

BRIDGING ENTREPRENEURSHIP
AND SOCIAL INNOVATIONS

Edited by

ELMAR STEURER

EMANUEL HERRMANN

Bridging Entrepreneurship and Social Innovations

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Edited by

Elmar Steurer and Emanuel Herrmann

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Short CV

- Emanuel has worked as a research assistant at the University of Applied Sciences Neu-Ulm since September 2017.
- His research scope is in the field of operations research where he focuses on transportation in order to develop new models and concepts to reduce the cost of last mile logistics. This involves mathematical programming and optimization techniques as well as the development of appropriate solution procedures.
- He received a bachelor's degree in Economics from the University of Bonn, Germany, in 2013 and a master's degree in Economics from Københavns Universitet, Denmark, in 2016. Since the summer of 2018 he has been enrolled as a PhD student at the Technical University of Munich, Germany.

Publications and presentations

- Herrmann, E., and Kunze, O. 2019. "Facility Location Problems in City Crowd Logistics." *Transportation Research Procedia* 41: 117–134.
- Technical University of Munich, mobil.TUM, "Facility Location Problems in City Crowd Logistics", April 2018.
- Co-Chair of "International Conference on Economics, Management and Technology (IEMT 2019)" Neu-Ulm University of Applied Sciences, November 2019.

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INTRODUCTION

This volume contains selected papers that were presented at the International Conference on Economics, Management and Technology held at Neu-Ulm University of Applied Sciences on November 19th to 21st 2019 (IEMT 2019). This series has emerged within a remarkably short time period as a truly multidisciplinary international conference and provides an international focus for innovative research on the application of a multiplicity of advanced entrepreneurship concepts to many areas of entrepreneurship and innovations.

It has drawn upon practical advances in Social Innovation and Transformative Business Management and robust methodological developments in management sciences generally and entrepreneurship particularly.

The papers in this volume are organized in two parts, Entrepreneurship and Social Innovations in the Health and Services Sector. The acceptance rate of 50% reflects both the increasing interest in the conference and the Program Committee's efforts to improve the quality of the meeting year-on-year.

We are grateful to and thank the members of the program committee and particularly Prof. Dr. Derrick I-Hsien Ting, Prof. Dr. Suppanunta Romprasert and Prof. Dr. Uta Feser for their highly appreciated input in establishing and organizing the conference.

PART A:
ENTREPRENEURSHIP

PQR ANALYSIS – A MANAGEMENT METHOD FOR THE ASSESSMENT OF 3D-PRINTING IN SPARE PART LOGISTICS

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Abstract

Spare part logistics has faced a significant number of challenges including spare part availability over recent decades, speedy on-site availability in situations of need, space consumption for spare part storage and, last but not least, potentially long distances from point of production or storage to point of consumption.

Three-dimensional printing (3DP) or additive manufacturing (AM) is a developing cluster of technologies, which may help to master these challenges significantly better than before. Even if 3DP is not a universal solution for all spare parts, for some spare parts it can already be used today, and for others, it might be used tomorrow.

We suggest a simple management methodology (the PQR analysis) which helps to identify potential business cases for 3DP in spare part logistics and enables the harvest of “low hanging fruit” potential.

Nomenclature

3DP	Three-dimensional Printing
AM	Additive Manufacturing
CAD	Computer-aided Design
DLP	Digital Light Processing
FDM	Fused Deposition Modeling
FFF	Fused Filament Fabrication

IGEQ	Intermediate Good Enough Quality
LCD	Liquid Crystal Displays
MJM	Multi-jet Modeling
OFQ	Original Full Quality
PQR	Printability, Quality, Returns and Costs
PQRS	Printability, Quality, Returns and Costs, Sustainability
SLA	Stereolithography
SLM	Selective Laser Melting
SLS	Selective Laser Sintering

1. Introduction

Spare part logistics faces a significant number of challenges. One key challenge is spare part availability. In order to be able to provide spare parts to customers, the spare parts have to be produced first. As a precise estimate of the future demand of spare parts is subject to many – often unknown – factors, the following dilemma is unavoidable: if, on the one hand, too few spare parts are produced, there will be a physical shortage of spare parts, which may violate service contract obligations and damage the image of the spare part provider. If, on the other hand, too many spare parts are produced, the excess spare parts not only have to be stored unnecessarily but eventually may need to be scrapped, which produces unnecessary costs. Thus, it is beneficial, especially in the end-phase of spare part service contracts, if smaller lot sizes of missing spare parts can easily be reproduced.

Another key challenge for spare part logistics is spare part replenishment times.

If spare parts are not available globally, they have to be produced on demand. Depending on the nature of the relevant spare parts, this may require significant lead times of several days or even several months. But even if spare parts are globally available somewhere, that does not mean that they are close to the locations where they are needed. A large distance between storage location and demand location means significant transport costs and replenishment times.

A third big challenge is spare part storage costs. Storage produces costs, as storage requires space (rent), management and operations (wages) and energy.

But if spare parts can be produced on demand and close to the demand location, these three challenges can be overcome. One option to overcome these challenges and to enable on demand, local production is the 3D-printing (3DP) – also called additive manufacturing (AM) – of spare parts. Companies which especially want to enter the technology of 3D-printing have to ask themselves if, how, and when to do this. Therefore, the following management questions play an important role: Which part families can be 3D-printed? Can they be printed in compliance with the required quality levels? Does 3D-printing of these part families make sense from a commercial point of view?

The research question we want to answer in this paper therefore is: Which set of methods allows us to answer these three management questions from a top-level decision-maker's point of view?

2. State of Science

In logistics, a number of simplistic but very efficient “three-category analysis methods” have been developed and are used on a daily basis. These methods encompass the ABC analysis and the XYZ analysis. Furthermore, common decision-making methods, as well as 3D-printing basics, are briefly named and described in the following sections.

2.1 Analysis and Decision-making Methods

The ABC analysis is a method that is often used in inventory classification (Flores and Whybark, 1988).

The key idea of the ABC analysis is to sort items or item classes by a relevant criterion (in warehouse logistics one possible criterion is the turnover frequency). This descending sorted list of item classes is divided into three categories A, B and C (in warehouse logistics, these categories are often A: fast turning goods, B: non-fast turning goods and C: slow turning goods). Based on the ABC categories, the item classes can be treated differently. In warehouse logistics, these different goods are often stored in different parts of the warehouse, where the handling technology is designed to match the handling frequencies. For example, A goods are stored in an automated high bay storage area, whereas C goods are stored on simple shelves where they are handled manually in case of need.

In other cases, the principle of ABC analysis helps to redirect the focus from a trivial (class C items) to a significant (class A items) view (Flores and Whybark, 1988).

Similarly, XYZ Analysis poses another approach to rank and differentiate products or items. It is a business management method, which distinguishes products by the variance of their demand or consumption (Scholz - Reiter *et al.*, 2012).

In this context X, Y and Z items are classified. The consumption of X items is to some extent constant, having rare fluctuations. Y items tend to have stronger fluctuations in consumption, while Z items show completely irregular consumption patterns (Errasti *et al.*, 2010).

The concepts of ABC- and XYZ Analysis can be combined to provide an advanced and more detailed classification of items (Errasti *et al.*, 2010).

A more general qualitative method for decision support is the cost-utility analysis (Bea and Haas, 2009). The cost-utility analysis poses a method which enables an evaluation of different strategical alternatives using different quantitative or qualitative criteria (Bea and Haas, 2009).

2.2 3D-printing

Until the present day, 3D-printing has been developed, analyzed and discussed exclusively from a technical point of view. However, it is difficult to identify the most commonly-used AM technologies among the multitude of different technologies. Whilst Bhushan and Caspers, 2017 and Silva and Rezende, 2013 both name FDM, SLA, and SLS as the most commonly-used AM technologies, other AM technologies such as multi jetting, ink jetting, or binder jetting are only named by one of the above authors and other promising AM technologies (such as SLM) are not discussed by either authors.

One can roughly cluster these technologies by the categories print-in-air, print-in-liquid, print-in-solids (usually in powder).

Table 1. 3D-printing technology clusters.

Print:	in air	in liquid	in solids
Technologies:	FDM FFF MJM ...	SLA LCD DLP ...	SLS SLM ...

We want to illustrate the differences between these printing technology clusters by giving a brief description of one exemplary technology per cluster:

Fused Deposition Modeling (FDM) forms 3D objects by printing heated filament onto a heated printing platform. Therefore, a heated extruder is used, which is able to discharge the filament through a heated nozzle and to build 3-dimensional objects layer by layer. In FDM, support materials, which are removed after the printing process (In-Process), can be used to build advanced structures and shapes (Bhushan and Caspers, 2017). Compared to other 3D-printing technologies FDM is relatively cheap and user-friendly, but also relatively low in printing accuracy (Boschetto and Bottini, 2014).

Stereolithography (SLA) produces 3-dimensional objects by curing photopolymer resin using UV light. The process takes place in a vat filled with liquid, photopolymer resin. A building platform sinks into the resin, where a laser beam with a specific wavelength cures a thin layer of resin. This process is repeated for every layer of the object, which is printed upside-down (Silva and Rezende, 2013). According to Bhushan and Caspers (2017), SLA has the highest quality in terms of resolution and surface quality. It often needs a support structure, which is removed at the end of the process, to provide a certain degree of strength and resistance while printing.

Selective Laser Sintering (SLS) is printing 3-dimensional objects by sintering specific powder materials. A thin layer of powder is transferred into a build chamber where a focused laser beam fuses specific areas of the surface. After one layer is edited, another layer of powder is pushed into the chamber, where it covers the already fused layers. Thus, the process of sintering can be repeated until every layer is completed. Because objects are printed in powder, there is no need for support structures (Bhushan and Caspers, 2017).

The choice of printing technology is one of several aspects that need to be considered if the question “Can a certain part be 3D-printed?” shall be answered.

3. The PQR Analysis

The PQR analysis was inspired by both ABC- and the XYZ analysis with respect to simplicity of use and a triplet of assessment options.

Similar to the cost-utility analysis, the PQR analysis also poses a decision-making method, which is able to consider different financial and non-financial aspects (printability, quality, and return and costs). The PQR analysis, which is presented in this paper, combines analysis and decision-making aspects and focuses on top-level management decisions for 3D-printing in spare part logistics.

As in ABC analysis and XYZ analysis, we suggest working with spare part families rather than with simple spare part items.

The conceptual idea behind our “three-category analysis method” is quite simple – classify spare part families with respect to the three dimensions:

- P: the ease of 3D production
- Q: the quality of 3D print results
- R: the returns and costs of introducing 3D printing for the selected parts

Thus, we name our method the PQR analysis. We also suggest introducing the following general classification scheme for each dimension:

- P+: 3D print technically okay (possible)
P?: 3D print technically questionable
P-: 3D print technically not okay (impossible as of today)
- Q+: quality level of 3D-printed objects okay (acceptable)
Q?: quality level of 3D-printed objects questionable
Q-: quality level of 3D-printed objects not okay (unacceptable)
- R+: introduction of 3D-printing commercially okay (beneficiary)
R?: introduction of 3D-printing commercially questionable
R-: introduction of 3D-printing commercially not okay (unacceptable)

Finally, we suggest summarizing the relevant partial results in a 2-dimensional PQR assessment scheme as depicted in Table 2.

Table 2. PQR assessment scheme.

P printability	✕		
Q quality	✕		
R returns & costs		✕	
✕ Assessment after analysis	+ okay	? questionable	- not okay

Thus, the PQR assessment scheme is a very simple and highly aggregated management tool. The interesting question is how this assessment can be conducted in an efficient way, i.e., achieve robust results with limited effort. Therefore, a method to conduct the PQR analysis is needed.

In the following section, we firstly want to discuss the different aspects of printability, quality and revenue and costs. We also present some checklists which shall help to assess these aspects. Finally, we want to discuss two conceptual alternatives to convert the analysis results into an overall PQR assessment.

3.1 P – Printability

In order to assess the physical 3D printability, we suggest first conducting a very short ex-ante printability check and then checking the 3D print process for possible indicators as to whether it makes sense to 3D print a certain type of spare part.

3.1.1 *Ex-ante Printability Check*

As printability cannot be granted without physically testing the 3D-print process, we recommend conducting a physical 3D-print test for selected parts of the spare part family prior to any management decisions (see sections 03.1.3–3.1.6).

As this physical 3D-print test is usually quite time-consuming, we also suggest a top-level ex-ante printability check prior to the physical 3D-print test in order to avoid unnecessary work.

This ex-ante printability check consists of the two questions in Table 3.

Table 3. Ex-Ante Print Checklist.

No.	Aspect	okay	?	not okay
EA1	Legality: Is it legal to print the relevant part, and have the required copyrights been secured?			
EA2	Print Tests Performed Before: Has the part successfully been 3D-printed before, e.g., in a prototype phase?			

A “No” for question EA1 should be a showstopper for one's own activities. Still, as other players on the market may not comply with legal requirements it may be wise to conduct further analysis even if question EA1 is negatively answered.

A “Yes” to question EA2 makes further analysis rather simple because the results of these tests can be used as a robust basis for further decisions. A “No” to question EA2 is not a showstopper but leads to the need for further analysis (see below).

Once this ex-ante printability check has been conducted positively, one can analyze further details regarding possible 3D print technologies and the relevant spare part family characteristics as follows.

3.1.2 Technology Choice

Before physical 3D-print tests can be conducted, a 3D-print technology has to be selected as a technical basis for physical print tests.

Thus, before we present checklists that refer to the printed objects, we first present the following checklists which refer to the following commonly-used selection¹ of AM technologies:

- Fused Deposition Modeling FDM
- Stereo Lithography SLA
- Selected Laser Sintering SLS

These checklists shall help to select a suitable 3D-print-technology for further testing.

¹ For the basis for this selection see section 2.2

Table 4. FDM Checklist.

No.	Aspect	okay	?	not okay
FDM1	<p>Printing Volume</p> <p>Spare parts have to fit the dimensions of the printer used. Building volumes in FDM printing usually range from 120 x 120 x 120 mm (Tiertime UP mini 2 ES²) for nonindustrial printers and over 1500 x 1100 x 1500 mm (The Box BLB Industries³) to 6096 x 2133 x 1829 mm (EB 2076 LX ERECTORBOT⁴) for professional printers.</p> <p>Due to non-exhaustive technology research deviations of range are possible.</p>			
FDM2	<p>Geometric Resolution</p> <p>According to (Bhushan & Caspers, 2017), FDM is able to print layer thicknesses from 125 to 300 µm and minimal wall thicknesses from 600 to 1000 µm. However, according to Ultimaker⁵, layer thicknesses up to 20 µm can be achieved.</p>			
FDM3	<p>Printing Materials</p> <p>FDM usually prints thermoplastics like ABS, PLA or PA (Bhushan and Caspers, 2017).</p>			
FDM4	<p>Post-Processing</p> <p>FDM requires support structures for advanced structures, which have to be removed at the end of the printing process and can leave residues.</p>			

² <https://www.tiertime.com/up-mini-2-es/>

³ <http://blindustries.se/3D-printers/the-box/>

⁴ <https://www.aniwaa.com/product/3d-printers/erectorbot-eb-2076-lx/>

⁵ <https://ultimaker.com/3d-printers/ultimaker-3>

Table 5. SLA Checklist.

No.	Aspect	okay	?	not okay
SLA1	<p>Printing Volume</p> <p>Spare parts have to fit in the dimensions of the used printer. Building volumes in SLA differ depending on the model of the printer. The building volume of typical, nonindustrial SLA printers on the market ranges from 98 x 55 x 125 mm (Sparkmaker⁶) over 300 x 335 x 200 mm (Formlabs Form 3L⁷) to 510 x 280 x 350mm (Photocentric⁸).</p> <p>Due to non-exhaustive technology research deviations of range are possible.</p>			
SLA2	<p>Geometric Resolution</p> <p>According to (Bhushan and Caspers, 2017), SLA is able to print layer thicknesses from 1 to 50 µm and minimal wall thicknesses from 300 to 600 µm.</p>			
SLA3	<p>Printing Materials</p> <p>SLA uses photoreactive polymers in resin form for printing (Bhushan and Caspers, 2017).</p>			
SLA4	<p>Post-processing</p> <p>SLA usually requires post-processes to rinse and harden the printed objects. Furthermore, in most cases, support structures are printed, which have to be removed after the printing process and can leave residues.</p>			

⁶ <https://sparkmaker3D.com/sparkmaker-original>⁷ <https://formlabs.com/3D-printers/form-3l/>⁸ <https://photocentricgroup.com/lcmagna/>

Table 6. SLS Checklist.

No.	Aspect	okay	?	not okay
SLS1	Printing Volume Spare parts have to fit in the dimensions of the printer used. Building volumes in SLS differ depending on the model of the printer. Printing volumes of nonindustrial printers range from 100 x 100 x 100 mm (Sharebot Snowwhite ⁹) to 1200 x 600 x 600 mm (SLS1200 Shaanxi Hengtong ¹⁰). Due to non-exhaustive search deviations of range are possible.			
SLS2	Geometric Resolution: According to (Bhushan and Caspers, 2017), SLS is able to print layer thicknesses from 20 to 150 µm and minimal wall thicknesses from approximately 500 µm.			
SLS3	Printing Materials SLS uses metals, ceramics, and thermoplastics in the form of powder as printing material (Cali <i>et al.</i> , 2012).			
SLS4	Post-Processing Due to the powder-based technology, post-processing usually requires dusting and powder recycling as well as the removal of possible auxiliary and/or support structures.			

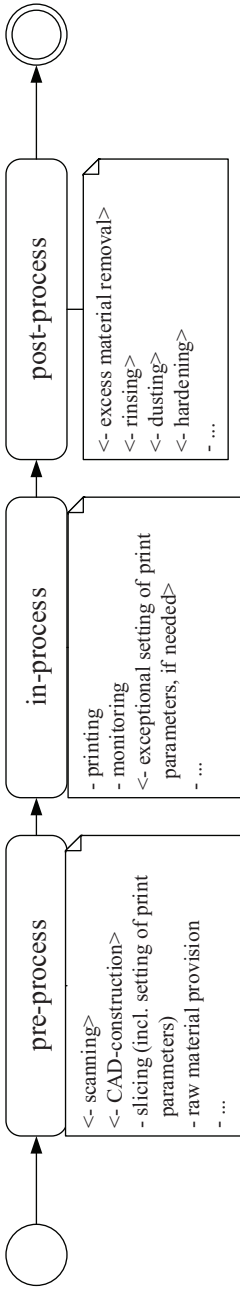
3.1.3 3D-print Process Steps

In order to assess the 3D printability of a certain spare part family, we suggest conducting this assessment along with the different 3D-printing process steps, i.e., the pre-process, the in-process and the post-process (Table 7).

⁹ <https://www.sharebot.de/index.php/sharebot-snowwhite-2/>

¹⁰ <http://www.spx-xian.com/etpenpage/EnEtpProductsShow.aspx?id=1352&nid=57>

Table 7. 3D-printing sub-processes.



This simple process model is also relevant for commercial assessment (see section 3.3 “R – Returns and Costs of 3D-printing”).

3.1.4 Pre-process

A printable 3D model of a spare part can either be based on a 3D-CAD-construction model or on a 3D scan of an existing physical spare part. For newer and future spare parts the first option is promising, but for older spare parts (where often only paper-based 2D-construction schemes exist) it is an interesting option to use 3D scanning of the finished part to obtain a 3D model. In many cases, this 3D scan needs to be refined by CAD-construction functions after the scan, as sheer 3D surface scanning does not always detect all the required details of the spare part (i.e., a hybrid scan and construction method is needed).

Table 8. Pre-print Checklist.

No.	Aspect	okay	?	not okay
Pre1	Print Data Availability Is there a suitable 3D-CAD image of the part available?			
Pre2	Print Data Availability Can a 3D-CAD-image be re-engineered by means of 3D-scanning and CAD-post-processing?			

A “Yes” to at least one of the questions Pre1 and/or Pre2 can be seen as a pre-requisite for further analysis, whereas a “No” to both questions can be seen as a showstopper.

Once the 3D model of the spare part is available, slicing is a process step that converts the 3D model of the spare part into a format that allows the 3D printer to produce the part by adding material slice by slice (depending on the relevant printer technology).

Finally, the raw materials (build materials, support materials and auxiliaries, e.g., platform glue, solvents, gases, etc.) which are to be used for the 3D-print are to be selected (based on the material characteristics, the required features of the spare part, and the printer specifics) and provided to the printer prior to the in-process.

3.1.5 *In-process*

The in-process is a rather simple process from a process point of view (i.e., print the object and monitor the printing), but it can be challenging from an exceptional parameter-setting point of view.

As 3D printing encompasses a vast variety of different printing technologies, these parameter settings often need to be adjusted (mainly in the pre-process) to achieve the best possible part quality, even if default settings often achieve reasonable results. Once these physical tests have been conducted, the following question can be answered (Table 9).

Table 9. In Print Checklist.

No.	Aspect	okay	?	not okay
In1	Test results Was the 3D print test successful?			

A “No” to this question is either a showstopper or leads to a new round of testing for a different 3D-print-technology.

3.1.6 *Post-process*

The post-process very much depends on the technology. Table 10 shows selected typical post-processing steps for different technology clusters.

Table 10. Typical post-process activities based on technology clusters.

Technology cluster	in air	in liquid	in solid
Typical post-process steps	<removal of support material (if used)>	<hardening e.g., for SLA>	<infiltration e.g., for binder jetting>
		rinsing and liquid recycling	dusting and powder recycling
	<removal of excess material (if any)>	<removal of excess material (if any)>	<removal of excess material (if any)>

Similar to the in-process, the post-process should also be checked using physical experiments (Table 11).

Table 11. Post-print Checklist.

No.	Aspect	okay	?	not okay
Post1	Test results Was the post-processing test successful?			

Once the results of the above checklist questions have been generated, one can summarize the findings by assessing the overall printability as either “okay”, “questionable” or “not okay” (see Table 2).

3.2 Q – Quality of 3D-printed Parts

Once the questions on printability are answered, the next step is to analyze whether the quality requirements of the part have been met by the selected 3D-printing process.

3.2.1 Generic Quality Aspects

Beitz and Küttner (1990) suggested a classification for measuring quantities, which we consider to be a suitable top-level checklist (Table 12)

Table 12. Quality Checklist.

No.	Aspect	Ref. ¹¹	okay	?	not okay
Q1	• shape and material (Form- and Stoffparameter)				
Q11	• geometric quantities (geometrische Meßgrößen)	W2.3			
Q111	• length (Längenmeßtechnik)	W2.3.1			

¹¹ Reference to the chapter number within Beitz & Küttner (1990)

Q112	<ul style="list-style-type: none"> • thread and gear (Gewinde- and Zahnradmeß-technik) 	W2.3.2			
Q113	<ul style="list-style-type: none"> • surface (Oberflächenmeßtechnik) 	W2.3.3			
Q114	<ul style="list-style-type: none"> • pattern recognition and image processing (Mustererkennung and Bildverarbeitung) 	W2.3.4			
Q12	<ul style="list-style-type: none"> • quantities of substance and matter 	W2.10			
Q121	<ul style="list-style-type: none"> • inorganic 	W2.10.1			
Q122	<ul style="list-style-type: none"> • organic 	W2.10.2			
Q123	<ul style="list-style-type: none"> • surface 	W2.10.3			
Q2	<ul style="list-style-type: none"> • function and process (Funktions- and Prozessparameter) 				
Q21	<ul style="list-style-type: none"> • kinematic and vibration quantities W2.4 (motion, velocity, speed, acceleration) 	W2.4			
Q22	<ul style="list-style-type: none"> • mechanic action quantities force, strain, stress¹² 	W2.5			
Q23	<ul style="list-style-type: none"> • fluid flow quantities 	W2.6			
Q24	<ul style="list-style-type: none"> • thermal quantities 	W2.7			

¹² This aspect can often be improved e.g., by using FDM-printers which can apply either glass-, carbon- or Kevlar-fibers during the print process.

Q25	<ul style="list-style-type: none"> optical quantities (light, color, refraction, polarization) 	W2.8			
Q26	<ul style="list-style-type: none"> electrical quantities (current, voltage, resistance) 	W3.2 & W3.3			
Q27	<ul style="list-style-type: none"> magnetic quantities 	V1.5.4			
Q3	<ul style="list-style-type: none"> environment and interaction (Umgebungs- and Wechselwirkungsparameter) 	W2.9			
Q31	<ul style="list-style-type: none"> radiation measurement 	W2.9.1			
Q32	<ul style="list-style-type: none"> acoustic measurement 	W2.9.2.			
Q33	<ul style="list-style-type: none"> climatic measurement (e.g., moisture) 	W2.9.3			

3.2.2 Selected Quality Aspects Relevant for 3D Printing

Depending on the nature of the spare part, many of the above quality aspects may be irrelevant. Therefore, we also present a simplified list of commonly relevant quality aspects that should be checked – note that this list is non-complete and not based on any statistical evidence, but just a first thumb-rule auxiliary for quick quality assessment.

