for the TCIsa. The TCIsa has been in the range of 90-98 for the 10 data points form the data set and for one iteration of the optimization procedure. This also confirms the reviews from the Trip Advisor data that Durban is one of the popular tourist destination due to its climate suitability for various tourist activities. This study recommends the validation of the mathematical model using more data points from the climate data set for Durban from 2009-2015 and to include more climatic variables.

MASKS AND THE SPREAD OF DROPLETS AND AIRBORNE VIRIONS

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Executive Summary

COVID-19 has necessitated that the population wear masks. Medical experts, such as Dr. Fauci from the National Institute of Allergy and Infectious Diseases, have suggested that wearing two masks may be more effective than one [1]. Numerous works have been done to understand the effects of masks on the spread of infectious respiratory droplets and airborne pathogens. Understanding the flow of air through and around the mask is of great importance, and has practical applications in mask design. The study group was tasked with modelling a mask and investigating the flow. As the brief was open to interpretation, the study group divided the problem into different subproblems to study various models. Subgroups were formed to work on the subproblems.

Subgroup 1 investigated a mask that is modelled as compressible porous media, undergoing small deformations that influence its permeability, as done by Köry et al [2]. The group considered two masks in contact with no gap between the two masks. The group chose the permeability to scale linearly with the deformation gradient because this is reasonable for small deformations. The steady state of the Navier equation was used because the poroelastic timescale is assumed to be much smaller than the operating time. Additionally, the mask was assumed to be uniform in the plane parallel the face, so it is sufficient to model in one dimension. The group derived the necessary equations and

boundary conditions and was able to solve the resultant ordinary differential equations analytically. The final solutions contain parameter values that are still to be determined.

Subgroup 2 investigated flow with adsorption in one-dimension, assuming two rigid masks in perfect contact. The group could investigate different strategies for changing width, porosity and permeability between masks. The team used an advection-diffusion system with a mass sink. To reduce the number of equations the adsorption term was related to the concentration using the Langmuir isotherm. The obvious goal of the model is to optimise the masks such that the concentration of water droplets and so virus exiting is minimised. This goal is constrained by the need to keep the pressure drop across the mask to acceptable levels, since this affects the comfort of the wearer. The resultant ordinary differential equations were solved numerically subject to the boundary conditions.

Subgroup 3 investigated mask design using the conservation of mass equation. The aim was to determine the effect of mask design with regards to the flow of air going through the mask or leaking out around the mask edges. A rigid and non-rigid mask were considered.

Subgroup 4 investigated the movement of air containing fluid droplets when wearing a mask using the standard Hiemenz model. The mask was modelled as a flat surface similar to that of, say, a face shield. A third order ordinary differential equations was obtained and solved numerically and representative trajectories of droplets of various sizes were obtained.

Subproblem 1 and subproblem 2 can be extended to include a small air gap between the two masks as this is expected in a real world scenario. Subproblem 3 can be extended to explore different mask materials in the non-rigid category. Subproblem 4 can be extended to consider the flow of droplets against and around a deformable and adsorbing surface.

References

[1] https://www.today.com/video/dr-fauci-double-masking-against-mutantcoronavirus- just-makes-common-sense-99959365958

[2] Köry J, Krupp AU, Please CP and Griffiths IM. The effect of compressibility on the behaviour of filter media, IMA Journal of Applied Mathematics, **85**, 2020, 564-583.

DIFFUSER RECYCLE RATE

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Executive Summary

In South Africa, sugar is extracted from sugar cane using a device known as a diffuser. Shredded cane, often referred to as bagasse, is introduced into the diffuser and moved along via a conveyor belt. Fresh water is fed onto the moving bagasse by a spray near the exit end of the diffuser. The water percolates through the bagasse and is collected by a tray beneath the conveyor belt as juice. That juice is then reintroduced above the bagasse further upstream in the motion of the conveyor to percolate through the bagasse again, after which it is collected and reintroduced again still further upstream. This process is repeated about 14 times and the final juice collected is sent for heating to remove the moisture. In this way the difference in concentration between the sugar in the cane and the sugar in the juice is maximized, leading to the most efficient extraction. The interval between two sprays will be referred to as a cell. Ideally, we would like the juice to move from cell to cell as a plug without mixing with the juice from other cells. Since the bagasse is moving with the conveyor belt, the sugar water percolates down the bagasse at an angle. This might result in the juice in one cell mixing with the juice in the next cell leading to inefficiencies in the device. Other inefficiencies may include dry regions in the bagasse and formation of voids. In the study group, we studied the flow of the juice as it percolates through the bagasse and derived a formula for the

amount of fluid in the recycle so that we have an idea on how to optimize the sugar extraction process. We began by looking at the simple one-dimensional flow model to understand the basics of flow through a porous medium and then we looked at a two-dimensional flow model for juice moving through a slowly moving bagasse. For future studies the formulae we derived for the dry-region and recycle can be compared with experimental data.