- Dimensional Precision (Silva *et al.*, 2008) – see Q11:
Dimensional precision can be described as the accuracy of the fit of the 3D model and associated printing result. It can be evaluated by calculating the mean dimensional difference (considering height, width, and length) of the model and the printed result (Silva *et al.*, 2008).
- Surface Quality (Okarma and Fastowicz, 2017) – see Q113:
In the context of spare parts, surface quality can be defined as the measure of surface deviation between a reproduced, 3D-printed part and the original part, which is used as a template. Therefore, good surface quality emerges from little surface deviation. Existing literature describes different measures to evaluate surface quality, for example by

comparing visual feature similarity metrics (Okarma and Fastowicz, 2017).

- **Rigidity/Flexibility** – see Q22:
Spare parts often have to fulfill requirements in terms of rigidity or flexibility. Before producing and using spare parts, these characteristics should be observed. Rigidity/ flexibility can be measured by exerting force on the object and evaluating its deformation.
- **Temperature Robustness** – see Q24:
Another potential quality requirement for spare parts is temperature robustness because specific parts are often exposed to extreme temperatures. Temperature robustness can be measured by evaluating the deformation of a print, which is exposed to specific temperatures. Therefore, temperatures which are found in the specific use case should be considered.
- **Chemical Robustness** – see Q12 and/or Q3:
Similarly, chemical robustness has to be considered for spare parts which have contact with chemicals while being used. As well as temperature robustness, chemical robustness can be measured by exposing parts to the required chemicals and evaluating their deformation.

Please note again, that due to the different requirements of spare parts depending on their specific use, it is not possible to provide one simplified set of quality criteria, which fits all possible uses. (For instance, “Wall Permeability” – for details see Gordeev *et al.*, (2018) – which is not included in the above bullet point list, may be critical for containers of liquids. Other examples are pressure resistance, UV robustness, etc.)

3.2.3 *The Concept of “Intermediate Good Enough Quality”*

In the production and usage of spare parts, it is important to consider quality requirements. Very often the quality of spare parts is assumed to be identical to the quality of original parts. But is this necessarily a requirement?

Parts that are used as a temporary replacement of the original parts only, may require a lower “intermediate good enough” quality (IGEQ) compared to spare parts that are designed for long-term use.

As one of the benefits of 3D printing is the relative ease with which it can quickly produce a single spare part close to the demand location, 3D printing opens a window for IGEQ items which can temporarily be used as a replacement of the broken original part until the “original full quality” (OFQ) spare part has arrived. Thus, machine downtimes might be reduced significantly.

This new class of IGEQ items might open a new low budget sector of the spare part market. This IGEQ market sector will most probably have to face competition from non-copyright-obedient players – but at least it will give a chance to copyright owners to face this competition in a defined market sector.

3.3 R – Returns and Costs of 3D-printing

In the following section, we want to give some generic guidance to assess the returns and costs of 3D-printing processes in the production of spare parts.

3.3.1 Returns

As the possible returns of 3D-printing are manifold, we suggest checking the following different aspects (Table 13).

Table 13. Possible Returns Checklist.

No.	Aspect	okay	?	not okay
R1	<ul style="list-style-type: none"> Increased Add-On-Value. Does 3d-printing provide some add-on value for the customers? 			
R11	<ul style="list-style-type: none"> Shorter time to customer / shorter lead times (due to local “produce to order” production leading to shorter machine downtimes.) 			
R12	<ul style="list-style-type: none"> Higher individualization (e.g., imprinted customer logos, tailor-made coloring, etc.) 			
R13	<ul style="list-style-type: none"> Lightweight fabrication 			
R14	<ul style="list-style-type: none"> Adequate quality 			
R1x	<ul style="list-style-type: none"> Other add-on benefits 			
R2	<ul style="list-style-type: none"> Sustainability. Does 3D printing allow for improved sustainability? 			
R21	<ul style="list-style-type: none"> Reduced material use for product 			
R22	<ul style="list-style-type: none"> Reduced transport logistics efforts (CO₂ footprint, fuel consumption, etc.) 			
R23	<ul style="list-style-type: none"> Reduced storage logistics efforts (storage space reduction, etc.) 			
R24	<ul style="list-style-type: none"> Use of biodegradable materials 			
R2x	<ul style="list-style-type: none"> Other sustainability benefits 			
R3	<ul style="list-style-type: none"> Higher Sales Revenues. Can a 3D-printed parts be sold at higher prices compared to traditionally produced parts? 			

3.3.2 *Costs*

In order to be able to assess the relevant costs, different scenarios (S1 make, S2 invest and make and S3 buy – for details see below) should be analyzed, which each imply different cost structures.

According to (Anderson and Weitz, 1986), the make-or-buy decision should answer the question of whether an activity should be performed within an organization by company employees or by an external agent.

The make-or-buy decision highly depends on costs, which should be evaluated individually for each scenario. To evaluate the different scenario costs, we suggest using a cost corridor, i.e., a corridor with potential costs ranging from a first approximate lower bound to a first approximate upper bound. Using such cost corridor estimates usually enables first management decisions before a cumbersome and more detailed cost calculus is performed.

In practical applications, a variety of scenarios for companies are possible when it comes to the implementation of 3D printing in the production of spare parts. As we are not able to cover all conceivable scenarios, we focus on three typical scenarios, which often occur in practice, to estimate a cost corridor:

- Scenario 1 (S1 – use and make): A company is planning the production of spare parts and has already invested in 3D-printers. Therefore, the required technology is already available and the invested money is considered as sunk costs.
- Scenario 2 (S2 – invest and make): A company is planning the production of spare parts but doesn't have the required technology for production with 3D-printing. To enable such a production, an investment is required.
- Scenario 3 (S3 – buy): A company contracts a service provider, who produces the required spare parts and sells them to the principal.

In the decision-making process of using additive manufacturing in the production of spare parts, the costs and revenues of these three scenarios should be evaluated to provide a good management decision. S1 and S2 are scenarios in which a company chooses the option “make,” while S3 describes the option “buy.”

Typical costs for each scenario are listed in Table 14.

Table 14. Cost Elements per Scenario.

	Fixed Costs	Onetime Costs	Variable Costs
S1 - use existing printing equipment and make	<ul style="list-style-type: none"> (none) 	<ul style="list-style-type: none"> Initial creation of 3D model* 	<ul style="list-style-type: none"> HR-costs Energy costs Material costs Depreciations Maintenance costs
S2 - invest in printing equipment and make	<ul style="list-style-type: none"> Purchase of 3D printers 	<ul style="list-style-type: none"> Initial creation of 3D model* 	<ul style="list-style-type: none"> HR-costs Energy costs Material costs Depreciations Maintenance costs
S3 buy	<ul style="list-style-type: none"> (none) 	<ul style="list-style-type: none"> Initial creation of 3D model* 	<ul style="list-style-type: none"> External spare part production costs
* if not available			

Therefore, we recommend checking the cost corridors for each of the scenarios 1–3.

Table 15. Cost Corridor Checklist.

No.	Aspect	okay	?	not okay
RCS1	Cost Is the cost corridor assessment acceptable in an S1 scenario?			
RCS2	Cost Is the cost corridor assessment acceptable in an S2 scenario?			
RCS3	Cost Is the cost corridor assessment acceptable in an S3 scenario?			

Note, that according to Hölscher and Helms (2018), a sheer cost comparison is only useful if resulting revenues are considered to be identical. Therefore, the cost assessment needs to be balanced with the possible returns (see section 3.3.1).

Note also that the cost structure very much depends on the estimated number of parts to be sold, which in turn has an impact on the preferable scenario. Therefore, it may make sense to conduct the cost assessment separately for all three scenarios in parallel, especially if the total number of different parts to be printed is difficult to estimate.

3.4 Create the Overall PQR Assessment

As of today, we see two different ways to conduct the PQR analysis and come to an overall assessment.

3.4.1 Checklist Approach

Once the above checklists have been filled in, they provide a basis for the final PQR assessment (see Table 2. PQR assessment scheme).

One might try to convert the different aspect assessments mechanically into an overall PQR assessment. However, there are two main obstacles to a mechanistic conversion.

On the one hand, one needs to differentiate show stoppers, must-have and nice-to-have aspects, which very much depend on the nature of the individual spare part (e.g., “Q123-surface” may be essential for some parts,

whereas for other parts this aspect may be negligible. Or “RCS3 cost” aspects may be essential for one part whereas they may be negligible for another part, where “R11 lead time” is crucial).

On the other hand, it is difficult to assign weights to the different criteria.

Thus, it is difficult (if not impossible) to conduct a sheer mechanistic conversion of the single aspect analysis into the final PQR assessment.

3.4.2 Expert Approach

Another approach is to create the PQR assessment based on expert opinions. If, for example, an experienced production engineer considers printability to be taken for granted, why not rely on the expert’s opinion? Or if cost aspects do not matter within a very broad corridor, and a robust “S3 – buy” option within this broad corridor is available, why not focus on other aspects?

Thus, an expert approach may be an efficient and effective realistic alternative to the checklist approach. The expert approach can easily be implemented by conducting an expert workshop. The task of this workshop is to discuss the different PQR aspects with the relevant aspects in order to come up with the PQR assessment.

3.4.3 Hybrid Approach

The hybrid approach is a combination of both – the checklist and the expert approach. It may start with an initial expert workshop, where easy-to-assess aspects are fixed and difficult to assess aspects are postponed to a second workshop. These difficult aspects should be assigned to experts, which in turn may use checklists and/or consultations with colleagues to come up with a robust assessment for the second PQR workshop.

4. Critical Discussion and Need for Further Research

First of all, we want to state that this paper is a conceptual paper rather than a traditional research paper. It attempts to harvest low hanging fruits and to come up with a 360° view method on the original management questions:

- Which part families can be 3D printed?
- Can they be printed in compliance with the required quality levels?

- Does the 3D printing of these part families make sense from a commercial point of view?

In this approach, we considered the different process steps (pre-, in-, and post-processes) and three different make vs. buy options. We also presented a first version of checklists for the aspects of printability, quality and return and costs.

Still, there are a number of issues that can be criticized. Firstly, the completeness question arises, i.e., is a PQR-view really a 360° view, or have relevant aspects been left out of focus? As of today, we think that the aspect of sustainability (which for now we included in the “R returns”) may require further research, which eventually may lead to a PQRS-Analysis, and where methods of carbon footprint analysis or eco-balance sheets could be used to assess the “S sustainability” aspects.

Secondly, this approach, for now, is a sheer qualitative approach. For each aspect one can assume that there are quantitative methods to assess single aspects (especially cost and investment calculus methods and sustainability assessment methods), and an extension of the presented analysis and assessment with respect to quantitative methods would be desirable.

Third, the aim of this approach is to be effective (i.e., come up with robust assessments) and efficient (i.e., do not waste unnecessary effort for this assessment). The approach presented is the first suggestion, and thus it cannot be compared with other approaches with respect to effectiveness and efficiency, yet. As soon as alternative approaches are available, the difficult task of comparing the effectiveness and efficiency of the different approaches should be undertaken.

5. Outlook

The trends of “individualization” and “quick time to market” will make it more and more interesting in the near future to consider 3D-printing, not only of spare parts, but also of original parts and individualized consumer goods.

Thus, even if we have focused the PQR analysis on spare part families for the time being, we see no obstacle to applying this approach to other goods as well.

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DESIGNING A VIRTUAL REALITY NEGOTIATION TRAINING INNOVATION WITH CREATIVITY METHODS

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Abstract

The current custom for research and practice is to take into consideration all potential digitalization technologies as viable options for optimizing negotiation management. This also applies to Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). Within the next three decades VR, AR and MR will gain more traction in various types of business applications. Previous research findings and a qualitative market study demonstrated that training, HR development and competence building are areas of business that use VR. Blended VR negotiation training innovation for sales representatives and sales managers was designed for this purpose. A creativity methods toolkit was used to ensure innovation progress in the face of bargaining and negotiation management. The methodology supported the process of understanding, defining, creating and selecting ideas, prototyping and testing. A mechanical engineering company specializing in corporate complex solutions and projects, and a software company with expertise in the field of VR-based 3D learning were included in the design process and implementation of this training tool. The result is an embodied conversational agent prototype, making use of artificial intelligence and gamification within a guided negotiation scenery.

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Keywords: *Digitalization; Sales; Virtual Reality; Negotiation Training; Creativity Methods; Lead Users*

Nomenclature

VR	Virtual Reality
AR	Augmented Reality
MR	Mixed Reality
ECA	Embodied Conversational Agents

1. Introduction

Increasing digitalization has made sales processes more efficient and effective (Elste and Binckebank, 2019). Research and practice are continually looking at new emerging digitalization technologies. Currently, this also includes VR, AR and MR (Martín-Erro *et al.*, 2014; Sihi, 2018; Dieck and Jung, 2019). The research focus of these technologies is primarily based on "customer-oriented activities." such as the digitalization of the customer journey or the development of the area of e-commerce (Wilmot, 2017; Goyal and Sergi, 2018).

Few research findings focus on the use of internal resource optimization in sales and the question of whether VR, AR and MR can be used to optimize internal sales processes (Mehler-Bicher, 2016; Scacchi, 2016). Exploiting all the possibilities that the technologies have to offer is therefore not important, except in terms of choosing the right technology for the specific area of use and to ensure that such digitalization gives the user added value (Elste and Binckebank, 2019).

This paper will address the question of how to create VR-based negotiation training using creative tools and lead user involvement, in addition to the question of which potential VR areas of application might be considered for B2B sales.

Our research is aimed at scientists and companies who are concerned about the issue of which sales areas lend themselves to digitalization using VR, AR and MR and how, in particular, initiatives in the areas of training with creative methods and lead user participation can be implemented. One key question is how digitalization initiatives can be successfully implemented

with the involvement of lead users during the training development process. The prototype development presentation shows companies and scientists a guide for designing their own VR projects up to the transfer into the build phase. This paper therefore shows how VR applications for sales can be developed in a way that guarantees that they are user-centered for sales. Our work focuses exclusively on the design phase of VR training. This paper does not consider the description of the build area and the technical implementation, such as the preparation of visual or linguistic characteristics of the prototype design developed in the research project.

This scientific work came about during the INNOSÜD research project. In collaboration with partners from the Complex Solutions Department and a software company from the 3D learning environment, an illustrative prototype element was developed as the basis for virtual negotiations in a blended learning approach.

2. The Current State of Research

Some research has been done in the field of sales. The research range extends from social skills training (Taupiac *et al.*, 2019) to its use to enhance sales processes (Hariharan *et al.*, 2020). There are some examples of VR negotiation training, demonstrating the potential of using VR technology in negotiation training (Table 1). Broekens *et al.* (2020) designed VR training which significantly enhanced the ability to communicate in negotiations and improved negotiation expertise. Based on their study, the authors conclude that purely experience-based learning is ineffective. If negotiation mechanisms necessary for the training are not understood, the authors recommend the incorporation of additional forms of training instructions. Ding *et al.* (2017) developed a VR negotiation training in which the user passively attended a negotiation and witnessed the negotiator's dialogue and thought processes. The authors found that this training improved the users' negotiation skills and self-efficacy. In their publication, Gratch *et al.* (2016) use a semi-automated conflict resolution agent controlled by natural language, demonstrating the benefits of virtual agents for negotiation training. In addition, in the description of NegoChat-A, an advanced negotiating agent, there is the potential for communicating with agents using natural language (Rosenfeld *et al.*, 2016).

In their work, Greco and Murgia (2007) also focus on the presentation of their VR negotiation game "Win-Win Manager," which contains gamification elements such as score tables and a feedback mechanism. There are currently still no publications describing the initial phase - the conceptual design - of VR-based negotiation training with the aid of human-centered creative techniques. This article also introduces the idea of a negotiation agent for VR negotiation training using specific creativity techniques and with the help of lead users.

Table 1. Literature Review on VR Negotiation Training.

Source	Title	Focus of the Study and Major Findings
Ding <i>et al.</i> , 2017	Virtual Reality Negotiation Training Increases Negotiation Knowledge and Skill.	VR negotiation training improves negotiation knowledge and skills.
Gratch <i>et al.</i> , 2016	Virtual reality negotiation training system with virtual cognitions.	Improving people's negotiation knowledge and self-efficacy through applied VR negotiation training.
Rosenfeld <i>et al.</i> , 2016 Greco and Murgia, 2007 Farshid <i>et al.</i> , 2018	NegoChat-A: A Chat-Based Negotiation Agent with Bounded Rationality. The benefits of virtual humans for teaching negotiations. Improving Negotiation Skills Through an Online Business Game.	Description of NegoChat-A and a negotiation algorithm with a natural language module for interacting with the agents. VR offers potential in teaching negotiations with virtual humans. Behaviors observed in VR training were similar to face-to-face training. The introduction of Win-Win Manager, an online multiplayer business game that focuses on negotiation. The business game can raise the negotiation skills of the players making use of feedback mechanisms.

3. Definitions

For purposes of clarity, some terms that are essential for the development of a VR negotiation training component are defined below.

3.1 VR, AR and MR

New IT-based technologies, such as VR, AR and MR, offer the business world many new applications (Cassell *et al.*, 2000). While the VR user leaves reality altogether and VR takes place in a completely computer-generated world, AR is based in the real world (Cassell *et al.*, 2000). This is augmented with digital information. MR refers to an intermediate form of VR and AR. Here, the real and the computer-generated worlds merge with one another (Cassell *et al.*, 2000). This type of technology makes it possible to convey information that has traditionally been conveyed through books, videos or lectures, offering new areas of application and potential for increasing efficiency in all operational areas.

3.2 Embodied Conversational Agents (ECA)

In order to create a VR negotiation training element in which the user negotiates with a purchaser (machine) in the form of a salesperson (person), a prototype has been developed in the form of interactive virtual agents. These virtual agents represent the graphical front end to the user. Since they are able to conduct the negotiation in our language (verbal and non-verbal), they are referred to in the literature as Embodied Conversational Agents (ECA) (Cassell *et al.*, 2000). The idea of the VR negotiation training element lays the foundation for the visual design of the ECAs and the content of the dialogues conducted by the ECAs.

3.3 Dialogue Trees

The development of dialogue trees is required to develop ECAs. The user can convey their intents to these ECAs in natural language. Dialogue trees are combinations of questions and possible answers. Intents and entity categories are developed from the responses. Using artificial intelligence, these categories are tested in the subsequent build phase with real dialogues and further enriched with data on deviant conversation processes (Williams *et al.*, 2015). The result of the underlying conceptual phase is a dialogue tree that provides the basis for the subsequent build phase.

4. Methods

4.1 Survey, Implementation and Evaluation of Expert Interviews

A survey was conducted with the help of expert interviews in order to identify possible VR areas of application in sales. Expert interviews are suitable in less structured environments to find the basis for innovations and developments (Franzreb, 2018). An interview guide was prepared for conducting problem-centered interviews (Mayring, 2016). The interview guide was standardized to make the interviews in the evaluation comparable. The interview guide basically consisted of an exploratory question, several key questions and additive ad hoc questions (Mayring, 2016). The interviews with sales experts were conducted until no new findings were obtained ($n = 10$). The sales experts were selected on the basis of their sales experience (a minimum of five years) from various industries. The interviews were conducted over the telephone and could be recorded by means of a tape recording with the consent of the interviewees. The interviews were first prepared in text form (Mayring, 2016). The tape recordings of the interviews were transcribed word for word to ensure a thorough evaluation. In this case, a transcription was carried out into normal written German (Mayring, 2016). The subsequent evaluation procedure followed a structured content analysis according to Kuckartz (Kuckartz, 2016). The software MAXQDA was used.

4.2 Development of VR Negotiation Training

A creative toolkit with human-centered design methods was used for the development of innovative products in order to develop a specific VR application for sales (Franzreb, 2018). This method was selected to allow potential users to participate in the development process and thereby to develop an innovation that can be put to practical use. This toolkit follows a process model and is divided into six phases: Understand (I), Define (II), Create Ideas (III), Select Ideas (IV), Prototype (V) and Test (VI).

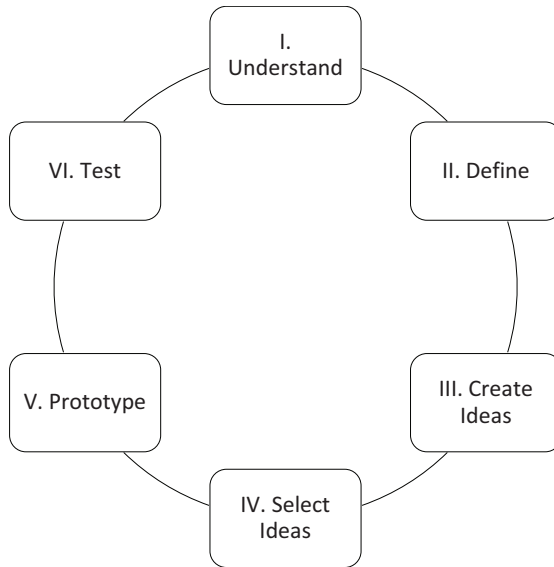


Fig. 1. Process Phases of the Creative Method Card Set.

The use of this human-centered design method requires potential users to participate actively in prototype development and evaluation. While passive user participation was methodologically appropriate in phases I and VI, active user participation was sought in phases II–V in order to engage the lead users in the essential development process (Ortlieb and Holz auf der Heide, 1993).

A design team comprising an area sales manager, a sales trainer and a training staff member from the mechanical engineering company involved was drawn up to develop the prototype (phase II–V). The purpose of this was to take into account users' objectives and needs in defining the VR training criteria and the design of the negotiation dialogue.

The area sales manager represented the user side and was responsible for ensuring a realistic design. The sales trainer provided training-related knowledge and supported the work in the design team from the point of view of global applicability. As an expert in training applications, the trainer contributed her expertise and experience, acted as a facilitator, and introduced her needs and requirements to the training.

In development phases I and VI, users provided passive support by being involved as test participants.

5. Results and Discussion

The following part is divided into a description of the results with a discussion of the areas, survey, implementation and analysis of potential VR application areas in sales, and development of a VR training application for negotiations.

5.1 Survey, Implementation and Analysis of Potential VR Areas of Application in Sales

The sales experts pinpointed three categories in which they came into contact with VR, AR and MR technology in sales. Product configuration and the digital twin were mentioned, as well as product presentation. The sales experts subdivided the product presentations into mobile and stationary product presentations. Visualizations were provided with mobile product presentations using technological aids, such as cardboard or head-up displays. The sales experts had points of contact with this form of product presentation, especially at trade shows. The sales experts found stationary solutions, especially in company-owned showrooms. In addition, sales experts have mentioned the use of VR in product configurations. The display of products was therefore visually illustrated using many different formats.

The points of contact with digital twins did not yet refer to a marketable use, but to a sales development stage.

Sales experts experienced new VR applications in the area of meetings and training. The meetings category was primarily about the desire to share information and experiences regardless of time and space. As an extension to existing technologies, sales experts saw the benefit of inserting items such as products into the meeting, thereby making them more imaginable. The training category focused primarily on enriching classroom training with virtual experiences, on quick rollouts with improved explanations and training on realistic products.

Our results were compared with a recent TUM study by Hutzschenreuter and Burger-Ringer (2018). The study reported that various industries are expected to increase sales over the next few years using VR- and AR-based

product presentations and product configurations. For meetings, they see potential in social settings through the use of VR as well as in the professional environment through Mixed Reality using digital models (Hutzschenreuter and Burger-Ringer, 2018). The authors ascribe the diffusion period for both applications to the period between 2030 and 2040.

The study evidences the spread of VR simulations in the training sector in the coming decade (2020–2030). The partners selected and supported the negotiation training topic, due to the integration of the research project into the “Innovative University” project which is funded by the Federal Ministry of Education and which calls for the transfer of specific university skills into the economy. The university’s scientific project management provided its state-of-the-art research in the area of negotiation theory as its core competence, while the company involved contributed practical expertise in virtual negotiation training in the B2B environment and the technology partner lent its technical expertise.

5.2 Development of a VR Negotiation Training Element

Each phase of the Creative Card Set is based on various method options (Franzreb, 2018), the selection of which is described below.

In Phase I "Understand," the method "Observation" was selected from the method card set. A company workshop on the topic "VR areas of application in sales and service" that spanned three days was monitored to understand the needs and potential areas of application of potential users. Ten participants from different departments and hierarchy levels in the company participated in the workshop. The target group was observed using this method without them knowing about it. Key findings on the issue were photographed and/or recorded to understand VR needs and potential users.

The "observations" in the first phase (Phase I) were almost identical to the experiences of the previous expert survey. In addition to "customer-based measures," such as the implementation of product configurators and the desire for showrooms, potential users saw virtual meetings and the use of VR in the internal training area as possible areas of operation. From VR in training situations, users promised a higher quality of the learning content, achieved through the visual experience of situations. They also promised increased motivation by incorporating playful content. Furthermore, the "observational" workshop showed that successful implementation requires a hands-on scenario and the ability to interact with language. In summary,

there was a particular requirement for the following criteria:

- the training application should be structured in terms of content and visual reality
- include gamification elements
- enable interaction with agents in natural language

A further company workshop was held on the subject of "VR Negotiation Training" for the reworking of phases II–V. Before the start of the second phase, the field of VR training in sales was limited to the subject of "negotiations." The subject of "negotiations" was selected because the required Phase I criteria (realistic experience, game and language) were the most appropriate in this sales Phase. Negotiations allow the integration of playful elements through linguistic interaction. The learning objectives of the developed VR training should include awareness-raising through the use of negotiating tactics, as well as practicing different negotiation styles and adhering to internal company guidelines. Due to the technological requirements of the ECAs and our technology partner, soft skills were not part of the VR negotiation training.

In Phase II "Define," the method "storytelling" was selected from the method card set. In preparation for this phase, the team was presented with a summary of previous research results. Problem areas in negotiations were subsequently defined through "storytelling" and requirements for the application were collected.

In the storytelling phase (Phase II), the participants mentioned negotiation scenarios that they found to be particularly challenging and which they would not like their colleagues to experience. Various negotiating tactics were presented, such as High Ball and Low Ball, Salami Slice, Good Cop and Bad Cop, Snow Job and New Instance (Table 2).

Table 2. Summary results of phases II–V.

Step	1	2	3	4	5	6
Method	Observation	Storytelling	Brainstorming	Dots Voting	Role play	Usability Test
Time	3 Day Workshop, 21.11.18	1 Day Workshop, 18.12.18				2 Day Workshops and Telephone Interviews, April–September 19
No of Participants	10	4				10
Question	Which Business Applications for Sales and Service are relevant to us?	Which negotiation tactic would you like to save your sales colleagues from?				How to bring the negotiation to a good outcome or a bad outcome?
Results	Product Configurator, Showroom and Training Sessions	High Ball/Low Ball (#2), Good Cop/Bad Cop (#5), Snow Job (#4), New Instance (#3) and Salami Slice Strategy (#1)				Intent Categories with 42 Test Sentences

In Phase III "Create Ideas," the identified negotiation situations should be further specified. For this purpose, the "brainstorming" method was selected from the method card set. Within a short period (20 minutes) many ideas for the task were generated and written down on cards. The other design members then enriched existing ideas and expanded their own ideas. The results from phases II and III were then recorded in a screenplay (Lokitz *et al.*, 2018).

Finally, Phase IV "Plus, Minus, Interesting" dealt with the evaluation of the different negotiation situations and the selection of a particularly practice-related setting. The ideas were weighted and prioritized in terms of their implementation. The Salami Slice tactic was selected by the participants as the variant with the highest practical relevance. For this reason, the participants created a screenplay (Figure 2) for the "Salami Slice" tactic. In addition to the description of the performers, possible interruptions, subjects of negotiation and the possible course of a dialogue between the seller and the counterparty (buyer and expert from the department) were presented in order to obtain the basis for the future design of the VR training.

The screenplay was subsequently defined in greater detail. In all, three ECAs were set up as facilitators of the training elements. A coach who does a briefing and debriefing, and the two ECAs "Paul" and "John" – the virtual subject matter expert from the purchasing department and the virtual purchaser. The names "John" and "Paul" are characters from the existing negotiation training. They have been transferred to virtual training on account of their high recognition value. The player controls the conversation in the role of the salesman and faces "Paul" and "John" during the negotiation.

The gamification elements have been defined as follows: Before the game starts, the player is given a selection of typical negotiation items linked to discounts. If the player gives more than a predetermined discount, the trial ends early. If the player tries to negotiate on negotiating items that he is not allowed to negotiate for, the game also ends early. At the same time, the player uses the negotiation styles "dominant," "avoiding," "accommodating," "integrative" or "ready to compromise" that are displayed on the screen. The goal is to apply the most appropriate style of negotiation in the respective negotiation scenario. In the scenario used, an integrative style of negotiation is usually the best option, whereas other

negotiation styles are less effective*. The coach shows the player his style of negotiation at the end of the negotiation (debriefing). The specification of the negotiation game is based on a summation of used intent categories subordinated to the negotiation style model (Voeth and Herbst, 2015).

The three training elements are structured as follows: The virtual briefing is provided by the virtual coach. He describes in advance the negotiation scenario in which the player will be located, as well as the available negotiating items and negotiating limits. The briefing is based on pure information without verbal interaction from the player.

This is followed by negotiation training: The core of this element is the interaction with the two ECAs "Paul" and "John." John and Paul ask their closed question to lead the player through the negotiation phases of entry, dialogue, solution and completion. The phases are based on the model (Voeth and Herbst, 2015). The player's responses were captured at each stage for the final debriefing. A model was chosen according to Voeth (Voeth and Herbst, 2015) to determine the negotiation styles. The negotiating styles were then subdivided into accommodating, dominant, integrative, evasive and willing to compromise. The negotiation styles are subsequently assigned the intent categories to ensure the definition of negotiation styles.

Four debriefing elements were designed for the virtual coach:

- A positive conclusion ("the pitch is won") if all requirements have been met,
- No conclusion ("the pitch was lost") by violating corporate guidelines,
- No completion ("the pitch was lost") by exceeding the permitted number of dominant behaviors,
- Game abort ("the pitch was broken") by violating particularly relevant corporate guidelines.

To develop the dialogues, the participants stated that the VR training should

* It does not address the theoretical considerations for selecting the "best" negotiation. For corresponding designs see Voeth and Herbst (2015).

be conducted from the point of view of a salesperson. The dialogues of the seller were therefore variably outlined and those of the other counterparty were constant. While the variable dialogues required the creation of different intent categories, the constant dialogues remained unchanged. Once the dialogue of the constant counterparty was fixed, participants were asked to describe the salesperson's dialogue once in the best negotiation mode, and once in a poor negotiation mode. The participants described the best negotiating mode as an integrative style of negotiation. The participants described a poor negotiation mode as a constantly dominant negotiation process. The best negotiation and worst negotiation dialogues were used as the initial training elements for the intent categories that were needed in the subsequent build phase. The intent categories "Reject Demand," "Integrative Discount," "Get Overview," "Provide Summary" and "Request Info" emerged from this phase.

While "Reject Demand" was assigned to the dominant style of negotiation, the remaining intent categories were assigned to the integrative negotiation style.

The "Role-play" method was chosen in phase V "Prototype." The design members had to play the resulting screenplay with Playmobil figures to test the existing design. To capture dialogue statements, the scenarios were repeated multiple times with different behavioral instructions. The team was then filmed. The dialogues were subsequently transcribed and used firstly as a template for intent categories in the creation of the dialogue trees and secondly as test sentences for subsequent training of Language Understanding Intelligent Services (LUIS) in the build phase.

In Phase V, 25 test sentences for the integrative intent categories were collected from the Lego role-plays and the first 15 sentences for the dominant intent category.

In Phase VI "Test", the method "Usability Testing" was chosen. In this phase, ten test subjects were asked to bring the prototype to a positive or negative conclusion or to act contrary to the specifications. Previously, each test subject received a 15–20-minute briefing. The test subjects' dialogues were recorded and then transcribed to improve the dialogue trees with further intent categories and then to include the sentences for training purposes of the artificial intelligence using speech recognition. Each dialogue phase of the ten participants lasted between 15 to 25 minutes. After each test round, the test subjects were interviewed in depth about the

fulfillment of the developed criteria. The interviews lasted between 25 and 32 minutes.

As the design team placed great value on capturing natural language, the prototype was integrated into a dialogue tree, which was based on the described grid from the negotiation style and negotiation phase. In the concluding usability test in Phase VI, this dialogue tree was played through several times with different test participants. From the usability test, further intent categories emerged for the subsequent development of artificial intelligence using speech recognition with LUIS. In addition to dominant and integrative intents, accommodating intent categories ("Accept Demand"), evasive intent categories ("Small Talk") and intent categories with comprehension difficulties ("Show Incomprehension," "Request Break" and "Request Repetition") came into play (Figure 1). Overall, 42 additional training sentences were collected for the intent categories in the subsequent build phase.

Designing a Virtual Reality Negotiation Training Innovation with Creativity Methods

Negotiation Phase	Negotiation Points	Dialogue										Dialogue Actor			
		Comment	Integrate	Summarize	Clarify	Others	Request	Accept Demand	Smalltalk	Incomprehension	Request break		Request Repetition		
Emergence		<p>"Thank you for coming to see us today. Since we last spoke, I've had a look at your offer and compared it to the offer another company has made us."</p> <p>John speaks up: "After this meeting, we're not going to continue, we haven't got time for that. We need this machine in 8 weeks' time at the latest. So let's not waste time, let's begin and see what you've got to offer us."</p> <p>The sales rep then breaks working together: "Yes, we would like to work about the challenges and demands of your position as a market leader in the field of food technology for quality for our customers and such like, and in accordance with that I sent you already an offer. I'd like to go through this offer with you now, point by point, so that we can clarify any issues and perhaps meet any special wishes you have. I realize that you are under time pressure so I've also been very concise. However, Mr Paul would prefer to work with our products. Today's negotiation will discuss with me give the correct to send them with for re-negotiation. So, let's take a look at your offer. We've noted that you offer us only twelve months warranty. We were a bit surprised about that - at the start you assured us of the excellent quality of your products! So a warranty can't be a problem for you. Your competitor will give us a warranty of 36 months at no extra cost. Can you offer us anything on this point?"</p>										John Paul			
	Warranty	That might go in favor of the competition	-off	Thanks for summing-up	As regards payment conditions, we're looking for 30 days with 2% early settlement discount. What are your thoughts on that?"	off	Let's get on with the reason we're here. We'll have time for small talk later.	off	Let's get on with the reason we're here. We'll have time for small talk later.	off	OK, sorry. I just had a thing in my throat. Let me repeat my question...	Take your time, John and me will have a coffee meanwhile.	Sure		
Dilemma		<p>John: "As regards payment conditions, we're looking for 30 days with 2% early settlement discount. What are your thoughts on that?"</p>										Agents			
	Payment Conditions	That might go in favor of the competition	off	Thanks for summing-up	Hi... we would like to talk about the delivery period and the price for handling operations with the machine and follow-up costs. Mr Paul, as the head of our lab, think this option is important."	off	Hi... your competitor has given us 30 days to pay. And we got late on the 15th. Because if we pay earlier that period. So.	off	Hi... sorry. I just had a thing in my throat. Let me repeat my question...	off	Take your time, John and me will have a coffee meanwhile.	Sure			
					<p>Let's talk about the next topic: As regards the delivery period, that stands of 4 weeks in your competitor's offer. Can you match that?"</p>										Agents
	Delivery Time	That might go in favor of the competition	off	Thanks for summing-up	We discussed like to talk about the best for handling operations with the machine and follow-up costs. Mr Paul, as the head of our lab, think this option is important."	off	Your competitor is happy with a delivery period of 4 weeks..."	off	Let's get on with the reason we're here. We'll have time for small talk later.	off	Let me repeat my question...	Take your time, John and me will have a coffee meanwhile.	Sure		
Installation		<p>Let's go on with the next topic: We want to have the machine in operation in 4 weeks' time. Is that possible with your offer?"</p>										Agents			
	Installation Time	That might go in favor of the competition	off	Thanks for summing-up	We have just talked about the warranty, payment conditions, delivery period and now...	off	We want to have the machine in operation as fast as possible..."	off	Hi... sorry. I just had a thing in my throat. Let me repeat my question...	off	Take your time, John and me will have a coffee meanwhile.	Sure			
Unraveling Phase I		<p>So, We've gone over all the points we wanted to discuss. But I have to point out that the basic offer is already 35% more than was in the budget. If we take your competitor's offer, we can stay within budget! Can you see your way to moving more in our direction?"</p>										Agents			
		That might go in favor of the competition	off	Thanks for summing-up	Your competitor is offering a complete package - one which is equivalent to your basic offer. So with your competitor, we're within our budget. Your company and mine need to come to some agreement here. What do you think?"	off	Your competitor is offering a complete package - one which is equivalent to your basic offer. So with your competitor, we're within our budget. Your company and mine need to come to some agreement here. What do you think?"	off	Hi... sorry. I just had a thing in my throat. Let me repeat my question...	off	Let me repeat my question...	Take your time, John and me will have a coffee meanwhile.	Sure		
Unraveling Phase II		<p>Don't you think we should try and find agreement now? Why don't you set out your final offer?"</p>										Agents			
		OK, I understand, can you see that we're at a point where we can repair a little in your direction.	off	Thanks for summing-up	If you could give us another 2% discount, if you preferred, could you a technical talk at the end of the year before the year finally.	off	Hi... sorry. I just had a thing in my throat. Let me repeat my question...	off	Hi... sorry. I just had a thing in my throat. Let me repeat my question...	off	Let me repeat my question...	Take your time, John and me will have a coffee meanwhile.	Sure		
Absorption Phase		<p>So with that, we're at the end of our negotiation - we're not going to reach agreement. I'm sorry but the way I see it, the other company's offer is what we're looking for. OK Good - we agree with the changes we've discussed. So, we're in business!"</p>										Agents			

Figure 2. Dialogue tree with phase representation.

The developed VR negotiation prototype is a training element that can be used in sales training and therefore in blended learning. The training element offers the opportunity to illustrate and simulate sales situations. Our validation showed that the VR negotiation training element is not applicable to every user. Rather it focuses on the B2B target group in the complex sales area. The prototype does not form a training element for the business-to-consumer area, as the context is much more complex. Based on a long sales cycle, which is nearing completion, with a further competitor in the pitch, the designed negotiation requires relevant negotiation expertise. The VR negotiation prototype is therefore not suitable for newcomers in the sales area. Basic knowledge of negotiations in general and special negotiation strategies are required. Therefore, basic training prior to the use of this VR application is necessary, as well a personal debriefing carried out by a physical trainer is highly recommended for the training of newcomers. Language was used very differently by the test subjects. Pauses, volume, several intentions per set led to a higher error rate in the understanding between human and machine. Consequently, a technical briefing on how to communicate with the bot should be added prior to the use of the VR application.

The applied tool plays an important role in the development process of the VR prototype. It has significantly supported development with the help of the lead user. A development without the tool would have been possible. The methods used are accessible to all. However, the combination of methods has structured the procedure and thus facilitated the goal management and motivated the participants to come up with creative solutions that would probably not have been possible in a series of conventional business meetings

6. Conclusion

In addition to a report from expert interviews with sales experts on possible areas of use of VR, AR and MR in sales, this scientific paper provides a user-centered option for implementation in the form of a VR negotiation prototype with the support of creative techniques and final validation. The paper is intended as a guide for practitioners who are faced with the task of developing VR training. For scientists, the paper offers a possible approach to the design of VR negotiation training elements with the involvement of lead users. It is safe to say digitalization is all-pervading and should not be discarded as a disruptive game changer removing the entrenched negotiation wisdoms. Moreover, we should welcome VR, AR and MR as

adjuvant training options to enhance the competence building process in contemporary negotiation management.

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THE RISK OF BEING POOR IN DIFFERING SOCIAL CLASSES OF THAI HOUSEHOLDS

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Abstract

This study aims to analyze the poverty situation in Thailand using SES 2017 data. The risk of Thai households being poor is explained by three FGT (1984) poverty indices: headcount ratio; average normalized poverty gap; and average squared normalized poverty gap. The analysis includes poverty decomposition by social class. The definition of the relative poverty line is 60 percent of the average median income (USD 133.82). The results show that the average headcount ratio of Thai households is 0.244, the poverty gap is 0.079, and the average squared normalized poverty gap is 0.068. Poverty decomposition estimation results indicate that the landless farmer class has the highest risk of being poor, and the professional class has the lowest risk, 0.484 and 0.042 respectively. The fiscal burden is approximately 1,171.89 million dollars per year if the government gives money to those poor people to raise their income to the poverty line. Land allocation policy may benefit landless farmers who need the most help from the government. The smart farmer policy is a rapid policy that the government should implement to enhance farmers' skills.

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Keywords: *poverty; risk of being poor; social class; Thai household*

1. Introduction

Eliminating poverty and hunger is an important sustainable development goal (SDG), which countries all over the world have set. The Thai government has established a key development strategy called "Thailand 4.0" and inclusive policies to accelerate the Kingdom's growth to a more advanced level. Many works of literature present evidence that poverty incidence responds firmly to economic growth. Also, the Asian Development Bank reported that income growth has a strongly positive effect on poverty reduction (Deolalikar, 2002). Thailand's annual growth was about 3.5 percent on average during 2011–2013 and paced up to 3.66 percent on average from 2015 to 2018. In recent years, household income declined due to economic downturns, and the poverty rate increased from 7.2 percent in 2015 to 9.8 percent in 2018. The absolute number of those classified as poor increased gradually, especially in the South (World Bank, 2020). Millions of Thai people face the risk of being miserable due to many reasons such as educational disadvantage, lack of capital and arable land, working in the informal sector with an unstable income, and inaccessibility of social security.

The purpose of this study is to analyze the poverty situation in Thailand using Socio-Economics Survey (SES) 2017 data conducted by the National Statistical Office in Thailand. More specifically, this paper aims to study the probability of households having an income lower than the poverty line, and also to study the factors that cause poverty. This study introduced an income threshold approach or a relative median income threshold as a poverty indicator. The European Union, the UK government, and many countries use 60 percent of median household income as a relative poverty line (Mack, 2016). In this study, the poverty line is also defined as 60 percent of the median household income, which is different from the usual poverty report in Thailand. The poverty situation reported by the Office of the National Economic and Social Development Board (NESDB) was based on the absolute poverty line, which was calculated from the minimum food consumption (food line) and essential goods consumption (nonfood line). The poverty line indicates the minimum requirement of goods and services for a person to survive. In the year 2017, the poverty line in Thailand was

USD 87.77 per person per month, and from this poverty line, the poverty headcount ratio was 7.87 percent, and the poor in the country numbered 5,325,000 people (NESDB, 2019).

2. Methodology

Three poverty indices from the Foster, Greer, and Thorbecke (Foster *et al.*, 1984) class were used as a tool for this study. Consider a population of persons (or households), $i = 1, \dots, n$, with income y_i , and weight w_i . Let $f_i = w_i/N$, where $N = \sum_i w_i$. In what follows, all sums are overall values of whatever is subscripted. When the data are unweighted, $w_i = 1$ and $N = n$. The poverty line is z_i for each i , and the poverty gap for a person i is $\max(0, z_i - y_i)$. For the common poverty line case (1) above, $z_i = z$, all i . Suppose there is an exhaustive partition of the population into mutually exclusive subgroups $k = 1, \dots, K$. The FGT class of poverty indices is given by

$$\text{FGT}(a) = \sum_i f_i l_i \left(\frac{z_i - y_i}{z_i} \right)^a, \quad a \geq 0,$$

where $l_i = 1$ if $y_i < z_i$ and $l_i = 0$ otherwise.

FGT(0) is the headcount ratio (the proportion of poor); FGT(1) is the average normalized poverty gap; FGT(2) is the average squared normalized poverty gap. The larger a is, the higher the degree of poverty aversion. It is a sensitivity indicator of large poverty gaps.

3. Empirical Study

The absolute poverty line that NESDC used to explain the poverty situation in Thailand is quite low. In 2017, the national poverty line was USD 87.77. The absolute poverty line does not take into account access to sanitation, water, and electricity and what effect that has on the quality of life. Meanwhile, the expenses per capita per month calculated from the Socio-Economics Survey (SES) data is USD 269.12, and the median income per capita per month is USD 199.50. Therefore, if people have incomes equal to the poverty line or slightly higher, which is considered to be beyond the poverty level, they might not have enough income to cover their expenses. So, the poverty line and poverty gap indicators should be re-examined. In this study, researchers used a relative poverty line to analyze the poverty situation in Thailand. Besides, if SES data shows that the median income per capita per month is USD 224.54, then the poverty line at 60 percent of median income per capita per month is USD 134.73. The calculation of the

poverty indices, according to FGT(a), is shown in Table 1. The results indicate that the headcount ratio is 22.4 percent, the poverty gap is 7.9, and the chances of poverty gap increase are 6.8 percent.

Table 1. Foster-Greer-Thorbecke poverty indices, FGT(a).

a=0	a=1	a=2
0.244	0.079	0.068

FGT(0): headcount ratio

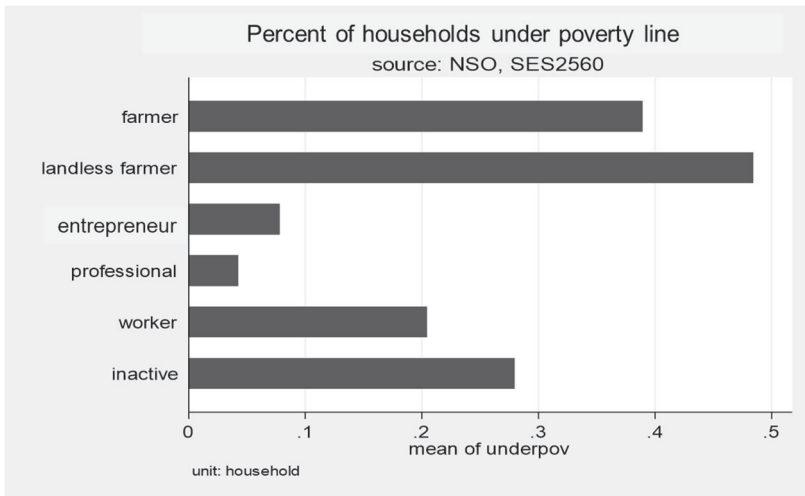
FGT(1): average normalized poverty gap

FGT(2): average squared normalized poverty gap

Moreover, the decompositions of poverty indices by population subgroups are essential for policy implementation. Poverty decompositions by subgroup are useful for providing poverty profiles at a point in time, and for analyzing secular trends in poverty using shift-share analysis (NESDB, 2019). For targeting the poor precisely, researchers categorize the social classes into six groups according to occupational group: farmer, landless farmer, entrepreneur, professional, worker, and inactive worker. The results of poverty decomposition by subgroup using the FGT(a) analysis are shown in Table 2. FGT(0) is the headcount ratio in each occupational group. The average headcount ratio is 24.4 percent, and the risk of being poor for a landless farmer, farmer, and an inactive worker is above average at 48.4, 38.9, and 27.9 percent, respectively. The groups with less risk of being poorer than average are the professional, entrepreneur, and worker groups. The professional group has the least risk of being poor. Most of them have a full-time job, a regular salary, and high human capital. The professional group has the highest years of schooling, as shown in Fig. 2. Next is the entrepreneur group. FGT(1) is the poverty gap of each subgroup. The average poverty gap of a landless farmer is the highest among subgroups, followed by a farmer and inactive workers.

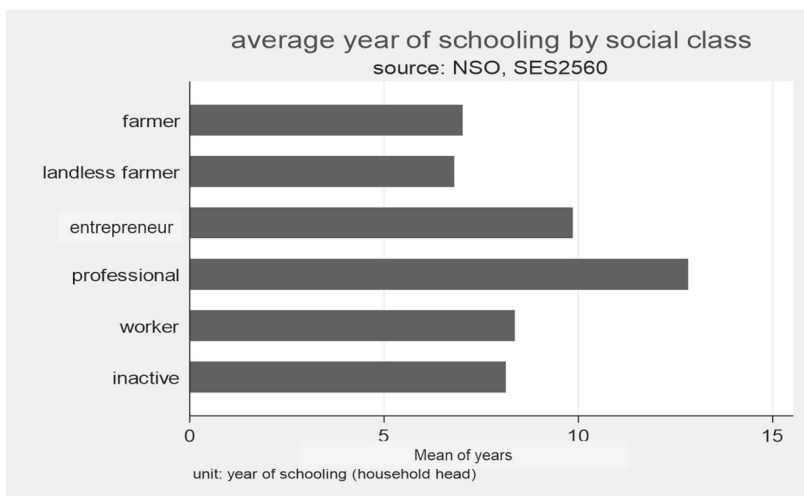
Table 2. Risk of Being Poor of Social Classes.

Social Class	a=0	a=1
Farmer	0.389	0.135
Landless Farmer	0.484	0.175
Entrepreneur	0.078	0.050
Professional	0.042	0.011
Worker	0.204	0.054
Inactive Worker	0.279	0.093
Average	0.244	0.079



Source: Calculation based on SES data 2017.

Fig. 1. Households under the poverty line by social classes.



Source: Calculation based on SES data 2017.

Fig. 2. Average years of schooling by social class.

4. Conclusion and Policy Implication

This study illustrates the risk of being poor in social classes in Thailand. The dataset for the analysis is from the Socioeconomic Survey 2017, which was conducted by the National Statistical Office. The poverty indicators in this study were calculated from the relative poverty line, which is 60 percent of the median income per capita per month. The social classes are categorized into six subgroups, which are farmer, landless farmer, entrepreneur, professional, general worker, and inactive worker. The landless farmer group seems to suffer from the risk of being poor the most followed by the farmer group. These two groups have less education than other groups. Their occupation has to face unstable conditions such as the weather. The inactive worker group also has a higher risk of being poor than the average. This group includes retirees and unemployed workers. Some of them have money transferred from the government. The professional group has the least risk of being poor because they have higher human capital than other groups. They have full-time jobs with a salary. Also, the entrepreneur group has less risk of being poor than average. They have the capital to invest and earn a high income.

The government should have a targeting policy for the poor, especially the landless farmer and farmer groups. The policy of land ownership distribution could help the landless farmer and also a compensation policy for unexpected conditions. Educational promotion for the educationally disadvantaged group may help them earn a higher income.

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RETHINKING THE SPECIFIC ROLE OF YOUTH BUSINESS COMPETITIONS IN PROMOTING ENTREPRENEURSHIP IN DEVELOPING COUNTRIES

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Abstract

Business competitions are an emblematic instrument of entrepreneurial education. In developing countries, great hopes are placed in these competitions to promote entrepreneurship among young people, even if the question of transferability of the values underlying them arises. The scope of this article is thus to clarify the specific role that entrepreneurial competitions should play in developing countries in order to be more effective with young people. To do so, we mobilize Callon and Latour's (1981) sociology of translation as a theoretical framework. The exploratory qualitative study we led among participants in an entrepreneurial pre-competition in Tunisia shows that convergence between stakeholders is mainly created by operative business tools, without cultural meaning and purposes of entrepreneurship being clarified. In addition, experts and coaches tend to prioritize team and value-proposition-centered approaches, while accompanied young people seem more deeply concerned about the impact they could individually have on the community. Consequently, the effectiveness of entrepreneurial competitions with youth could be improved by reducing this mismatch and encouraging educational, institutional and business accompaniers to develop more person-centered approaches.

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Keywords: Youth; entrepreneurial education; entrepreneurial competitions; venture creation; Sociology of translation; Tunisia.

1. Introduction

Since the end of the 1990s, entrepreneurship has gradually become a strategic issue for societies, and entrepreneurship deficit a public problem that authorities must solve (Chambard 2013). As a result, a transnational rhetoric has developed at the highest political levels, presenting entrepreneurship education as a depoliticized, logical and even obvious response to the context of economic crisis and widespread competition (Starck 2017). The entrepreneurial issue then became an unavoidable and legitimate dimension of public policies, and educational institutions were strongly mobilized in the service of developing the attractiveness of business creation (Chambard 2013). Hence the generalization of entrepreneurial education.

According to the English-language literature, entrepreneurial education has three main objectives: acquiring general knowledge related to business and economic value creation (Entrepreneurship Education); providing learners with the specific skills needed to create and run their own business (Small Business Education); developing general skills that can be useful in many work and life situations (Pepin 2011). In Francophone literature, these aims generally correspond to two families of objectives: developing the “enterprise spirit” and developing the “entrepreneurial spirit” (Léger-Jarniou 2008). The entrepreneurial spirit development is then expected to support the enterprise spirit over time (Stark 2017).

Among the formative tools for entrepreneurship, business competitions undoubtedly constitute the most familiar, popular, standardized, and mobilizing tool (Starck 2017) and worldwide it is hoped that they will promote youth entrepreneurship. However, their effectiveness with young people remains questionable, especially in developing countries. In such contexts, entrepreneurship is a real challenge for social change, and it is important to develop adapted levers and instruments for its promotion so that it resonates with young people.

So, our research issue is the following: How can the effectiveness of entrepreneurial competitions be improved so that they engage young people in entrepreneurship in developing countries? More precisely, we aim to

clarify the specific role these competitions should really play, so that they become impactful on venture creation by young people in these countries. Our research proposition is that the main role of these competitions should be to align the different actors involved in the running of these competitions with the same (cultural) meaning of entrepreneurship so that it becomes easier for young people to project themselves into entrepreneurship and engage in it.

To research this, after the introduction (1), we will review the literature on entrepreneurial competitions (2) and set out our theoretical framework, which is Callon and Latour's (1981) sociology of translation (3). Our empirical research will consist of an exploratory qualitative study with participants in an entrepreneurial pre-competition held in Tunisia (4). The study will be closed with an in-depth discussion of the results and their theoretical and practical implications.

2. Literature Review

Youth business competitions are considered as one of the flagship instruments related to entrepreneurial education deployment. They can be at all levels, subject areas and disciplines, around free or specific themes, with individuals or teams. Adopting the logic of project-based training (Starck 2017), they are an opportunity to synthesize and operationalize several purposes of entrepreneurial education. Besides, they provide nascent entrepreneurs with opportunities for networking, financing and investment (Thomas *et al.* 2014).

An entrepreneurial competition allows participants to experiment with what is at the heart of the transition to entrepreneurial action, namely preparing a creative and coherent project within the allotted time according to an agreed framework in the business world, and convincing potential stakeholders who serve as a jury.

Thus, it is an intense, immersive experience that highlights business creation's challenges and constraints (pressure of time, others' expectations, opportunity identification and value creation, operational functioning of the future company, problem solving), and its most exciting aspects (success, entrepreneur's achievement). It is therefore an area of discovery of the business world and entrepreneurial socialization, and a privileged framework for developing an entrepreneurial mindset, gaining experience and learning.

Competition participation experience is supposed to have immediate outcomes (knowledge, attitudes and capabilities acquisition), and longer-term outcomes (mobilization and development of the acquired attributes) (McGowan and Cooper 2008, 36; Watson 2016).

The main characteristics of entrepreneurial competitions (often considered to be their main assets) lie in:

- Polarization of the reflection on functional and operative dimensions: the activity of stakeholders is led towards a goal to be achieved (productive dimension) by involving participants in their own training (constructive dimension). The heart of thinking is then moved from "why" to "how-to-do" issues, thus avoiding controversy (Starck 2017).
- Standardization of implementation and practices (Starck 2017): the "Business plan" is a centerpiece of the entrepreneurial competition experience (Schwartz *et al.* 2013). Its production is almost ritualistic (Honig 2004), as are its oral presentation "codes" and assessment modalities.
- Plasticity of sense: it has multiple meanings for the various participating actors (Starck 2017).

These characteristics probably explain the enthusiasm for entrepreneurial competitions as a privileged instrument of entrepreneurial education.

However, in addition to growing skepticism towards the business plan as a formative and structuring tool for entrepreneurship, there is a lack of empirical evidence regarding the impact of these competitions on young people (Schwartz *et al.* 2013), especially in terms of engagement in venture creation. Therefore, the role of these competitions needs to be rethought (Watson 2016) insofar as they have become above all a privileged means of institutional communication for various economic, institutional and educational actors, rather than impactful formative frameworks.

This is all the truer in many developing countries since the dominant values in these countries (collective achievement models, conformism, avoidance of autonomy, fear of risk and failure) are not conducive to entrepreneurship. For example, in the Moroccan context, Chapus (2018) has shown how entrepreneurial competitions have become a means for participants to acquire symbolic capital (recognition, legitimacy) without this capital being converted into economic capital (effective company creation). Thus, by the

"paradigmatic" changes they bring about, entrepreneurial education and its tools can be likened to a cultural revolution (Chambard 2013) in these implementation contexts. Their discontinuity compared to usual/traditional practices (Djellal and Gallouj 2012), and the need to adapt them to the uniqueness of the context (Richez-Battesti *et al.* 2012) make it possible to approach them as a social innovation process.

3. Theoretical Framework: Callon and Latour's (1981) Sociology of Translation

Two visions of innovation are often opposed: the diffusionist vision which considers that completed and quality innovations are diffused through a communication process (Rogers 1995; Havelock 1969), and the constructivist perspective which views innovation as a translation process that results in the construction of innovation meaning by members of a social system.

As for promoting entrepreneurship, especially through entrepreneurial education, the dominant rhetoric and practices reveal a diffusionist approach (conveying entrepreneurial values, approaches and tools from developed countries to developing ones). But this dominant conception has shown its limitations in terms of effectiveness because its "universalist" discourse and tools do not make sense in all cultural contexts of implementation. Thus, the built character of entrepreneurship is increasingly accepted, and a constructivist reading of social change processes through entrepreneurship can therefore prove to be more realistic.

The translation model (Callon and Latour 1981) makes innovation a process of social construction through which new knowledge is "translated" for different actors in order to federate them around a shared meaning of innovation, possibly by redefining/re-conceptualizing it. This is achieved through a series of round trips, interactions and meaningful negotiation operations with these actors. It will allow innovation to move into different environments and produce effects there (Akrich *et al.* 1988). The process ends when the expanded network thus formed stabilizes and converges on the meaning of innovation, in other terms when actors are aligned by translation (Callon 1991, 212). Given the number of actors and intermediaries in this process, human and non-human spokespersons are appointed to bring the perspectives of actors and social groups.

Entrepreneurial competitions can be considered as one of the most emblematic tools of entrepreneurial education (non-human spokespersons), whose ambition is to introduce new resources and realities (social change) for young people and all the economic, social, educational and institutional components that surround them. This spokesperson must therefore be legitimate and reliable (Akrich *et al.* 1988), and really contribute to strengthening ties between actors (Callon and Latour 1991). The translation must engage actors in action and "not generate a misuse of meaning" (Amblard *et al.* 1996, 135).

However, in many developing countries, there has often been a misuse of the meaning and purposes of entrepreneurial competitions. These have mainly become a networking and institutional communication space, and a playful and not-engaging framework for most participating youth. Beyond learning certain strategic and technical skills which will rarely be converted into entrepreneurial intentions and commitment to business creation, these competitions should therefore be an opportunity to make entrepreneurship culturally accessible to different categories of actors (young people, educators, experts, administration, support and funding structures), allow a mutual understanding of reasoning patterns of each other and align them with a shared meaning of entrepreneurship in context (the cultural meaning of value creation, type of entrepreneurship activities and projects that make sense to young people and coaches, sizes of companies). For example, it would be useless and disappointing for young people to encourage them to be innovative and creative if their projects were evaluated by cautious appraisers; it would be pointless to go into very sophisticated approaches in terms of value creation models without the potential partners being able to join.

Hence our research proposal: the main role of entrepreneurial competitions in developing countries is to align participants with a situated and shared vision of entrepreneurship.

4. Empirical Evidence from a Study in Tunisia

This part will be structured as follows: after a quick overview of the Tunisian context, we will present our methodology, describe the studied entrepreneurial competition and finally report the results and discuss them.

4.1 Overview of the Tunisian Context

In Tunisia, promoting entrepreneurship among young people has become a priority. Entrepreneurship education was gradually generalized from the end of the 1990s. It constituted a significant state investment with a view to reducing unemployment among higher education graduates. It has been expanded by setting up business incubators in universities from 2001 and by a major support and financing mechanism for business creation dedicated to higher education graduates in 2005. In this context, an impressive number of youth business competitions have been organized by various structures (universities, Higher Education Ministry, banks, foundations, NGOs, companies, support structures). However, we can question the effectiveness of these competitions in view of the persistence of students' and graduates' preferences for salaried employment, even if they remain particularly exposed to long unemployment (Dhaoui 2016, 100). Young people have very little presence in the creation of new companies and the management of enterprises (ITES 2018)*.

Actually, entrepreneurship education has been grafted onto an educational and university system characterized by a very vertical relationship to knowledge, strong disciplinarity and lack of transversality. Moreover, in Tunisia, young people are generally over-protected and hyper-assisted by their families (Touzani *et al.* 2015). They tend to reproduce the success models favored by their elders (search for security and established positions; preference for typical jobs in the public service) and to delay the deadline for entering professional life by extending their studies. They prioritize values of immediate well-being and conformism and do not recognize themselves using Western achievement values (individualism, autonomy, willingness to achieve) that often correlate with entrepreneurship (Taktak-Kallel 2012). Furthermore, there are no strong entrepreneurial traditions, nor an industrial/innovation culture in Tunisia. Thus, entrepreneurship experience is quite limited and big difficulties are associated with business creation. All these factors explain youth reluctance to start a business.

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4.2 Methodology

This is qualitative-exploratory empirical research. The research strategy is the exploratory case study (Wacheux 1996) with a comprehensive aim (Hlady-Rispal 2002). The study deals with a unique case. It aims at “understanding the functioning of a phenomenon through a dive into its constituent elements” (Mucchielli 2007). It deals with a pre-competition bringing together the main stakeholders (young students and members of student associations who have already participated in youth entrepreneurial competitions, trainers and coaches, representatives of support and funding institutions). This “boot camp” is a preparatory session in Tunisia for a major international student entrepreneurship competition. It is supposed to reproduce the dynamic that starts between the participants and the approach and spirit of the competition itself (in terms of gathering participants, coaching approach, project assessment criteria). As a reminder, our goal is to understand the specific role an entrepreneurial competition should play with young people to get them on the path of business creation. Our approach is both inductive in the sense of Merriam (1998) (listening to the emerging reality of this case, discovering and interpreting) and deductive in the sense of Yin (1994) (testing our research proposal).

Since we were part of this event as a professor and coach in entrepreneurship, our posture is that of observant participation that “suggests the preponderance of participation over observation and signals the transition from ‘pure participation’ to observation by a ‘conversion to research’” (Soulé 2007). We participated in all the activities of the team to which we were assigned (step-by-step shaping of the customer value proposition, oral presentations, debriefings), experienced the team's operating challenges and also observed and noted the progress of the pre-competition and the interactions between the participants.

In addition, after four days of teamwork, we had in-depth interviews with nine participants. We approached them with an interview guide. The latter “includes a list of themes that must be addressed during the interview” (Evrard *et al.* 1997, 99). The addressed themes were: 1/ Participants' conception of entrepreneurship, 2/ How do they view the role of entrepreneurial competitions, and 3/ Whether they consider that lack of convergence among participants on the meaning of entrepreneurship is positive or negative. The responses have been fully transcribed and the data manually processed. To analyze the data collected, we used thematic content analysis which consisted of selecting and extracting information likely to answer the research issue and interpreting it.

4.3 Description of the Event and its Progress

This was a five-day "boot camp" organized by Open Startup Tunisia as part of its new program, OSTX. This program is aimed primarily at encouraging entrepreneurial intentions and innovation among young people and contributing to the creation of a pool of start-ups from the university, by focusing on interdisciplinary dynamics in universities. The participants in the boot camp (35 teachers and students) were trained by international trainers. The objective was to set up a task force that will train and coach the students of the three pilot universities of Tunis who will participate in the first edition of the OSTX competition. The finalists will be integrated into the OST preincubation program. The OSTX program is the result of a public/private partnership between Columbia University, the Tunisian Ministry of Higher Education, the United States Embassy, the BIAT Foundation for Youth and several other preincubation, incubation and financing structures.

The students were from different age groups and institutions, active members in associations and pre-incubators; most of them had already participated in entrepreneurial competitions, some in the area of social and solidarity entrepreneurship. The event was held in English.

The event started with a presentation of each participant. Then there was a team-building event and teams were formed. Each team, made up of students and teachers, represented their university. Then, thinking began about how youth and coaches who will participate in the final competition will be mobilized. The heart of the boot camp's running was the Design-Thinking approach. It was expected to result in modeling a business proposition (team, current problem, customer, value proposition, an idea for a solution, product, how does it solve the problem, validation by customers' interview and main learning, next steps and needs). After each step, there was an oral presentation and a debriefing for each team. The same approach will be followed in the competition itself. So, the main focus was making heterogeneous teams shape valuable offers by acquiring a customer-driven approach.

4.4 Main Results

As for the vision of entrepreneurship among the interviewees, responses showed a diversity of views. Some focused on entrepreneur's motivations and behaviors, others on innovation, market, value creation and impact on

society, and others on the importance of networking and/or operational aspects. Some focused on the "How-to-do" side and others on "For-what" issues. Illustrations:

Respondent 1 (female, an expert from Columbia University Entrepreneurship) said: "An entrepreneur is someone who is dissatisfied with their situation and status and wants to change it. He is someone who solves problems creatively."

As for **Respondent 2** (male, a young coach): "Entrepreneurship is that you can do a project to touch something that has not been exploited yet (a new target for example) or to achieve a target in a new way. An entrepreneur does not make a project to make money, but above all to have an impact (on society, consumers, other businesses) more than the others."

Respondent 3 (male, co-founder of a company and young coach) argues: "Entrepreneurship means meeting with the right people and being able to divert/ circumvent difficulties to seize opportunities. To create order and generate value, you have to meet the right people. Then there are the other operational sides. The objective is not clear or frozen, it clarifies with time. The flexibility to deviate from the original purpose or to clarify it must exist. There is a lot of disorder and so you have to persevere without being rigid."

Respondent 4 (male, a company's young co-founder with Respondent 3) focused on the importance of perseverance, with flexibility on goals.

Respondent 5 (female, business school student and an active member in a student club) emphasizes the social purpose of entrepreneurship, namely providing a solution to graduate unemployment and "allowing fresh graduates to have a life."

For **Respondent 6** (female, digital economy student and an active member in a student club): "Entrepreneurship is the art of combining creativity, efficiency, right decisions and productivity to achieve certain projects and goals."

Respondent 7 (male, consultant and expert from Columbia University) said: "Entrepreneurship is a team that solves a problem. You need a team even if one person has the idea."

Respondent 8 (male, business school student) put forward a very academic definition of entrepreneurship: "Entrepreneurship is a group of people who start a business, have an idea and will market a product created according to the needs of the market. They must develop several strategies including the marketing strategy. Everything must be planned before the design of the company. We must first target the Tunisian market and then internationalization."

Respondent 9 (female, economics student) insisted on qualities like creativity, passion, vision and devotion to achieve something.

It should be noted that the figure of the entrepreneur with a strong impact on the community returned in several responses (it came up in the responses of three young interviewees, namely respondents 2, 6 and 9). This seemingly inspiring entrepreneur model echoes McClelland's (1961) need for achievement and needs for belonging and power over the community, shown by this author as the most powerful motivations to undertake.

As regards the participants' views on the role of entrepreneurial competitions, the interviewees seemed to unanimously value entrepreneurial competitions, and the contribution of these competitions seemed to go without saying for them. Only Respondent 6 said: "*Business competitions are a way to test her creativity, to see if the idea of a project can really have an impact in Tunisia.*" She thus expressed a strong expectation in terms of a high impact project in its specific context.

As for divergence in views with regard to the meaning of entrepreneurship, most of the respondents did not perceive this divergence as a disadvantage, except for one respondent (Respondent 5 who is a Master's degree student, elder of the youth participants, an active member in a student club and has participated in many entrepreneurial competitions). She said: "*Yes, and actually it could be a very good tool to create a different vision that contains all the visions to benefit from all of them.*" Apart from her, divergence in views was seen as a source of mutual enrichment and a major asset of entrepreneurial competitions rather than a problematic issue. Thus:

For Respondent 1 (Expert), "*It makes the teams stronger and richer.*"

Respondent 2 (young coach) said: "*For example, a coach pushes me to think in terms of profit and sustainability of the company, and I open up her perspectives with my ideas, vision and own conception of entrepreneurship.*"

Respondent 6 (student) stated: *"If the coach or the assessor thinks there is a problem with the productivity of my future project, he must tell me."*

Respondents 8 and 9 (both students) thought that, despite diversity, the goal is the same: *"It is about creating. At the end of the day, what matters is to market and make money. So you have to work"* (Respondent 8); *"It is about making money"* (Respondent 9).

4.5 Discussion

The pre-competition was designed to bring out interesting and realistic value propositions around which youth business projects will be designed. This approach allows potential entrepreneurs to make important learning and avoids polemical aspects (why undertake, what means of undertaking for participants, what types of entrepreneurship we are talking about) since the heart of the competition focuses on the "How-to-do" side (identify valuable offers through Design-Thinking process). In addition, one can consider that youth exposure to such an international event brings them openness, diversity, tolerance and ways of thinking "outside the box." However, we can note from the discursive registers of the interviewees that they do not always speak about the same realities when speaking about entrepreneurship. Neither do they have the same implicit referents in terms of prioritized values, attitudes towards risk-taking, and propensity for technological innovation. What stands out in particular from the responses is that experts and coaches, while recognizing the importance of the entrepreneur, seem to take for granted the existence of entrepreneurial attributes among young people and favor approaches centered on projects and teams. Whereas young people rather tend to place themselves on the register of motivations and aims of entrepreneurship and seem to have strong motivations to be recognized as individuals.

As a result, young participants certainly acquire a solid, sophisticated and attractive approach to project study, but they will not be able to mobilize outside the formative circles. This is mainly because they are too far removed from the entrepreneurial realities they perceive in their immediate environments, and it is not inspiring enough to speak to them in terms of "For-what" and allow them to identify with entrepreneurs.

Consequently, for most youth who take part in entrepreneurial competitions, these mainly remain a playful framework that does not engage them in action. In fact, a number of young people have become "serial participants"

in such events. So, at most, these competitions can be assimilated to an area of approximate entrepreneurial socialization as their learning is rarely converted into venture creation.

5. Conclusion

The purpose of this contribution was to clarify the specific role entrepreneurial competitions should play in effectively promoting venture creation among young people in countries with no strong entrepreneurial traditions like Tunisia. Considering that entrepreneurship could be seen as an important lever of social change in such a context, we mobilized the constructivist framework of Callon and Latour's (1981) sociology of translation. We phrased the research proposal that entrepreneurial competitions in developing countries should bring together youth and various stakeholders from education, business and institutional worlds around a situated and shared meaning of entrepreneurship. The empirical study conducted as part of an entrepreneurial pre-competition in Tunisia revealed, in particular, very heterogeneous conceptions of entrepreneurship among participants, without this divergence being considered as a disadvantage. From this point of view, our research proposal was invalidated.

However, a closer reading revealed a mismatch between the approaches of the coaches (rather team and value-proposition-centered), and youth expectations (they are searching for exciting achievement perspectives, which logically require more person-centered approaches). Following Shapero and Sokol's (1982) entrepreneurial event formation model, coaches tend to work on feasibility perceptions of starting a business, while there is still a lot to do in the level of perceptions of an entrepreneurial act's desirability.

In terms of operational implications, this means that the effectiveness of entrepreneurial competitions could be improved by reducing the gap between experts' preferred approaches and young people's aspirations (to be well listened to and valued as individuals). Coaching approaches and tools should then be more responsive to youth, in order to allow them to project themselves as impactful future entrepreneurs. For example, this could be achieved by intensive exposure of the young participants to inspiring local entrepreneurs who would act as coaches and mentors.

The study also opened up a culturalist theoretical perspective which it would be interesting to deepen, to see whether the observed trend with regard to young people's expectations is the manifestation of a cultural trait. In Tunisia, which is a collectivist culture, young people possibly want to emancipate from others, and creatively assert and prove themselves as individuals.

Despite the limitations of this study, most of which are those usually associated with qualitative studies (small sample, lack of heterogeneity in the profiles of respondents, significant interpretative biases and difficulty of generalization), we hope to have opened up a perspective that would benefit from being extended to other cultural and institutional contexts, in view of the importance of entrepreneurial education and its instruments today.

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SPORTS TOURISM MANAGEMENT PROGRAMS ON ENHANCING FOR COMPETITORS AND THE AUDIENCE ATTENDING TRIATHLON EVENTS IN THAILAND

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Abstract

The purposes of the study were to develop sports tourism management programs to enhance the events for competitors and the audiences attending triathlon events in Thailand and to assess the differences between expectations and satisfaction toward sports tourism management programs. This study was conducted in three stages, as follows: (1) data analyzed and synthesized from related documents, then program created and the sports tourism management programs justified by five experts; (2) the seven components tested with thirteen programs by pilot study; (3) the programs evaluated. Data were analyzed using descriptive statistics and the Modified Priority Needs Index (PNI modified).

The research showed that the sports tourism management for the competitors and audiences attending triathlon events comprised thirteen programs. All participants had higher satisfaction scores than expectation scores in all programs. Moreover, PNI modified analysis showed that the top five rankings from high to low were: Program 4: Choosing in tourism program (.31), followed by Program 7: Budget accommodation (.25), Program 6: Luxury accommodation (.24), Program 3: Tourism in special interests (.21), and Program 5: Travel expenses (.19), respectively. It could be concluded that sports tourism programs could increase the number of competitors and audiences and enhance the event to give more comfort and

convenience to participate in the triathlon event.

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Keywords: *sport tourism management; triathlon event; enhancing program*

1. Introduction

Sport is one of the largest and most significant industries in the world and many people around the world are involved, it is also a common factor for creating a passion for tourists (Taleghani and Ghafary 2014). Sports tourism comprises various adventurous outdoor activities such as rafting, river trekking, rock climbing, mountaineering, sea kayaking, and paragliding, and this industry has grown substantially in Thailand. Also, it is a niche market, which is broadly described as a tourism activity generated by participation in sporting activity. That activity can be a sporting event or competition, a tour of a sporting facility, or a training camp. Participation might involve being a competitor/participant, official, or spectator. It is generally recognized that there are three types of sport tourism, being Sport Event Tourism, Active Sport Tourism, and Nostalgia Sport Tourism (Gibson 1998).

Triathlon events are unique settings to explore sport development as they are made up of three well-established single sport disciplines – swimming, cycling, and running. Triathlon has developed independently as a sport, that is, it does not share or align with any of the nations from the single sport disciplines, nor does it align sport development practices with them (Bentley *et al.* 2002).

With excellent facilities, modern infrastructure, renowned hospitality, and value for money, Thailand attracts hundreds of thousands of sports tourists every year. The past decade has seen a dramatic increase in the number of large-scale sporting events in Thailand, the majority of which take place in and around Bangkok. Running races, golf tournaments, triathlons, conventions and the like not only attract thousands of participants, they also commonly attract large numbers of spectators and friends and relatives of those participating in these events. The benefits of sports tourism are various, such as participants in sporting events are likely to arrive in the country a few days before a given event and stay after the event to recover. Sporting events are also increasingly seen as social events, so it is not

uncommon for an entire family or a group of friends to plan a holiday around a particular event (The Sponsorship Experts, 2018).

Event sports tourism (EST) has become an especially important economic sector and is increasingly so, it is attracting more tourists, media, and investment for the host communities and many local areas/regions and states have identified the expenditures by visitors as a potential source of economic or employment growth (Lin and Lu 2017). The Tourism Authority of Thailand (TAT) under the Ministry of Tourism and Sports (MOTS), therefore, is well aware of the benefits of a thriving sports tourism sector, also the Minister of Tourism and Sports unveiled plans to turn Thailand into a sporting hub (The Sponsorship Experts 2018).

The triathlon in Thailand has come to depend on TTF (Thailand Triathlon Federation) for the delivery of its events, and to play a key role in the development of the sport, at least at the elite level. As the researchers are involved with triathlon both in Thailand and abroad, they found that there were no sport tourism programs during the time of the triathlon competition in Thailand. Triathlon competition events need more recreational activities to enhance them for competitors and audiences attending the events in Thailand. The TTF as an organizer of the triathlon competition events also wants them to meet the needs of triathletes for both the competition services and the facilities.

Besides, this study applied the service marketing theory of Booms and Bitner (Booms and Bitner 1981) as a strategy for developing sport tourism programs for triathlon events in Thailand. The seven Ps of Marketing are Product, Price, Promotion, Place, People, Process and Physical evidence. Meanwhile, triathlon competition events require and get involved with public spaces including roads, water reserves, and public parks for the staging of events and services, *e.g.*, transportation, hotels, food and beverages, and tourist attractions.

Therefore, this study would like to develop sport tourism programs for extra services combined with triathlon competition events to create incentives and to make triathlon competition events more interesting. Yet, this study focused only on the sport tourism programs and not the competition because the competition has a standard race system. The triathlon tourism programs are the programs that facilitate the triathletes and spectators to have more fun and enjoyment during the events. Besides, they can generate income in Thailand in many dimensions. The programs can connect cooperation from many agencies together and bring income to the local people. This can lead

to the creation of careers and can create an understanding of the context of sports tourism for sustainable development.

2. Method

The study was conducted in three phases, (1) data were analyzed and synthesized from related documents, then the program was created and the sport tourism management program justified by five experts; (2) the seven components with thirteen programs were tested by pilot study (3) the program was evaluated. The details were as follows:

Phase 1: develop the sport tourism program.

1.1 Analyzed and synthesized data from related documents, *e.g.*, journal articles, theses, and textbooks.

1.2 Draft a sports tourism program for triathlon in Thailand based on the service marketing mix (seven Ps) – product, price, promotion, place, people, process and physical evidence, and the questionnaire for evaluating the satisfaction and expectation of the participants in the triathlon competition.

1.3 Justify the sport tourism program by five experts who are knowledgeable and capable of tourism management, sports, recreation, and marketing with at least five years' experience.

The content validity and reliability of the programs and questionnaire were the following: the content validity index of the thirteen sports tourism programs with seven components by five experts had high validity (the average of all programs was 0.86), and the reliability coefficient of the questionnaire was determined by a Cronbach's coefficient of 0.719.

Phase 2: the pilot study.

2.1 Two trials on the thirteen sport tourism programs for triathlon competitions in Thailand, namely, the first event was the International Challenge Triathlon at Nakhon Nayok, Thailand, 2017 and the second event was the twin sports competition at Buriram, Thailand, 2017.

2.2 The samples in this study that were used in this stage consisted of two groups, *i.e.*, group 1 – volunteer triathletes and spectators who were willing to join the sport tourism program in the Triathlon International Challenge at

Nakhon Nayok (48 participants) and the twin sport competition at Buriram (59 participants), randomly selected by accidental sampling; and group 2 – the International Triathlon Committee (nine persons), as the key informants. The people included in group 2 were as follows, managers in sports tourism businesses (three persons), managers of sport sponsored entrepreneurs (three persons), and directors of the Triathlon International Competition Committee (three persons). All of the key informant persons needed to have experience for five years or more.

2.3 Tools for this study were comprised of three types, as in the following: (1) Draft of the sports tourism program for the Thailand Triathlon Competition, (2) Questionnaire of the expectations and satisfaction of the participants in the triathlon competition, and (3) seven semi-structured interview questions for the International Triathlon Committee.

2.3.1 The draft of the sport tourism programs for triathlon competitions in Thailand consisted of thirteen programs as follows (see Figure 1): Program 1: Tourism in cultural sites, Program 2: Tourism in natural attractions, Program 3: Tourism in special interests, Program 4: Choosing in the tourism program, Program 5: Travel expenses, Program 6: Luxury accommodation, Program 7: Budget accommodation, Program 8: Purchase channels in travel programs, Program 9: Payment channels, Program 10: Tourism information, Program 11: Personnel services to facilitate tourism, Program 12: Independent travel programs, and Program 13: Transportation, see Figure 1.

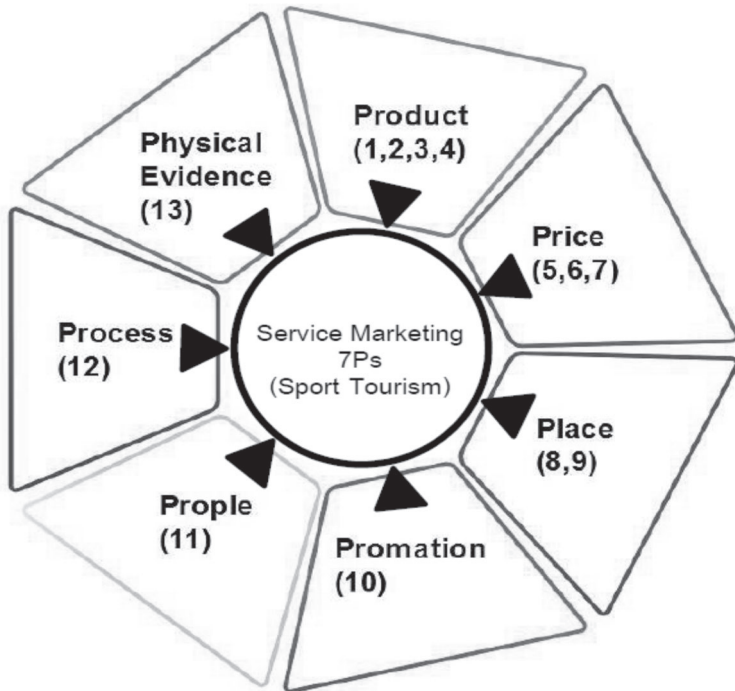


Fig. 1. Draft of sports tourism programs based on the service marketing mix (7Ps).

2.3.2 The questionnaire of the expectations and satisfaction of the participants in the triathlon competition in Thailand used a five Likert rating scale and divided the average score into five groups as follows: average score 4.21–5.00 = highest level, average score 3.41–4.20 = high level, average score 2.61–3.40 = moderate level, average score 1.81–2.60 = low level, and average score 1.00–1.80 = lowest level, these were analyzed by descriptive statistics (frequency, percentage, mean and standard deviation).

2.3.3 Seven semi-structured interview questions were designed and thematic analysis was employed to conduct with nine key informant persons during the Triathlon International Challenge at Nakhon Nayok, Thailand, 2017. Through the in-depth interviews, the study contributed to a better understanding of the International Triathlon Committee by identifying benefits and constraints as well as managing the impacts of hosting EST.

2.4 The mean difference scores were compared between expectations and satisfaction during the first and second trial triathlon events by independent sample t-test. The results found that the mean score of satisfaction was higher than the mean score of expectation in all sport tourism programs in the first and second trial triathlon events. There was not a significant difference in mean difference scores between the first and second trial sports events at level .05. This means that the thirteen draft sport tourism programs have developed well, had a good quality, and can be used practically.

Phase 3: the effectiveness of sports tourism programs for triathlon in Thailand.

3.1 According to the results of data analysis from Phase 2, the researchers then managed the thirteen sport tourism programs in the international triathlon competition at Krabi, Thailand in 2018, shown in Figure 2.

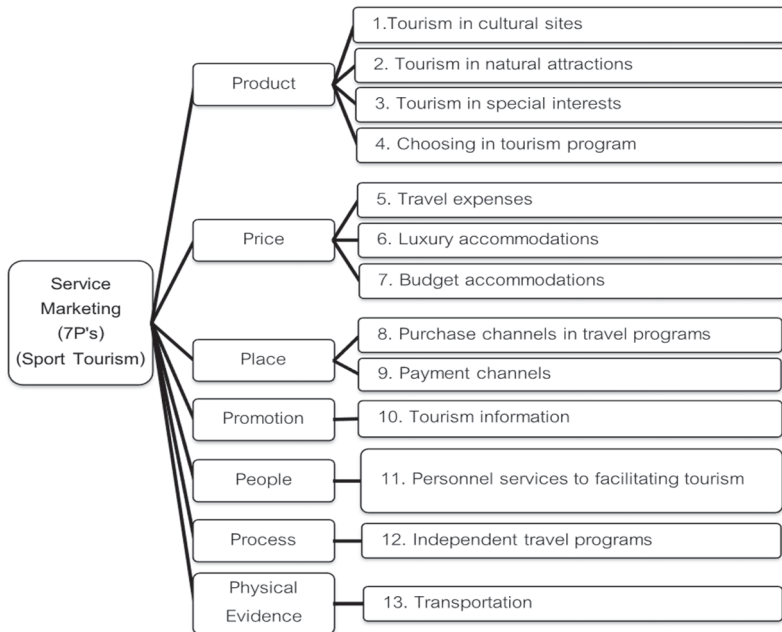


Fig. 2. The sports tourism programs for the international triathlon competition at Krabi, Thailand, 2018 based on the service marketing mix (7Ps).

Program 1: Tourism in cultural sites – used public relations to promote cultural travel activities by introducing cultural tourist attractions in the area of the competition venue. In this event, we provided the travel to cultural sites by going around Krabi town, Tiger Cave Temple, Clown Fish Breeding Center, with travel in an eight-seater van (Price: 650 baht/person).

Program 2: Tourism in natural attractions – introduced information about natural travel activities such as rafting and visiting the park. In this event, we provided the travel to natural attractions, soaking in the hot spring waterfall, emerald pool with van and lunch (Price: 1,000 baht/person).

Program 3: Tourism in special interests - consisting of adventure tourism activities. In this event, there was a rock-climbing tour at Railay Bay with a speed boat trip, and including lunch (Price: 1,000 baht/person).

Program 4: Choosing within the tourism program – offering the package travel programs after the finish of the competition and not far from the venue of the triathlon competition. In this event, it was a travel program of one day (six hours) on the Krabi Sea (four Islands) by speed boat (Price: 1,000 baht/person).

Program 5: Travel expenses – suitability and value for total expenses while triathlon athletes or spectators join the competition activities (between 5,000-15,000 baht). The application fee for the triathlon competition does not include accommodation and other travel expenses, the cost of an application fee was 4,000 baht per person, accommodation cost was 1,200 baht/room/night, and travel expenses was 1,000 baht per person. Therefore, they might select travel programs as an extra program dependent on participants.

Program 6: Luxury accommodation – three-to-five-star hotels (mid to high level) were arranged for the participants, price range between 3,000 baht - 6,500 baht. The hotels were comfortable with beautiful decorations. They had both exterior and interior areas, with good service equipment, and in good condition. The room size must be bigger than thirty square meters including a bed with a size of four feet or more. The TV must not be less than twenty inches in size with no less than twelve channels. There was a refrigerator, mini-bar, and complete communication equipment. Toilets must be clean, large, and sanitary ware must be clean, beautiful, and complete with appliances. Also, there were three types of apartments to choose from. The restaurant must have both Thai and international cuisine,

also a fitness room with more than seven types of equipment, and a swimming pool.

Program 7: Budget accommodation – cheap hotels with one or two stars and had the least important options for participants such as interior furniture and general facilities available, price range between 590 baht–2,500 baht.

Program 8: Purchase channels in travel programs – the way to purchase tourism and accommodation programs, the organization of the triathlon competition cooperates with local tour companies to create tour packages and hotel reservations.

Program 9: Payment channels – the money transfer methods such as credit card payments for other services that are provided by travel agencies or organizations that manage booking systems, namely via the internet or telephone.

Program 10: Tourism information – the acknowledgment of tourism information on travel and competition schedules. The organization of the triathlon competition used public relations for advertising via social media such as Facebook, Instagram, Twitter, etc. since social media can easily access information.

Program 11: Personnel services to facilitating tourism – the service from the staff was friendly and polite and included providing tourism information.

Program 12: Independent travel programs – these were convenient for independent travel by personal car and could create memories and lead to other tourist attractions which were not yet known. They should not be located far away from the participants' accommodation or as a passageway during the journey.

Program 13: Transportation – it was convenient to travel during the competition with an eight-seater van or tour bus or bicycle transportation for the competition.

3.2 The sample group in this phase was the volunteer participants in the thirteen sport tourism programs of the international triathlon competition at Krabi, Thailand, 2018 (68 participants).

3.3 The questionnaire of the expectations and satisfaction of the participants in the triathlon competition in Thailand used the five Likert rating scale and divided the average score into five groups as follows: average score 4.21–5.00 = highest level, average score 3.41–4.20 = high level, average score 2.61–3.40 = moderate level, average score 1.81–2.60 = low level, and average score 1.00–1.80 = lowest level, these were analyzed by descriptive statistics (frequency, percentage, mean and standard deviation).

Furthermore, the researchers applied the Martrilla and James (1977) techniques of Importance-Performance Analysis (IPA), (Martrilla and James, 1977) for the management of triathletes' and spectators' satisfaction. IPA is a business research technique developed as a marketing tool to examine and suggest management strategies. Although originally developed for marketing purposes, its application has extended to various fields, including tourism. This technique can help tourism stakeholders in diagnosing underlying deficiencies and setting priorities in tourism development.

To operationalize the IPA analysis, it is critical to determine the attributes of services delivered to the customer. Based on the predetermined attribute, two dimensions were classified: (1) the importance of each attribute and (2) judgments of its performance. Therefore, the questionnaire was developed to assess each sports tourism program with questions that surrounded the significance of the attribute and how well an attribute was delivered so separated into two sections. Then, using the central tendency of each (mean values) the attribute was calculated and rank-ordered from high to low categories.

The central tendency of each attribute's importance and performance was paired and used as coordinates for plotting the respective attribute in a two-dimensional grid that has been divided into four quadrants as follows:

- Quadrant 1 means Concentrate Here: the area has high importance but low performance,
- Quadrant 2 means Keep up the Good Work: the area has high importance and high performance,
- Quadrant 3 means Low Priority: the area contains attributes that have an important level and performance is likewise low, and
- Quadrant 4 means Possible Overkill: the attributes were invested with much more effort than guest concerns considered important.

Each quadrant in the IPA was divided by the importance of the attribute from high to low (in the vertical axis) and the performance of the attribute from high to low (in the horizontal axis). As a result, the disparity between expectation and satisfaction from the triathlon athletes and spectators was established. It indicated that the customer was either satisfied or dissatisfied with the attributes of the services consumed.

3.4 The effectiveness of the sports tourism programs was analyzed by using the Modified Priority Needs Index (PNI modified) (Wongvanich 2007), then explaining the rank of the sport tourism programs from highest to lowest. The formula of PNI modified = $ID/D - \frac{\text{the expectation (ID)}}{\text{the value of the satisfaction (D)}}$.

3. Research Findings

3.1 Demographics of the Participants

Table 1 shows the demographic status of the participants in the international triathlon competition in Krabi, Thailand, 2018. There were 40 males (58.8%) and 28 females (41.2%). The majority of the participants were in the age group 30–39 years (44.1%), followed by the age group 20–29 years (26.5%). In this triathlon event, there were 25 triathlon athletes (36.8%) and 43 spectators (63.2%).

Table 1. Demographic characteristics of participants.

Demographic Variables		n=68	%
Sex	Male	40	58.8
	Female	28	41.2
Age in years	20–29	18	26.50
	30–39	30	44.10
	40–49	13	19.10
	50–59	6	8.80
	> 60	1	1.50
Status	Triathletes	25	36.8
	Spectators	43	63.2

3.2 Analysis of the Expectation and Satisfaction Level of the Participants

The mean scores in the thirteen sport tourism programs of the participants' expectation and satisfaction are shown in Table 2. It was seen that the means of the satisfaction of participants in this triathlon event were rated highest in P.12: Independent travel programs (4.22), P.9: Payment channels (4.15), P.4: Choosing in tourism program (4.09), P.7: Budget accommodation (4.06), and P.6: Luxury accommodation (4.03), respectively.

In contrast, the expectation of participants in this triathlon event was rated highest in P.12: Independent travel programs (3.85), P.11: Personnel services for facilitating tourism (3.78), P.9: Payment channels (3.75), P.10: Tourism information (3.69), and P.1: Tourism in cultural sites (3.66), respectively. Moreover, P.4: Choosing in tourism program was ranked with the highest gaps between these sport tourism programs, followed by P.6: Luxury accommodation, P.7: Budget accommodation, P.9: Payment channels and P.12: Independent travel programs, respectively. This seems to indicate that triathlon athletes' and spectators' expectations, as measured by the importance they attribute to a wide range of programs, were met by that triathlon athletes' and spectators' satisfaction.

Table 2. Descriptive analysis of triathlon athletes' and spectators' expectations, satisfaction and gap.

Sport tourism Programs	Expectation level			Satisfaction level			Gap	
	\bar{X}	S.D.	Order	\bar{X}	S.D.	Order	\bar{X}	Order
P.1: Tourism in cultural sites	3.66	0.89	5	3.91	0.91	8	-0.25	10
P.2: Tourism in natural attractions	3.46	0.92	12	3.69	0.92	12	-0.23	11
P.3: Tourism in special interests	3.53	0.89	8	3.81	0.90	11	-0.28	7
P.4: Choosing in tourism program	3.49	0.89	11	4.09	0.84	3	-0.60	1
P.5: Travel expenses	3.59	0.83	6	3.85	0.93	10	-0.26	9
P.6: Luxury accommodation	3.50	0.86	10	4.03	0.88	5	-0.53	2
P.7: Budget accommodation	3.56	0.84	7	4.06	0.99	4	-0.50	3
P.8: Purchase channels in travel programs	3.56	0.80	7	3.90	0.93	9	-0.34	6
P.9: Payment channels	3.75	0.82	3	4.15	0.82	2	-0.40	4
P.10: Tourism information	3.69	0.72	4	3.96	0.95	7	-0.27	8
P.11: Personnel services for facilitating tourism	3.78	0.83	2	4.01	0.97	6	-0.23	11
P.12: Independent travel programs	3.85	0.78	1	4.22	0.84	1	-0.37	5
P.13: Transportation	3.51	0.74	9	3.66	0.96	13	-0.15	12

3.3 Comparison Between Expectation and Satisfaction in Sport Tourism Programs

A comparison of the expectation means and satisfaction means for sport tourism programs is shown in Table 3, and it can be seen that the average score of expectation in all programs is greater than the average score of satisfaction. The differences in these means were tested for statistical significance (via a paired sample t-test) and the differences between the expectation and satisfaction means were statistically significant for all programs ($p < 0.05$).

Table 3. Comparisons score between the expectation and satisfaction in 13 sport tourism programs.

Score	n	Mean	S.D.	D^-	t	p-value
Expectation	13	3.61	0.12			
Satisfaction	13	3.95	0.17	0.34	0.09*	< .001

* Statistically significant at the .05 level

3.4 The Effect of Sport Tourism Programs

The Modified Priority Needs Index Analysis of sport tourism programs is shown in Table 4. There is a PNI modified value between 0.12 and 0.31. PNI modified showed that the top five rankings from high to low were Program 4: Choosing in tourism program (.31), followed by Program 7: Budget accommodation (.25), Program 6: Luxury accommodation (.24), Program 3: Tourism in special interests (.21), and Program 5: Travel expenses (.19), respectively.

Table 4. Results of the Modified Priority Needs Index Analysis (n=68).

Sport tourism Programs	PNI modified	Priority
P.1: Tourism in cultural sites	.18	7
P.2: Tourism in natural attractions	.19	6
P.3: Tourism in special interests	.21	4
P.4: Choosing within the tourism program	.31	1
P.5: Travel expenses	.19	5
P.6: Luxury accommodation	.24	3
P.7: Budget accommodation	.25	2
P.8: Purchase channels in travel programs	.18	8
P.9: Payment channels	.14	9
P.10: Tourism information	.12	13
P.11: Personnel services for facilitating tourism	.13	12
P.12: Independent travel programs	.14	10
P.13: Transportation	.13	11

3.5 Importance-Performance Analysis (IPA) to Manage Sport Tourism Programs

Analysis of expectations and satisfaction levels for sports tourism programs in the international triathlon competition Krabi, Thailand, 2018 applied from Martilla and James, (Martilla and James 1977) is illustrated in Figure 3. It found that all programs are located in Quadrant 2: keep up with good work.

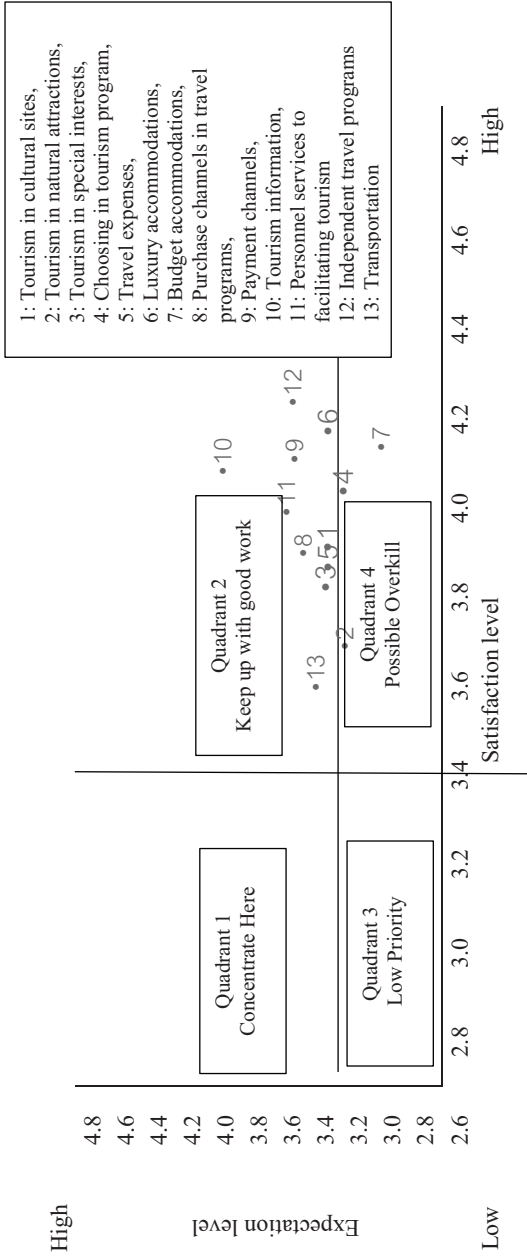


Fig. 3. Importance-Performance Analysis (IPA) to manage sport tourism programs.

4. Discussion

4.1 The results show that the sport tourism management for competitors and the audience attending triathlon events was comprised of thirteen programs. The participants had higher satisfaction scores than expectation scores in all thirteen programs. This means that the triathletes and spectators had enjoyed and were happy with our extra programs in the international triathlon competition in Krabi, Thailand, 2018. This finding was consistent with our prediction because it might have been influenced for several reasons. First, all sport tourism programs had been developed by the service marketing concept of Booms and Bitner (Booms and Bitner 1981). The service marketing concept (it is also known as the seven Ps of Marketing) consists of Product, Pricing, Promotions, Placement, People, Process and Physical evidence. This service marketing concept is a set of tactics that a company/enterprise can use to promote and encourage potential customers to buy their services. This finding is consistent with the study of Roonrapuntha, Sungkawadee, Jansila and Prachanban (2015) studying a sport management model for golf tourism. It was found that of the marketing mix (4Ps) factors affecting the decision to play golf for tourism, three marketing mix factors that had a significant impact on golf player's decisions in sports tourism were products, marketing supports, and the price. It also found that there were two types of golf management and tourism management, namely, the model of sports tourism management with the tourism emphasis and the model of golf management for tourism with golf sport emphasis (Roonrapuntha et al. 2015).

Second, triathlon sport events require strong contact with the surrounding context, especially during the challenge route course. Therefore, the touristic component has been identified by expert practitioners as a key characteristic of the overall system of the offering of a triathlon sport event. In this study, we used the five experts who were knowledgeable and capable of tourism management, triathlon sports, recreation, and marketing with at least five years' experience to approve our sport tourism programs. The content validity and reliability of the thirteen sport tourism programs applied by the service marketing with seven components by five experts had high validity (the average of all programs was 0.86), and the reliability coefficient of the questionnaire was determined by the Cronbach's coefficient (= 0.719). Validity and reliability are two significant measures to determine the quality and efficacy of the data. Validity is about accuracy and whether the instrument measures what it is intended to measure while reliability is about precision; it is used to check the consistency and stability

of the questionnaire. Thus, the results obtained could demonstrate that our sport tourism programs would be associated with a positive satisfaction score. However, the present study adopted self-reported instruments to measure satisfaction and expectation toward our sport tourism programs, and thus the common method variance (CMV) would be a considerable concern.

4.2 In addition, the research findings reported that there are statistically significant differences between the means in expectation and satisfaction. This has been caused by triathletes' and spectators' attitudes and motivation. They considered sports tourism for fun, entertainment, relaxation, and escape to be key issues, and this was borne out in the comments from the spectators who participated in the present study. This conforms to Lovett's findings (2011), who examined the motives of participants in sprint distance triathlon. The purpose of this study was to explore the motivational factors of a group of triathletes to better understand the specific motives that drive them to consume the product/service and to participate in triathlon events. This study looked specifically at participants in a sprint triathlon, the shortest of the three main triathlon competitions. He found that motivational differences existed in triathletes based on levels of activity (competitiveness) and levels of experience (Lovett 2011). Besides, this corresponds to Chang and Tsai (2016), who studied the influence of sports tourism attractiveness, motivation, and experience on revisit intentions. They found that in sports tourism-based activities, gaining multiple experiences (*e.g.*, interactions that assist tourists to form closer bonds with each other, relaxation practices, stress relief, physical strength enhancement, flexibility or fitness improvement, and trust in activity instructors) was the main factor influencing tourist satisfaction in the activities they have participated in (Chang and Tsai 2016).

4.3 The findings showed that the effectiveness of sports tourism programs was analyzed by using the Modified Priority Needs Index (PNI modified) which found that the top five rankings from high to low were the program of choice in tourism (product), followed by the program budget accommodation (place), program luxury accommodation (place), program tourism in special interests (product), and program travel expenses (price). Most of the participants chose the tourism program as the first priority for traveling during the triathlon competition for relaxation with a group of friends after a day of triathlon competition at tourist attractions. Traveling allows a person to experience a change of atmosphere and bring a new perspective along with a sense of rejuvenation into a person's life. This

result is consistent with the study of Woraphan and Pathumphon (2015). This study found that the sport tourism situation in Ubolratana is continually growing. Behavior and motivation for traveling were as follows. 1) Entertainment. 2) Create a friendship. 3) Escape the turbulence (Woraphan and Pathumphon 2015). Moreover, according to the study of Phelps (2006) about the creation and development of an international sports federation: A case study of the International Triathlon Union from 1989-2000. He found that sports tourism in triathlon competitions was organized as a support program during sports competitions (Phelps, 2000). Moreover, Harada *et al.* (2019) found that the image of the tourist destination of the venue is a strong motivating factor for participating in the triathlon event. So, it is important for the event organizer to consider tourism attractiveness at the venue to increase the number of participants (Harada *et al.* 2019). Also, the study of Russell and Jamieson (2008) found that the leisure program for relaxation can be achieved in many ways by engaging in independent relaxation. It also depends on the favorite activity of a group of people such as reading books, watching television, listening to music, going on a picnic, cooking, playing with pets, etc. However, these activities should have a plan to be supported and advanced (Russell and Jamieson 2008).

4.4 Additionally, the assessment of two different segments of triathletes and spectators were compared, thus illustrating the potential of IPA to carry out a differential diagnosis of the service. The finding showed that the IPA of sports tourism programs in the international triathlon competition Krabi, Thailand, 2018 found the thirteen sport tourism programs are located in Quadrant 2: keep up with good work. It indicated that the triathletes and spectators were satisfied with the attributes of the services consumed. The performance of the sport tourism programs was accordingly as high as the importance. This result is consistent with the study of Zhang and Chow (2004) which illustrates that the IPA model as a useful managerial tool can be applied in identifying an area to which marketing resources should be allocated in order to improve and enhance the quality of tour guide services provided (Zhang and Chow 2004). Also, Rial *et al.* (2007) showed that IPA is a widely used tool in services marketing, for the management of sport centers (Rial *et al.* 2007).

5. Conclusions and Recommendations

This paper aimed to develop the sport tourism management program on enhancement for competitors and the audience attending triathlon events in Thailand and to evaluate the expectations and satisfaction towards sport

tourism management programs. This study was conducted in three stages, as follows: (1) analyze and synthesize documents, then create the programs; (2) test the thirteen programs by pilot study (3) evaluate the effectiveness of the programs. The research showed that the sport tourism management for competitors and the audience attending triathlon events comprised thirteen programs. All participants had higher satisfaction scores than expectation scores in all programs. The Choosing in tourism program was the highest favorite in the program, followed by Budget accommodation, Luxury accommodation, Tourism in special interests, and Travel expenses, respectively. Moreover, the IPA found the thirteen sport tourism programs are located in Quadrant 2: keep up with good work. This means that for the sport tourism programs the triathletes and spectators were satisfied with the qualities of services consumed.

In summary, the thirteen sports tourism programs in the triathlon event as extra services are good and unique incentives that attract triathletes and spectators to pay a visit, including more comfort and convenience to participate in the triathlon event.

The results can serve as a reference for related decision-making authorities regarding future sports tourism-related planning for triathletes and spectators in triathlon events as the following: the organizer should arrange a period in the sports tourism program for a one day trip (< six hours) after the triathlon competition, they should have planned multi-traveling programs such as traveling to cultural sites, natural attractions, and special interests. Moreover, the organizer should provide the participants with many varieties of channels to buy travel programs, for payment of service fees, and communication channels with service personnel. Finally, the attractiveness of a tourist site to tourists comprises the scenery, participation, memories, and both services and facilities that satisfy their needs; a combination of these factors boosts tourists' intentions to revisit.

This study could not access the group of triathletes and spectators in the triathlon event, who did not understand Thai or English, because the questionnaire was set only in those two languages. Moreover, this was conducted during September 2018, so it cannot explain the participant's attitude during the surrounding years.

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PART B:

**SOCIAL INNOVATIONS IN
HEALTH AND SERVICES SECTOR**

INNOVATION OF EVOLUTION ON MUSIC INDUSTRIES

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Abstract

The objective of this study is to analyze innovation replacement of music industries, using SWOT analysis, comparing three types of music industry parties – music companies, team producers, and customer behavior – using primary documentary-related research works and secondary data obtained from various related websites of music enterprises. In the past few years, technological change has been very fast, especially in terms of entertainment, and the entertainment industry has significantly adjusted, particularly in the music industry. Not only the content and platforms but also the strategy of the music industry has been changed. Music is a product of human creativity and it can be classified as the creative economy. Before about the year 2000, music was delivered through tape cassettes and CDs, but since technology has further developed all the designs must be changed as MP3s were launched; this has had a crucial impact on the music industry. To listen to music, streaming services are now offered. Moreover, Thailand has been developed to be Thailand 4.0. This is the policy given by the Thai government which will use technology, creativity, and innovation to drive its economy. This transformation will affect all of the music industry parties including music companies, team producers, and customer behavior. The SWOT analysis showed that all three types of music industry parties had adjusted capacities due to the change in technology and consumers’

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preference from tape cassettes to web music. The government sector gives support in terms of sales distribution strategies training, creativity innovation on capital investment partners and tax incentives. As a result of how technology in the music industry developed, it has become more convenient from the point of view of the consumer. At the same time, the effects on music companies meant that they are forced to reform in order to survive. So, after conducting the SWOT analysis, appropriate marketing strategies could be formulated to support the actual music investment phases.

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Keywords: *evolution in technology, music industry, creativity, transformation.*

1. Introduction

Music is produced from ideas to provide something new which originally begins with imagination and a person practicing. The outcome is a product or a piece of work that will be distributed in the market. So, one might say that music is a creative job. According to John Howkins's perspective, who is the philosopher of the creative economy, he explains that input and output are in the form of ideas that are perceived by society as a person's capability to continually come up with new things. The creative economy consists of product management based on a creative perspective to provide two values which are intangible, intellectual property as well as the physical carrier or platform. Moreover, those two values will have different proportions for each industry because those two mentioned components have to use the ideas to produce the intellectual property and the physical carrier of the product to distribute in the market. According to this information, music is a creative economy. In order to successfully become popular music, many important components are needed, consisting of a production team, public relations, marketing, promotion, and distribution channels. All of these components significantly contribute to the music business. However, the life cycle of music has an average of three to six months approximately because listeners' tastes are always changing. The music's age is limited and listeners have a variety of choices to select from for their preferred music based on the voice and external appearance of the singers. Due to these conditions, building an image is required as well as practices including public relations and marketing promotions in order to effectively promote the singer to raise people's interest (Panichakoon 2002). Therefore, every

element is related to those essential components, composed of music producer, singer, public relations, marketing and any special activity resulting in the music industry. Besides, this industry provides a total revenue that reached 4,280 million baht in 2014 (Entertainment Entrepreneurship Association referring to marketer 2014). Moreover, the music business has been significantly changed because of changing technology. In addition, several crucial components have changed such as the listening channel, working procedures, work administration of the music company, singer, music style, as well as employees who are involved in the music industry. Therefore, this paper can infer that various music companies had to be closed due to the lack of effective management. Some companies expanded their line of products, which is totally challenging to impel Thailand's progress to become Thailand 4.0, that concentrates on development in terms of technology and innovation, including the creative economy. Music can be expanded with the unlimited thinking of humans; it relies on technology and innovation for further development. The objective of the paper is to analyze the innovation replacement of music industries, using SWOT analysis, comparing three types of music industry parties – music companies, team producers, and customer behavior.

Literature Review

The music business in Thailand has been developed since 1967 and has continually grown due to up-to-date technology. Then, capitalism was governed by the Thai government after government revolutions that changed from subsistence economic activities to commercial economic activities in 1932. Another important reason to completely drive the music business in Thai was reaching Western culture; it was the starting point of listening to music in Thai and finally expanded the music industry. To achieve this success, teenagers were the major target group for listening to music. As a result, the factors mentioned were fully pushed forward for the music industry to achieve ten thousand million baht during the peak of the music business between 1983 and 1997. The famous singer called “Grand-x Band” launched onto the market in 1979 and received good feedback, selling ten thousand albums under the first launching. In 1983, XO album sold one million albums in Thailand. These were significant factors to inspire the music business and many music companies were established to produce the music. For example, RS Sound Company Limited was formed in the music business in 1982 and its current name is RS Public Company Limited. Moreover, Grammy Entertainment Public Company Limited was set up in 1983 and the present name is GMM Grammy Public Company

Limited. Nithi Thud Production Company Limited was also founded and it has currently changed its name and stopped producing singers. Each company has its own distinctive creation based on the expected target group designed by the company. According to the growth of music companies and positive responses from listeners, the well-known music companies in Thailand like RS Public Company Limited as well as GMM Grammy Public Company Limited established subsidiaries to come up with varieties of music styles including pop and rock music as well as dancing music which will be supported by public relations and marketing to widely meet consumer requirements. Due to these changing conditions, in teenager groups around 80 percent used to prefer international songs but have changed to around 60 percent now listening to Thai songs, which was the key element affecting the expansion of the Thai music market. Music companies were then launching 200 sets per year with a selling value higher than 10 million cassettes per year and the trading value was at least 600 million baht per year. In the peak period of song selling, every music company produced music reaching 50,000 cassettes per day. Regarding the amount of music and its revenue, it can be described that the Thai song business had highly grown and distributed income to other sections including other employment in the music industry such as music producer, singer, publicist, and marketer. In order to better support this industry, technology and human assets are needed which leads to the flow of finances in the domestic music industry. Moreover, since the music business flourished before 2007, it was in a period unfamiliar with the internet or social media channels but people mainly listened to music through three channels; music albums, radio, and television. With the successful age of music companies, if there were total sales above one million cassettes, it inferred that they had achieved their expected goals. So, you can observe that new marketing activity occurred. For example, they might plan to launch special albums for celebrating one million sales with additional songs and decorated with a new front cover. Accordingly, it stimulated consumers to purchase them to keep as a collection. When the most prosperous time for music occurred, however, the crucial changing point came which negatively influenced the Thai music business. One of the reasons for the change was that people encountered the economic crisis in 1997 and found pirated goods. Another factor was new technology which caused lower trends in the music business and they needed to adapt to coming innovations. So, the CD burner was built in 2000 and continually developed in the form of MP3. Then, it led to imitated music easily under the copyright and finally become “Thep Phee Cee Dee Theung” or pirated goods. Furthermore, the purpose of this unexpected situation was not only

for business, but it was also for distributing among them. Even though they were not intending to sell, it was the reason for the declining music business. This paper can say that there was a dark age in the music business in 2002–2007 and music companies aimed to reduce costs and avoid producing singers. Moreover, they used to produce albums containing seven to ten songs, but this had to be changed by launching single albums to evaluate the feedback as to whether it was successful before further developing a full album.

The definition of disruptive technology is given by many academicians. Clayton Christensen, from Harvard University, has given the definition of disruptive as the company developed the product to reach some point and that the price of the goods is higher to meet the high-end consumer regardless of the low-end consumer. Moreover, those products and services still remain in the old operation, ignoring customer demand due to changes in the environment, society, and technology. So, new technology will replace the old version of a technology that does not respond to what the customer wants (Christensen 2009). During twenty years of the music business, disruptive technology occurred based on cassettes or CDs that replaced the record player. Besides, all of these technologies will be replaced by digital songs and listening through the streaming system. This situation is happening widely in the music industry around the world. The above picture illustrates that developed music devices change in each period. When a new music device is developed, the old version will be replaced, such as cassettes, there will still remain some devices used like record players. To clearly depict the changes, figure 1 shows the changing of technology affecting listener behavior. The changing technology for listening to music can be classified into four periods which are the following.

Period 1: Listening to music via cassette with a full album and subsidiary albums: Yellow and Green records store in 1983.

Period 2: Listening to music via CD and gradually declining use of cassettes in 1993.

Period 3: Listening behavior of consumers changes to CD with 90 percent of the music market in 2003.

Period 4: Digital songs or music downloading has gained the main listening proportion from the CD listening type in 2013.

Moreover, streaming is now a new music channel and listening to songs online holds the major proportion of the market. So, every innovation will

be substituted for obsolete technology corresponding with disruptive technology as found by Clayton Christensen. Basic revolution influences the music business to adapt automatically. Companies that ignore adaptation or changing will definitely close down due to changes in technology. Thus, one can see that a big company has obviously adjusted the business administration and closed down the subsidiaries, including merging the business in order to support the management and be consistent with market mechanisms.

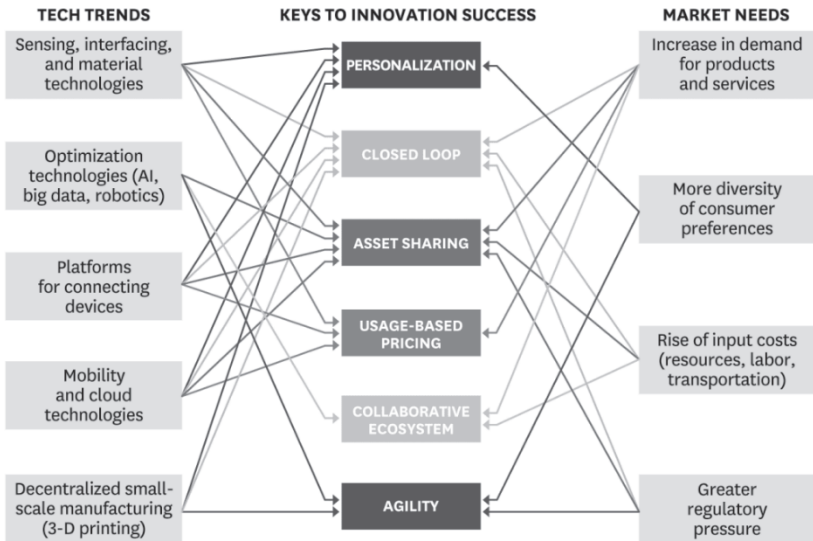
After those technologies had developed, especially listening channels, music companies had to adapt themselves after 2006. Finally, adaptation clearly appeared. For example, consumers were first allowed to download music legally in Thailand with the cooperation between True Corporation Public Company Limited and LOVEiS Company Limited who offered “Eleventh Song” through www.trueworld.net. They expected their website’s members to lawfully listen and download the music without any expense. So, this can be the new dimension of legal music channels. Nonetheless, Thailand was faced with an extreme pirated goods problem during that period. Even though the music company always provided the campaign of legal purchasing, it was still unsuccessful based on the high level of intellectual piracy. The result after free downloading through digital channels influenced the big music companies like GMM Grammy Public Company Limited and RS Public Company Limited. These companies started to adjust their working strategy by producing music and distribution channels to widely reach the target group and survive in this business. For GMM Grammy Public Company Limited, they adapted in terms of music distribution channels and marketing such as distributing downloaded music in the form of singles and full albums, recording information of downloaded music and listening history to realize the customer’s behavior. So, it allowed the company to offer goods and favorite music to meet the customer’s tastes and also significantly improved the usability of the website (Damrongchaithum 2007). RS Public Company Limited still produced CDs for sale and gradually reduced CDs to meet the market demand. Moreover, the customer’s behavior has changed the listening style through music downloading. Thereby, this company gained revenue from digital which became higher than CDs and they also expanded the digital music channel to correspond with the decreasing CDs (Chetchotsak 2020). If we observed the whole music industry in Thailand during the adaptation time, we found that every company had to adjust itself in order to survive in the music business.

2. Research Methodology

SWOT analysis is used as a tool for identifying the factors that a company has to consider while formulating a strategy to achieve the goal of the company (Rangkuti 2009). The analysis can be used by the company to analyze their strengths and opportunities and maximize them to their benefit and advantage, while on the other hand minimizing weaknesses and threats to the company. According to Gitosudarmo (2001), Amanah (2015) and Boonyatisathan (1990), SWOT analysis can also be used to evaluate the degree of strengths of the internal factors of the company. Furthermore, the external factors can also be analyzed so that the company can reduce its weaknesses and establish comparative advantages for its business. Moreover, if one checks through the combination of technology and the market, it will be expressed as in the figure below:

Linking Technology and the Market

The six features that characterize successful innovation all link a recognized technology trend and a recognized market need. Trends were identified by an analysis of regularly published industry reports from think tanks and consulting companies such as the McKinsey Global Institute, PwC, and the Economist Intelligence Unit.



SOURCE STELIOS KAVADIAS, KOSTAS LADAS, AND CHRISTOPH LOCH FROM "THE TRANSFORMATIVE BUSINESS MODEL," OCTOBER 2016

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Fig. 1. Change of technology affecting listener behavior.

3. Discussion

Thailand 4.0 is the policy and vision for developing the Thai economy or the economic development model under the current government. Prayut Chan-o-cha, who is the Prime Minister of Thailand and the head of the National Council for Peace and Order (NCPO), aims to develop the nation and completely drive this country with innovation, technology, and creativity. According to the Thailand strategy, music is one of the creative jobs which are influenced by technology and innovation to reach the target customers. Regarding the SWOT analysis, it shows that the "Entertainment" strategy, which is to bring "Entertainment" such as the music business, radio business, and media business together with "Commerce" like RS Mall. Strengths in entertainment expertise can definitely turn into a supporting business, even though 60% of its income comes from commercial businesses, but the music entertainment business with 40% revenue will definitely contribute to its success. This coming year, with digital TV competition, if there is a 5G issue, will be very challenging. There are some outstanding radio businesses such as "Met 1-O-7" which has been the number one radio media in the minds of listeners for many years and meets the listeners' tastes with many activities. Furthermore, the 1990s concert stream or a remembered artist is still in market demand. Pushing for new artists and new music genres will definitely make the earnings of the music group approximately 500 million baht. Regarding the quickly changing environment during the last twenty years of the music industry, particularly in the last five years, every company needs to rapidly adapt due to the new technology and innovations. Thus, it impacts the music companies and entrepreneurs who are involved in the music business. They must change their thinking methods and working processes to cope with music development in the age of Thailand 4.0. The findings will classify the network of music businesses based on Thailand 4.0 at present, this paper claims that one of the obvious changes in the music industry is the channel of listening to music. In the past, the music listeners needed music devices such as a CD player, cassette player, or MP3 player. Since the disruptive technology occurred in 2013, there was another new channel that significantly impacted the music business which is streaming. Streaming can be played through a multi-media file on the computer without downloading from the internet, which is similar to MP3. So, this paper can show that this new trend is gaining interest from consumers and becoming the music listening's standard due to its simple usage, free services, and monthly payment with unlimited music choices. These attractive reasons make the streaming system well-known.

Music applications via streaming systems are also of interest to and downloaded by Thai such as Deezer, Joox, Line Music, and Apple Music which use a database similar to the iTunes store. So, a lot of music choices are offered and provided at different charges in accordance with the company's policy. As the evolution of music devices is continually occurring, many companies have to adjust their music operations. The most obvious adjustment evident is the acceptance of the company toward these crucial changes and their company's adjusted strategy.

Due to evolving technology, the administration of music companies is increasingly affected. Companies that mainly conduct music business like GMM Grammy Public Company Limited have adjusted the company's structure by laying off some employees to enhance the management. Normally, GMM Grammy Public Company Limited would conduct a performance appraisal every year. If there is a department whose duties and responsibilities are unmatched with policy or complex work, it will be improved to accord with the assigned policy (Daoreung 2010). Regarding music production, since the main revenue of those music companies has been dropped, the company then needs to change the production process to be consistent with the current technology and consumer behavior. For example, the company used to launch a full album containing seven to ten songs and it then changed to a single which sold through a download system (Komchadluek 2009). The advantages of this approach enable the company to reduce the risk of capital loss due to the lower production cost because it produces fewer CDs and also evaluates whether each singer's feedback means that they are famous among Thai. In recent years, a new singer does not have to have their own full album or even a famous singer can launch a single album only. However, when the special opportunity comes, an exclusive album could be created and launched to the market.

In the current situation, building up a new singer is more challenging. In terms of the music producer's viewpoint and the singer's perspective, the album is not currently the same story as it combines single songs, which is different from the previous concept that already specified the music direction under the full album (Auethawornsook 2016). However, the singer has to adapt because they cannot withstand this change. Despite this, creating new singers or launching new songs has decreased. On the other hand, building on the music for drama is quite popular and provides a new method for singers to survive. The obvious example is "Narongvit Techatanawat" who is a famous music composer in Thailand. Moreover, he produces the songs for many well-known singers for both GMM Grammy

Public Company Limited and RS Public Company Limited. Finally, he resigned from his job to establish a new department called “Chandelier Music” which is responsible particularly for creating drama songs under the Three channel. In addition, he composed several popular songs for drama which have been shown on the Three channel since 2009, consisting of “Hai-Chan-Doo-Lae-Thur” (Poo Yai Lee Kub Nang Ma), “See Hau Jai Hheng khun khow”, and the drama of “Su phab bu rhut Ju Tha Thep.” All of these drama songs have been successful based on the awards received and good feedback from viewers and music listeners (ASTV Manager Online 2014). Even though he has directly conducted under the Three channel he chooses the appropriate singers who exactly suit the assigned song. So, this movement effectively propels the music industry in Thailand.

Public Relations and Marketing in the music business have changed extremely when compared with the past. In the past, after the music company finished creating music, it planned for public relations by firstly launching through the radio. Then, the sample music video was released and there was a pause for a while before a complete music video was released via the music channel on television. With the music production, some music from the full album was chosen and advertised to society. If the first song gained good feedback, other songs from the album were selected to publicize towards society. Papers could evaluate its success if the total sales were higher than one million cassettes. If it achieved the expected goal, they tended to launch the exclusive album for the one million cassettes celebration. Moreover, this exclusive album might include a new song and an outstanding front cover to reward the customers and stimulate sales. As a result, this marketing technique has been exceedingly favored since 2007. After releasing the single song, public relations have to be adjusted to better suit the current working processes. Advertising through radio and television still exists, but social media currently plays a more important role in public relations, especially with Thai music to meet the teenager and adult groups because these two groups are mostly involved with social media. Based on the research that studied the strategies of marketing communication in the music industry, two music companies where they mostly adapted to social media were chosen to study, these were composed of Kamikaze (RS Public Company Limited) and Genie (GMM Grammy Public Company Limited).

This paper can summarize that social media was chosen by the music companies to communicate and advertise the music and singers consisted of five categories: Facebook, Twitter, Instagram, Line and YouTube. These social media are exactly interacting with the people. So, many music

companies use these effective tools for the purpose of marketing and public relations so that they can respond to how the customer interacts. Furthermore, each social media provides different characteristics which are the following: for Facebook, it is the main channel applied by the company to communicate with the audiences in both formal and informal conversation. Moreover, its content offers pictures, video clips, messages, and shared other content. It also allows creating an event for promoting the marketing of the music company. Twitter is one of the social media that was applied to quickly deliver short easily understood messages. Thus, music companies use Twitter as an effective communication tool to access other communities or the main website. Instagram has concentrated on the content of posted photos and brief videos, so it emphasizes the contents that relate to personnel or singers rather than the music company. Line is also used for communication by music companies and its trend is continually increasing corresponding with its popular feedback of simple usage. Some music companies and singers have official Line accounts, such as BEC-Tero Music, GMM Grammy, RS, Loveis. For the official line of singers, examples are Stamp Apiwat Eurthavornsuk, Cocktail Band, Bodyslam Band, Thongchai McIntyre, and Saksit Wetsupaporn. YouTube is another music channel that is significantly used by music companies, especially in the pattern of videos. So, many music companies select the YouTube channel to advertise and replace the music channel on television. Besides, YouTube is also applied for storing the products of music companies or even of the singer who does not have any contract with a company and is allowed to adopt a channel to spread their performance. Therefore, several famous singers started making video clips to show their performance, such as Room39 band, Ploychompoo Yankee Paravee Waikaw who got one million views and posted videos through her channel.

So these five social media can summarize that music companies and singers are supported by these channels. They allow fan clubs direct contact with the singer. If it is compared with the past communication between music companies and fan clubs, the main channels were letters or concert meetings or even other stage performances. In the current situation, social media plays an important role in human life. In order to survive in this business, it forces the singers and music companies to be adaptive due to up-to-date technology. Furthermore, there are varieties of songs and they can be evaluated by the number of viewers on the YouTube channel. Moreover, the number of viewers can define whether that song is successful. Finally, when the listening behavior of the audience has changed, it will reflect the result back to the singer in order to adapt and exactly meet what the market

needs (Auethavornsook 2016). At present, the music business is as popular when compared with the past and it is more difficult for singers to successfully launch their music. On the other hand, national music contests performed in Thailand have become more popular now. If compared with the national music contests in the past, a few stages were set up, but they dramatically attracted a lot of people to get involved. The popular music contest in Thailand was “Siamkonkarn” but it currently has changed its name to “KPN Award.” This contest has been going for thirty years with the creation of famous singers such as Orawee Satjanonth, Thongchai McIntyre, Nunthana Boonlong, Amita Tata Yang, and Nuengthida Sophon. Another two well-known national music contests from ten years ago have been “The Star Contest” founded by Exact Co., Ltd which started broadcasting in 2003. Moreover, “UBC Academy Fantasia” has been a popular music contest that has currently changed its name to “True Academy Fantasia” with the initial broadcast in 2004. These two music contests can reach large audiences through television and have been constantly on air for ten years. Even though the music business in Thailand has fallen in terms of total music revenue, music contests are likely to continuously increase, especially in digital television. Each channel comes up with varieties of music contests under copyright and their own contests such as The Voice, The Voice Kids, Stage Fighter, Suk Wan Duan Pleng, Ching-Cha Sa Wan, Mai Thong Kham, The Masked Singer, Master Key, Kik Doo Songkram Pleng, and Dan Dara.

According to the political economy (Kaewthep 2013), media is one of the industries that aims for making profits. Therefore, music contests or other related music channels have increased in the market because the customer demand is higher and still needs this entertainment type. However, media have currently changed which caused the developed pattern. Drama and series are other occurrences of music extensions that are applied to build movies or short series such as Love Song Love Series which belongs to GMM25 Channel and True Love Story which broadcasts on True4U Channel. In addition, Genie records, who launched the “Thieng Wai Glang Thang” song extended through a new movie because of its popular music video which significantly contributed toward the revenue process under the adjusted presentation. New music production is discontinuous compared with the past. The trend of the individual music concert has been dropped, and it causes lower revenue. Nonetheless, live music has become more popular among the music industry due to more organizing of music concerts and music festivals held in Bangkok and other main provinces. Moreover, famous foreign bands have always organized and performed concerts in

Thailand. So, the total value from this live music grows annually by about 6.1%, reaching 5.6 billion baht from 2014 to 2019. The return of famous singers from the past has been arranged for concerts in recent years, such as the Party Reunion Concert, the singer from album 6 2 12, combining singers who sold one million copies in celebration of GMM Grammy, Raptor band, and Ruangsak Loychusak. As customers who grew up with historical music during the period of 1990 to 2007 or the 1990s are increasing the demand for these activities and these customers, who currently have purchasing power and a desire to recall their past remembrances through those memorable songs.

4. Conclusion and Implication

Technology development and innovation are widespread throughout the world including Thailand. Therefore, forecasted trends are expected which can be categorized into two types; 1. Technology will influence the evolution of the music business, such as virtual reality which unties the limitations of a specific time and place. Moreover, live music can be established, such as ABBA in 2018, with the combination of full virtual reality that will support the customer. This action can enhance a new customer's experience due to the changing of time (Yodhong et al., 2016). 2. New customer behavior is called the "New Global Citizen" who accepts the differentiation and connects through the internet to respond to an individual's need. So, the marketer will be unable to conduct mass marketing to penetrate through the market as previously but they need to adjust to marketing customization that directly penetrates through the individual's need. For example, listening to music via the streaming system will store the playlist history and offer the individual's music database to satisfy each listener which is managed by the Spotify application (Yodhong et al., 2016). Technology has been developing music production and music listening channels which have caused significant changes in the music business since ten years ago, especially in 2012. Since most people tend to listen to music via streaming or digital systems, it seriously impacts the music companies, distributors, and music retailers to shut down their businesses because of the lack of new products. Moreover, many singers changed to other careers which substituted for their existing job. Public relations and marketing also adjusted; therefore, social media plays a key role to better enhance the music. Despite the crisis in the music business which had occurred, new technology and social media have recovered the situation unexpectedly and provided new opportunities. At present, everyone can access the technology easily which has resulted in many

independent music companies and even the singers, who do not have a contract are allowed to post their songs via social media such as Facebook or YouTube. These social media permit users to create their own channels under their name. Its advantage is reducing the music monopoly. Since everyone can create their own performance and are allowed to distribute by themselves, then the customers have more rights to choose from the increasing music choices. Furthermore, competition has been continually increasing and adjusting all the time, leading to the launch of innovations corresponding with customer behavior and Thailand 4.0 that impel the developments in Thailand. The music business is still existent but music companies and singers, or even the consumer, have to adapt themselves due to technology and innovation. As a result, music has always endlessly found the creative contest to differentiate the performances and has gained good feedback from the listeners.

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HEALTH BEHAVIOR CHANGE: USING A NUDGE THEORY-BASED NUTRITION INTERVENTION TO REDUCE SUGAR- SWEETENED BEVERAGES CONSUMPTION AMONG UNIVERSITY STUDENTS

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Abstract

Sugar-sweetened beverages (SSBs) consumption is one important cause of non-communicable diseases (NCDs) in Thailand. Policy makers launched a policy to tackle NCDs. This study examined the effects of a nudge theory-based intervention with an attempt to explore health behavior change in added sugar consumption using information provision bias as a theoretical background. Designing a health intervention was conducted with the help of university students from Srinakharinwirot University. Sixty-eight subjects completed an online questionnaire assessing socio-demographics, health status, SSBs consumption, as well as personal and environmental factors related to SSBs consumption. Subjects were divided into three groups; Framing 1: receiving nutrition information from the Thai Health Promotion Foundation, Framing 2: receiving negative information provision bias, and Framing 3: receiving positive information provision bias, and all were followed up after three weeks. After being informed of the recommended amount of sugar intake from Framing 1, the results showed no significant reduction of SSBs intake in week 1 compared to pretest (week 0). A significant decrease in SSBs consumption was observed in week 2 compared to week 1 and week 0. However, there were no significant differences in Framing 2 and 3 after receiving any information provision bias. Framing 1 would be the best policy to use with young consumers.

Keywords: *Nudge Theory; Information Provision; Behavioral Economics; NCDs; Sugar-sweetened beverages*

1. Introduction

Non-Communicable Diseases (NCDs) are an important global health problem (Bureau of Non-Communicable Disease 2017). They are caused by behaviors such as drinking and eating unhealthy foods, doing less exercise, smoking, and drinking too much alcohol. A report from the World Health Organization (WHO) in 2018 showed 71% of deaths from across the world were caused by NCDs (WHO 2018). For Thailand, the report from the Ministry of Public Health (Bureau of Non-Communicable Disease 2017) in 2018 showed that 67% of deaths were caused by NCDs. Nowadays, many countries adopt nutrition policies to decrease the risks and prevent people from becoming new NCDs patients. For example, governments create food and drinks advertising policies to give health information to people. The government believes that consumers are rational. However, the numbers of NCDs patients are still continually increasing. The unsuccessful policies are explained by the behavioral economics theory. Almost all people consume foods for their pleasure in the present time and ignore health consequences in the future. The tendency of almost all people's behavior is called "Present Bias" (O'Donoghue 1999). Few consumers are concerned about nutrition and their health (Grunert 2010). To remedy the problem, this study focuses on consumer behavior relating to sweet drinks by university students because these consumers have a high risk of becoming new NCDs patients. This study begins with a survey of the general information and nutrition knowledge of 218 Srinakharinwirot students and 147 Thammasat students. The results showed that 77.72% were female, 50.27% had a normal body mass index (BMI between 18.5 and 24.9) and 61.68% exercised for less than 30 minutes per day. Furthermore, the recommended amount of sugar for daily intake according to the WHO (WHO, 2015) is 6 teaspoons per day. However, the results from the survey showed that 84.42% did not know about the recommended amount of sugar and 61.23% consumed more sugar than 6 teaspoons per day. The results showed that most of the subjects had a normal BMI, but they had a chance of becoming new NCDs patients. Thus, this study wished to investigate and analyze the effect of nutrition information on the consumption patterns of SSBs of university students by adopting the nudge theory (Thaler *et al.* 2008) from behavioral economics. The results from this study will lead to suggestions for nutrition advertising policy to reduce the NCDs problem.

2. Objectives

To examine the effects of a nudge theory-based intervention with an attempt to explore health behavior changes in added sugar consumption by using information provision bias as a theoretical background.

3. Methods

This study collected the consumption behavior toward sugar-sweetened beverages over 3 weeks from 68 economics students at Srinakharinwirot University. In week 0 we collected the demographic data and health status of the subjects, which included gender, BMI, underlying diseases and sugar-sweetened beverage consumption of the representative subjects. The subjects were divided into 3 groups which had a concordance with gender, BMI and underlying diseases. In each group, the subjects received a campaign message about consuming less sugar-sweetened beverages for 2 weeks, 3 days per week. For the first group, the message was “Enough sweetness at 4 grams,” (Thai Health Promotion Foundation) which was created by the Thai Health Promotion Foundation. For the second group, the subjects received a negative information provision bias, “consuming more than 6 teaspoons of sugar per day will increase the chance of getting a non-communicable disease (NCD).” In the last group, the subjects received a positive information provision bias (Lo *et al.* 2012; Gustafson 2017), “consuming less than 6 teaspoons of sugar per day will decrease the chance of getting NCDs.” The positive and negative information provision bias was created by the researcher. The analysis was divided into two parts; part 1, experimentation of the information provision bias which affected the amount of sugar-sweetened beverage consumption by comparison of the average of consumption in each week, and part 2, to analyze the factors which affect the amount of sugar-sweetened beverage consumption by Analysis of Variance, ANOVA.

4. Results

Table 1. Demographics data and health status of subjects.

Gender	n	%
Male	19	27.94
Female	49	72.06
Total	68	100.00
BMI	n	%
< 18.5	15	22.06
18.5 – 24.9	35	51.47
≥ 25	48	26.47
Total	68	100.00
Underlying Diseases	n	%
Yes	16	23.53
No	52	76.47
Total	68	100.00

Table 1 shows the demographic data and health status of 68 subjects. According to the research, most of the subjects, approximately 72.06%, are female, 51.47% are of normal weight, with a BMI of about 18.5 to 24.9, and 76.47% having no underlying diseases.

Table 2. The amount of SSBs consumption.

Subjects	n	Week	Mean (ml per day)	Mean Difference (ml per day)	t	p-value
Group 1	23	Week 0	495.48	-	-	-
		Week 1	383.41	-112.07	-1.5856	0.0576
		Week 2	265.43	-117.98	-1.8810	0.0311*
Group 2	23	Week 0	339.17	-	-	-
		Week 1	309.67	-29.50	-0.5245	0.3004
		Week 2	265.43	-44.24	-0.8031	0.2117
Group 3	22	Week 0	345.07	-	-	-
		Week 1	246.67	-98.40	-1.5876	0.0584
		Week 2	320.67	74.00	1.2105	0.8859

*significant difference

Table 2 shows the averages of SSBs consumption according to the 3 groups of subjects. In week 0, before the campaign started, groups 1, 2, and 3 had average consumptions of 495.48 milliliters per day, 339.17 milliliters per day and 339.17 milliliters per day respectively. Later, after the subjects in each group received the campaign message, the first group tended to consume fewer SSBs after the 1st week and with statistical significance after the 2nd week. For the second group, although the consumption by the subjects decreased, a significant difference was not found in this group. For the third group, the campaign message only affected the decrease in consumption in the second week.

Table 3. The factors affecting the amount of SSBs consumption.

Subjects	n	Factors	F	df	p-value
Group 1	23	Gender	11.24	1	0.0010*
		BMI	4.41	2	0.0134*
		Underlying Diseases	24.38	1	0.0000*
Group 2	23	Gender	0.010	1	0.9127
		BMI	1.90	2	0.1517
		Underlying Diseases	4.30	1	0.0395*
Group 3	22	Gender	0.91	1	0.3411
		BMI	1.92	2	0.1495
		Underlying Diseases	3.66	1	0.0574

*significant difference

Table 3 shows the factors affecting the amount of the subjects' SSBs consumption by using the Analysis of Variance (ANOVA) method. According to this, for the first group the factors affecting the amount of SSBs with statistical significance were gender, BMI and underlying diseases. Females tended to have lower consumption than males. The overweight with a BMI ≥ 25 tended to consume fewer SSBs than the underweight and normal weight persons. Moreover, those with underlying diseases tended to consume fewer SSBs than people with no underlying diseases. According to the second and the third groups, the factor that affected the amount of SSBs with statistical significance was only underlying diseases because the message which these two groups received only focused on the effect on health of consuming sugar-sweetened beverages.

5. Conclusions

The results of this study found that the campaign to reduce sugar-sweetened beverages consumption affected consumers' behavior because the campaign messages nudged consumers to gradually change their behavior. Particularly in the first group, the campaign message had neutral framing, which was the most effective because the message could nudge the consumer in many ways of thinking, for instance, the group of females who were concerned about their bodies, the group of overweight people who needed to control their consumption of food and sugar-sweetened beverages as well as the group of people who had underlying diseases and needed to consume as medically advised. Concordance with the Thai Health Promotion Foundation's campaign is very effective because this campaign creates positive incentives for consumers by changing behavior gradually without force (Thaler *et al.* 2009). On the other hand, positive and negative information provision bias focused on the negative effects on health of consuming sugar-sweetened beverages. The messages only nudged the underlying diseases group. Moreover, the campaigns of positive and negative information provision bias were not very effective because the subjects were students, who were not as concerned about the negative health effects of consuming sugar-sweetened beverages as the group of workers were. Therefore, Neutral Framing is the most effective campaign message for the subjects, which were young people.

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THE IMPACT OF THE THAI ELDERLY IN THE ECONOMIC DIMENSION

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Abstract

This paper studies the concept of the Thai elderly in the economic dimension. Its knowledge border also reaches into negative and positive effects on the economy. The former illustrates the causes of the negative impacts of the elderly on the economy. It reveals that high public spending on government pension funds, elderly living allowance, and medical expenditure lead to fiscal burdens. The aggregate output growth declines in the long run. Meanwhile, the latter attempts to explain the hypotheses of why the elderly can contribute to the economy. The main key is human capital investment. It reveals this with the main government policies, labor policy, education policy, and health policy. Further, the elderly lead the positive effect in the economic dimension via the extension of retirement age, lifelong learning, and good health.

Keywords: *Elderly; Economic dimension; Human capital*

1. Introduction

Thailand entered the aging society stage in 2005 and will enter the aged society stage in 2021, which means the elderly will form more than 20 percent of the total population. It is expected that Thailand will enter the super-aged society stage, which means the elderly account for over 28 percent of the total population, in 2031. The entering of the aging society stage in Thailand was mainly a result of successful family planning between 1972 and 1995, which caused the fertility rate to decrease. Fifty years ago, Thailand had a population growth rate higher than 3 percent per year, but recently the population growth rate has dropped to 0.5 percent per year. In

addition, a universal health insurance system has been established since 2001 and this plays an important role in increasing the life expectancy of Thai people. The life expectancy at birth of Thai people, both in males and females, has increased. The data for the years 2000 to 2005 showed that at birth, males had an average life expectancy of 68.15 years and females had an average life expectancy of 72.39 years. Additionally, the millions of the generation born between the years 1963 and 1983, which are more than 1 million people each year, are moving into the elderly age group (Department of Older Persons 2016). The situation of the Thai elderly in 2017, was that there were 11,312,447 persons in total. The number of men accounted for 5,083,681 persons or 44.94 percent and the number of women accounted for 6,228,766 persons or 55.06 percent. Considering the age levels, they are classified into 3 groups. The early age group, 60–69 years, accounted for 57.4 percent, the middle age group, 70–79 years, accounted for 29 percent and the late age group, 80 years and over, accounted for 13.6 percent (National Statistical Office 2017). Entering into the aging society will affect Thailand's development and economic growth in the long run, including the fiscal budget and the quality of life of the Thai population.

The population aged 60 and above has the highest poverty share with 8.48 percent poverty incidence by age group, as shown in Figure 1. Also, the elderly with incomes below the poverty line reached 34.3 percent as shown in Figure 2 (Foundation of Thai Gerontology Research and Development Institute 2016). This means that if the Thai elderly do not have enough savings, it may affect their livelihood and fiscal burden.

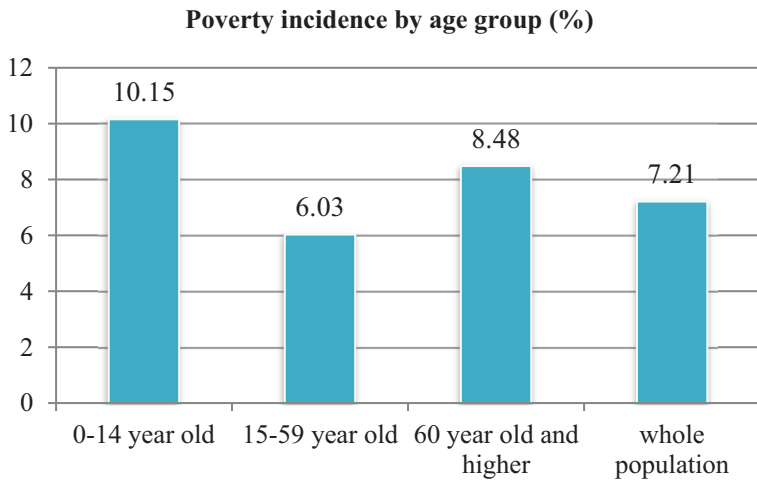


Figure 1. Poverty and Inequality in Thailand in 2015.

Source: *Foundation of Thai Gerontology Research and Development Institute, 2016.*

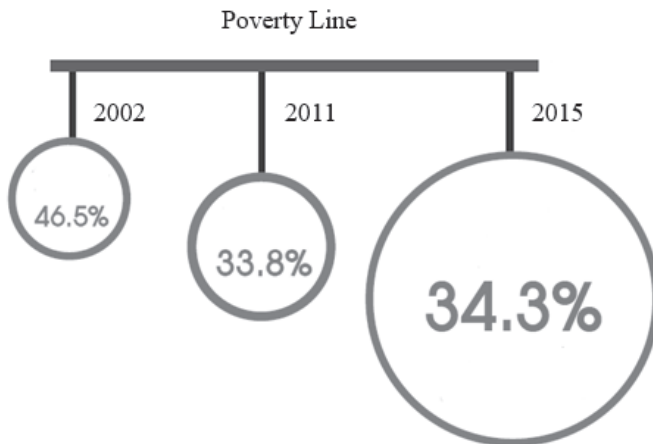


Figure 2. Elderly's income below the poverty line.

Source: *Foundation of Thai Gerontology Research and Development Institute, 2016.*

Children remain an important source of income for the elderly as shown in Figure 3. The 2014 Survey of the Elderly in Thailand found that the principal source, with 36.7 percent of elderly income, came from a child.

The second most common source, with 33.8 percent of elderly income, was from working. About 14.8 percent of income was from the government allowance, while 4.9 percent had pension income as their primary source, 4.3 percent relied on a spouse, and under 4 percent had primary income from interest income. Nevertheless, the trend in elderly income from a child is on the decline. The National Survey of the Elderly in 2007, 2011, and 2014, found that reliance on a child for the primary source of income declined from 52.3 percent in 2007 to 40.1 percent in 2011 and 36.7 percent in 2014 (National Statistical Office 2014).

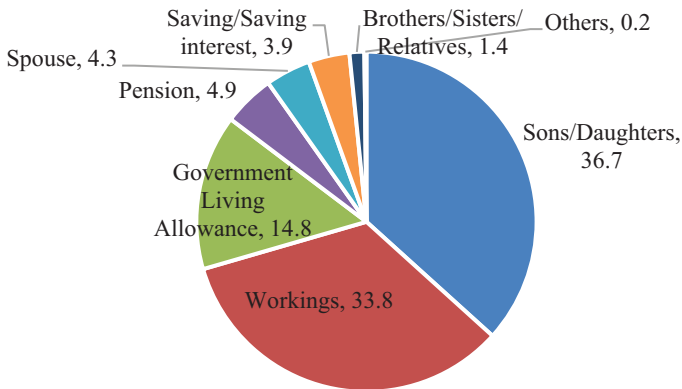


Figure 3. Elderly's main sources of income, 2014.
Source: National Statistical Office, 2014.

Starting in 1993, the Department of Public Welfare began administering elderly welfare subsidies of 200 baht per month for persons aged 60 years or older who were classified as “poor.” This allowance was increased to 300 baht in 2009 and was made available to all elderly people not covered by other income security schemes. This resulted in the number of elderly people receiving the cost-of-living allowance increasing from 1.8 million in 2007 to 7.3 million in 2013. Approximately 800,000 elderly people did not receive the allowance since they were covered by other pension schemes. This left 1.5 million elderly people who did not receive the government allowance or government pension in 2013, yet the number receiving the monthly allowance has increased yearly and the amount of individual allowance has increased in value as well, as shown in Figure 4.

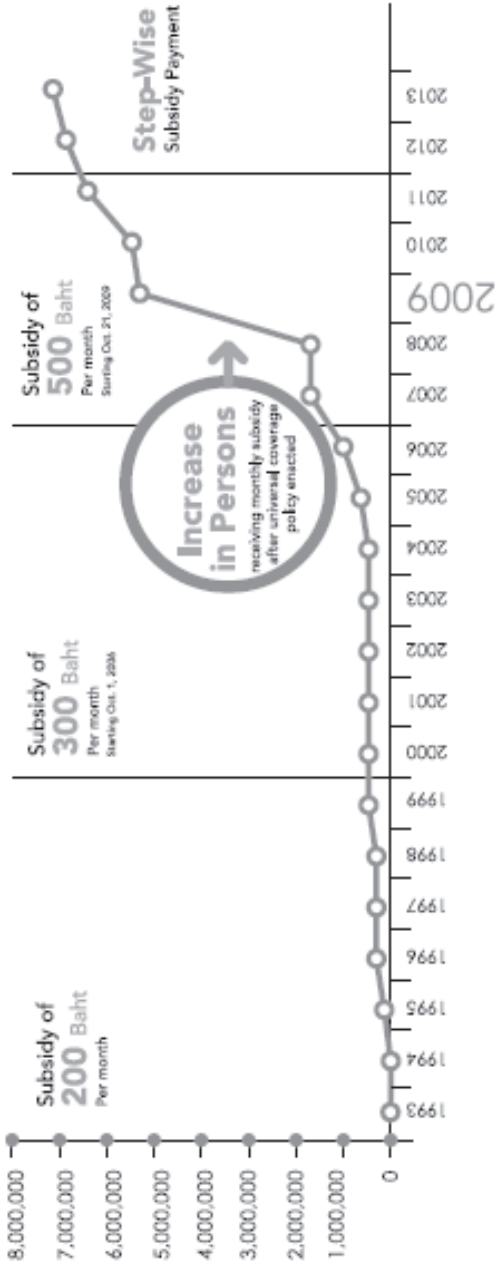


Figure 4. Number of Elderly Receiving the Monthly Cost-of-Living Allowance: 1993–2013.
 Source: Department of Local Administration, 2014.

Table 1. Cost-of-Living Allowance by Age.

Age	Monthly Allowance
60–69 years	600 baht
70–79 years	700 baht
80–89 years	800 baht
90 years or more	1,000 baht

Source: The Secretariat of the Cabinet, 2011.

Table 1 shows the cost-of-living allowance by age. Currently, the government uses the fiscal budget to take care of the Thai elderly. The elderly allowance budget is increased by the proportion of the elderly. Table 2 indicates the government has allocated the budget for the elderly allowance increasing, with an amount of 21,963,075,000 baht in 2009 and an amount of 66,359,650,800 baht in 2018 (Department of Older Persons 2019). Its increase was accounted for 3 times in just 10 years.

Table 2. The elderly allowance budget in 2009–2018.

Fiscal budget (Year)	The amount of the Thai Elderly (Person)	The amount of allowance budget (Baht)	The elderly allowance per head (Baht)
2009	5,448,843	21,963,075,000	4,031
2010	5,652,893	32,779,232,400	5,799
2011	6,521,749	37,893,398,000	5,810
2012	6,784,734	52,535,425,200	7,743
2013	7,308,315	58,347,043,200	7,984
2014	7,664,599	60,999,878,400	7,959
2015	7,749,138	61,879,284,200	7,985
2016	8,012,853	63,219,443,300	7,890
2017	8,158,313	64,783,645,200	7,941
2018	8,379,782	66,359,650,800	7,919

Source: Department of Older Persons, 2019.

The study of the Thailand Development Research Institute which was supported by the Thai Health Promotion Foundation found that the ratio of health expenditure from the past until the present was increasing. The ratio of health expenditure to total expenses of the government is on an increasing trend. Regarding aging society factors, the OECD forecast that Thai health expenditure over the next 13 years will be estimated at 4.8 billion to 60 billion baht in 2032. If the government has not yet issued measures to control the lifestyle habits of the elderly, it will be expected to increase the cost to 2.2 trillion baht (Thailand Development Research Institute 2016). Consequently, Thailand should be handling the fiscal burden from the aging society by learning about the demographic change and preparing policy management in the economic dimension. This can be achieved by attaching importance to human capital by promoting and supporting the role of the elderly, such as by providing lifelong learning, an extension of the retirement age, promoting health care, and allowing local communities to play a role in welfare arrangements with the participation of the elderly. These actions would enable sustainable management of the aging society, reduce the fiscal burden, and ultimately lead, in the economic dimension, to economic growth.

Therefore, this study is a preliminary analysis related to demographic change in the case of decreased fertility and increased longevity which leads to an aging society. We then study the negative impact of the elderly on the fiscal burden and the government policies for managing the elderly in economic dimensions. Especially the study analyses the policies which are related to human capital investment, and as a result, the role of the elderly in having a positive impact.

2. Conceptual Framework

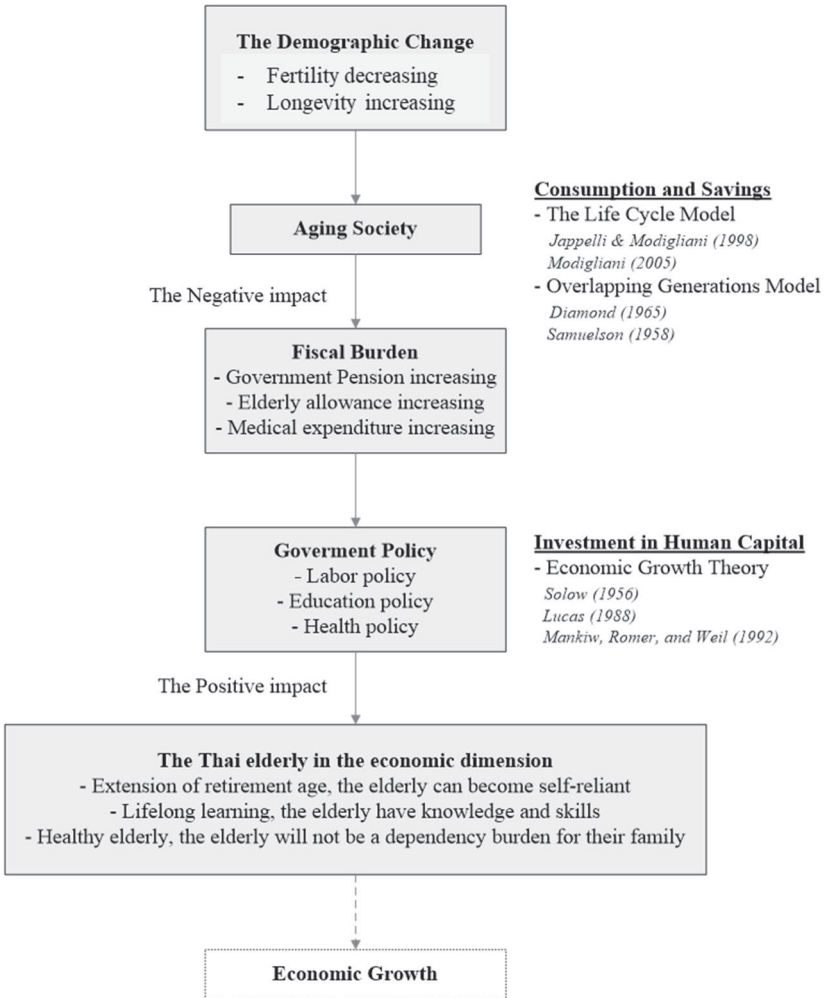


Figure 5. Conceptual Framework.

Source: Author.

3. Related Theory

In economic theory, there is a relationship between income, consumption, and savings of households in the economy. The known theory is the Life Cycle Model, based on the ideas of Franco Modigliani (2005), who said that consumption does not depend on the income at the time but depends on the forecast income throughout all of their life; past, present, and future. With consumption, most people will consume to get maximum satisfaction at a certain moment. Savings are needed to have money for consumption in the retirement period or when there is no income from work. In the life cycle model, consumers will use life income and property value to determine consumption and savings. Consumption tends to increase rather than be stable, while consumer incomes will gradually increase early on up to a period that has the highest income. After that, income will gradually decrease. This is due to the early and late stages of life being less effective at work than in the middle of life or the working age. This is the reason why the cost of living at the beginning and the end of life is greater than the earned income. In the middle of the life period, there is a period of high work efficiency causing consumers to have more income than expenses. Therefore, consumers during working-age years will bring in excess of their expenses to save money for living at the end of their lives (Jappelli and Modigliani 1998).

Another theory further developed from the life cycle model is the Overlapping Generations Model (OLG) based on the concepts of Diamond (1965) and Samuelson (1958). The theory has an emphasis on relationships between generations and overlapping living. Everyone must go through three ages of life, the child age, the working age and old age. At any one time, there will be three overlapping generations. The first generation is called elderly, namely the grandparents. The second generation is called the working age, namely father and mother. The third generation is called childhood, namely children. This model has relationships across generations which mean income is transferred and helps each other, such as in childhood having to rely on parents for studying in school while the elderly people rely on their child for a living. Therefore, the second-generation working age is the highest economic and social role. Aside from having to raise children, they must also care for or deliver to the parents as well. However, dependency may not mean only money but may mean dependence on non-monetary resources, such as helping with daily life, health care, and traveling outside the house, etc. (Pattamasiriwat, 2008). But in truth, at present, many elderly people can be self-reliant by themselves because they

have accumulated assets giving them enough wealth. Many elderly people have incomes even during retirement, such as receiving a pension or regular income from annuity life insurance. Savings and investments are related because the money invested is from savings, therefore saving is an important part of the investments for economic growth. These investments will include physical capital investments and human capital investments. The physical capital investments include tools, machinery, buildings and software to produce goods and services, etc. Human capital investments include all types of human-related investments such as education, research, investment in health and life insurance, etc. because humans are the owners of the raw materials, the labor, the producers and the consumers. Therefore, human capital plays an important role in the economic dimension.

In the theory of economic growth due to human capital, there are many concepts. The most well-known theory is economic growth based on Lucas's model (1988) which suggests that human capital is the knowledge and expertise available in labor. Human capital is a type of production factor to produce goods and services. The knowledge or skills come from the decision of the workers whether to choose to accumulate knowledge or to work. If choosing to invest in study or finding current knowledge and skills, they must sacrifice current work or consumption in exchange for rewards increasing in the future as a result of having more knowledge and skills. Lucas's study suggests that technology in each country is divided into two characteristics, one part is pure technology that is common in all countries. The second part is the result of the human capital of each country. Human capital will increase as people in most societies have higher skills. From this study, it can be explained why countries with the same technology grow at different rates. This is because production, aside from depending on the level of technology use, also depends on the national average human capital per capita level.

Another theory related to human capital is economic growth, according to the model of MRW; Mankiw, Romer, and Weil (1992) reviewing the concept of the Solow model (1956) that studies the relationship between investment and savings. The MRW model has added significant production factors and human capital to the model. According to studies from 98 countries, it was found that the income differences in each country were caused by the differences in the accumulation of physical capital and human capital. The countries which have high productivity per unit of labor will have a high level of technology and a high level of investment in physical capital. Other countries which have high levels of skills will have an

accumulation of knowledge or investments in human capital although the population growth rate is low. The MRW model can be applied in Thailand because Thailand has accumulated capital, both physical capital and human capital. Especially, human capital is promoted by government policies, labor policy, education policy, and health policy. This results in elderly people with knowledge and skills. Policy guidelines for the extension of the retirement age allow the elderly to be self-reliant. Promoting health care gives the elderly well-being. Promoting participation at community and local levels enables the elderly to participate. Reducing the elderly allowance would make it possible to reduce the financial burden and allow the elderly to contribute to economic growth.

4. Results

This study considers four components that are linked to each other. The first is the demographic change leading to the aging society. The second is the negative impact of the elderly on the fiscal burden. The third is the economic dimension policy for management. The fourth is the positive impact of the Thai elderly in the economic dimension.

- The demographic change

The steadily increasing number of elderly people has resulted in Thailand advancing into an aging society since 2005. The main causes of the transition to an aging society are a decrease in fertility or a reduced birth rate, and longevity or reduced mortality (Foundation of Thai Gerontology Research and Development Institute 2011). This has led to the demographic change shown in Figure 6.

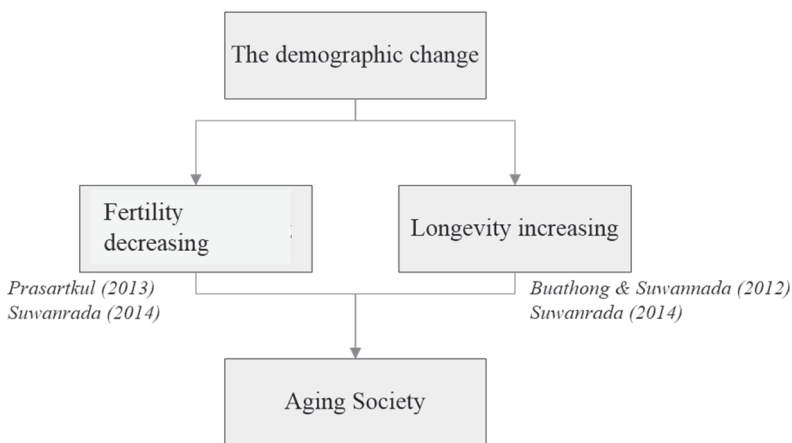


Figure 6. The demographic change.

Source: Author.

- Decreasing fertility

In particular, the Total Fertility Rate (TFR) has decreased markedly since the latter end of the Third National Economic and Social Development Plan that focused on family planning, causing the structure of the population to change (Suwanrada, 2014). This is consistent with Prasartkul (2013) who indicated that the average number of children per woman of reproductive age has decreased sequentially from 4.9 per woman in 1974 to only 1.6 children per woman in 2013 and to approximately 1.3 children by 2033 (Office of the Permanent Secretary for Social Development and Human Security 2013).

- Longevity increasing

While the Thai elderly continuously live longer from the longevity index data, the average life expectancy of the Thai population at birth has increased. In the time between 1964 and 1965, the average life expectancy at birth of males was 55.2 years and females 61.8 years. In the time between 1995 and 1996, the average life expectancy at birth for males increased to 70.0 years and for females to 75.0 years. According to the estimates by the Office of the National Economic and Social Development Board, over about the next 30 years the average expected life expectancy at birth of males will be 76.0 years and females 82.7 years. As a result of these demographic changes, there is an imbalance between the elderly population and the labor

force (Suwanrada 2014). Additionally, the pattern of living of Thai households has changed at the same time with the changing of the population structure. The Thai elderly are living alone more, caused by longevity increasing (Buathong and Suwannada 2012).

- The negative impact on the fiscal burden

Entering the aging society means a decrease in the proportion of labor to the total population in the country. While the proportion of the elderly to the population in the country has increased, it will negatively affect income tax collection. There is an inconsistency between the increased welfare expenditures of the elderly while the collection of tax income tends to decrease. This is a risk factor in the fiscal budget as shown in Figure 7.

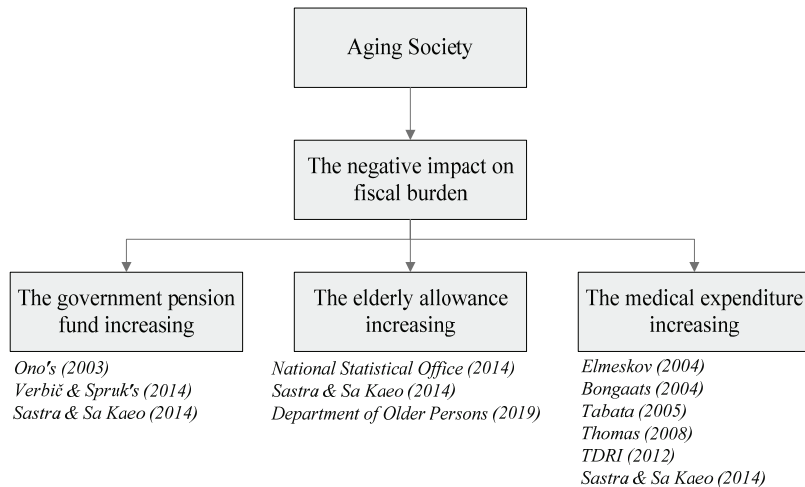


Figure 7. The negative impact on the fiscal burden.
 Source: Author.

- The Government Pension Fund increasing

Many scholars agree on the fiscal burden of the elderly, such as Verbič and Spruk (2014) who studied 33 countries, 31 in the OECD and 2 other non-OECD countries. They found that the demographic structure had changed due to the fertility rate being decreased and people having more longevity. As a result, government pension expenditures are higher in accordance with the old age dependency ratio. This is consistent with Ono's (2003) study which suggested that the increase in the number of older people will make

the fiscal burden and the government pension (Pay-as-you-go) increase because the government must pay a certain amount of money to each civil servant upon retirement. The increase in the number of elderly people, especially civil servants, will increase the budget deficit. Accordingly, for the budgetary expenditures for social welfare projects during 2014–2023, the financial burdens are expected to be, arranged in descending order, the Pension Fund, National Health Security Fund, Allowance for the Elderly, Government Pension Fund of the civil servants, Medical Welfare and Social Security funds. The first ranked government budgeting is the Government Pension Fund (Sastra and Sa Kaeo 2014).

- The elderly allowance increasing

The Survey of National Statistical Office (2014) found that the principal source of the Thai elderly income came from a child. The second most common source of elderly income was from work or employment. However, the government living allowance is the third source of elderly income. The elderly allowance budget is increasing by the proportion of the elderly. Currently, the government uses a fiscal budget to take care of the Thai elderly. Its increases were accounted three times in only 10 years between 2009-2018 (Department of Older Persons 2019). This is consistent with Sastra and Sa Kaeo (2014) who forecast the budgetary expenditures for elderly allowance during 2014–2023, the main part of the fiscal burden is from allowances for the elderly.

- The medical expenditure increasing

For the medical expenditures, Elmeskov (2004) carried out studies in Europe and Bongaats (2004) carried out studies in the G-7 countries. The studies showed that the rising trend of the elderly leads to a higher level of fiscal burdens. The studies coincide with Tabata (2005) who found a consistent correlation between government subsidies and the average age, meaning that the fiscal burden of welfare and future medical expenses will increase as the numbers of the elderly increase. As a result, it may reduce the benefits of future generations. Therefore, social security for health may be a solution that can reduce the fiscal burden. According to Thomas (2008), studying the fiscal burdens in the Czech Republic, it was suggested that if the government reforms on taxes, expenditures, and social welfare, it will be able to reduce the country's fiscal pressures as a result of entering the aging society.

In the Thailand Development Research Institute (2012) estimates for the budget for the elderly between 2012-2021, the government revenue tends to increase under the assumption of economic growth in the base case of 7 percent per year, and the elderly's medical expenditures will also increase dramatically as well. In addition, Sastra and Sa Kaeo (2014) forecast the budgetary expenditures for medical expenditure during 2014–2023, show medical expenditure is increasing, leading to fiscal burdens. Therefore, the government should respond to the needs of most of the elderly as efficiently as possible.

- The government policy

Regarding the numbers of elderly people increasing, this will lead to fiscal burdens. Consequently, many countries in the world, including Thailand, need to adjust the processes and find the appropriate policies for managing the aging society. This is especially important for the economic dimension policy in relation to labor policy, educational policy, and health policy. The government policy is shown in Figure 8.

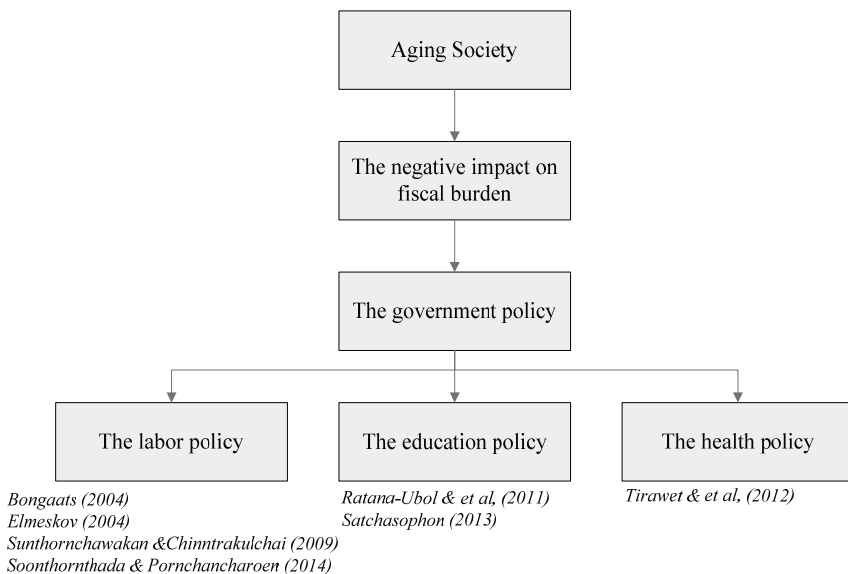


Figure 8. The government policy.

Source: Author.

- The labor policy

The first government policy to manage is the labor policy. The government should extend the working period or increase the opportunity to work for the elderly. This is especially important for the elderly who are still healthy and have knowledge, in order to have enough income to sustain life without relying heavily on children or the government (Sunthornchawakan and Chintrakulchai, 2009). In addition, creating job opportunities for the elderly will help alleviate future labor shortages. For establishing national guidelines and mechanisms for driving the labor policy for the elderly, Soonthornthada and Pornchancharoen (2014) suggest the labor policy for the elderly should cover the systems in both public and private sectors. Moreover, career opportunities should be expanded for informal work in order to achieve systematic practice in all sectors. To manage the ageing society in the future, the government should reform the labor policy for managing the Thai elderly.

Bongaats (2004) suggests the government should promote childbirth to increase the labor force in the economy. Moreover, the government should reduce the elderly allowance or extend the retirement age. This extension of the retirement age will reduce the pension fiscal burden because the elderly can still work. This is in accordance with Elmeskov (2004) who agreed that there should be a new definition of retirement by extending the retirement age, which in the long run will be able to reduce the budget deficit.

- The education policy

The second government policy is the education policy, especially lifelong learning. An estimated seven million Thai senior citizens regularly participate in social activities, usually as members of clubs or groups. There are 64,000 elderly enrolled in 1,163 schools for the elderly to promote lifelong learning, established by the Department of Older Persons (2016). These figures indicate that many older Thais are involved in social activities and are still active. Ratana-Ubol *et al.* (2011) found the lifelong education management for senior citizens was designed mainly to maintain healthful conditions for senior citizens aged between 60 and 64 years old. The education facilitators and instructors included local public health officers who conducted short-term training sessions where personnel acted as the main education media as well as learning sources. The results of this education management can be assessed through observation. Consistently, Satchasophon (2013) found the educational concept for the development of vitality in the elderly to be wealthy and lead to the solution of the burden of dependency is lifelong learning. Thus, the government must have policies

and programs to keep the elderly as active and valuable citizens of society, turning the aging situation of Thailand into an opportunity rather than a burden on the individual, family, community, and nation.

- The health policy

The third government policy is the health policy. The medical expenses in Thailand, including the National Health Security Scheme social security fund, provide contributions in four cases, including illness, disability, birth and death, and government medical expenses (Tirawet *et al.* 2012). There is a predicted trend for these to increase steadily during the 20 years between 2013–2033 at an average of 5.0 percent per year. Therefore, the government proposed to control medical expenditures by extending the principles of risk diversification and creating equality, by establishing a central organization for financial supervision and negotiating services from various hospitals, as well as promoting health and disease prevention.

- The positive impact of the Thai elderly on the economic dimension

However, the rapid increase in the number of elderly people may not be a problem to the fiscal burden, if they are healthy and/or have a high level of experience. The positive impact of the Thai elderly on the economic dimension is shown in Figure 9.

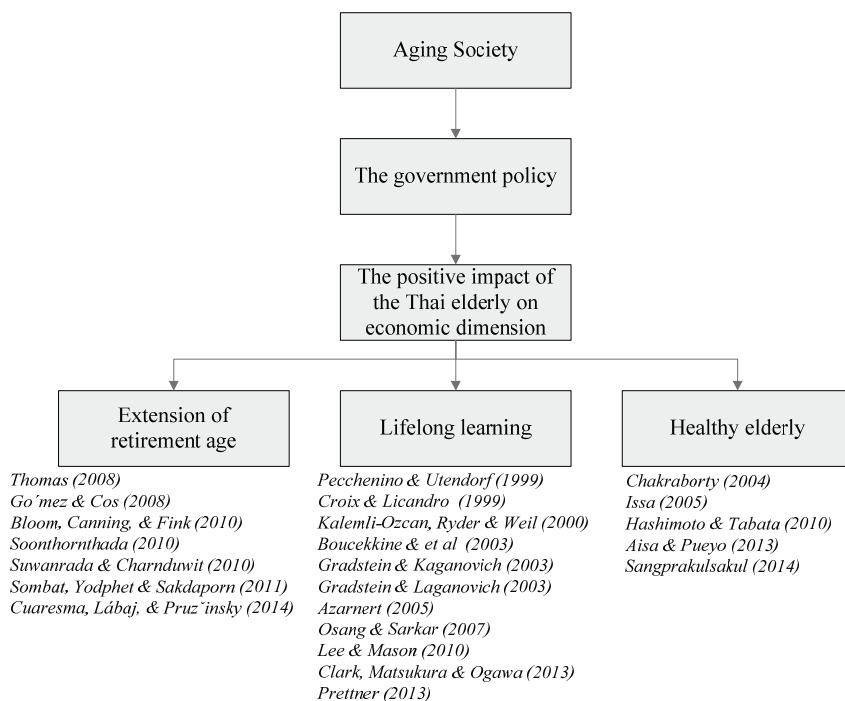


Figure 9. The positive impact of the Thai elderly on the economic dimension.

Source: Author.

- Extension of retirement age

Many studies support the extension of the retirement age. According to Soonthornthada (2010), the elderly have economic values in measurable ways, such as working, income, or savings, leading to stability in life and reducing the risk of poverty. The elderly have social value as human capital that creates benefits for the community and society. Consistent with the study of activities that show the benefit of the elderly, Sombat, Yodphet, and Sakdaporn (2011) found the value of the elderly. Besides the benefits of business activities that are paid from work, monetary compensation, the elderly also give service activities. This especially includes activities in families and society that are not paid or work in a volunteer manner that cannot be assessed in monetary values.

The Constitution of the Kingdom of Thailand Article 53, the social welfare policy, stipulates that persons over the age of sixty years and who do not have enough income to support themselves have the right to receive public welfare facilities with dignity and appropriate assistance from the state. Therefore, concrete practical guidelines for the constitution should be established. The welfare expenses for the elderly care, such as living allowance for the elderly, social security fund contribution, elderly and child allowance, National Savings Fund, Subsidies Government Pension Fund, and contributions to the Government Pension Fund (GPF) tend to continuously increase between 2013 and 2033, an average of 8.2 percent per year. Therefore, it is proposed to increase the retirement age of workers. The government should improve the benefits of social security funds to be consistent with the income from the contribution and increase the contribution rate by a salary ceiling that is used to calculate the contribution. Additionally, the government must promote the role of people in saving while still working. Suwanrada and Charnduwit (2010) propose the design of an appropriate and possible national savings system allowing people to participate in saving while working to reduce the fiscal burden in the future.

In addition, Bloom, Canning, and Fink (2010), Cuaresma, Lábaj, and Pruzínsky (2014), and Go´mez and Cos (2008) suggest that the elderly can affect the economic dimension and economic growth of the country through the increase of human capital accumulation. When humans accumulate capital, they can work longer as well. Thomas (2008) suggested that if the government reforms taxes, expenditures, and social welfare, it will be able to reduce the country's fiscal pressures as a result of entering the aging society. In addition, it is proposed to increase the VAT rate from the original, reducing the burden of paying health benefits and adjusting the pension system by extending the retirement age from 60 years to 65 years, along with adjusting the number of years of work that will receive pensions from 25 to 35 years. It was forecasted that the budget deficit will be reduced by 0.5 percent of GDP within 1 year after the reform and decrease by 0.25 percent of GDP within 2 years after the reform. Consequently, it will benefit the government's budget balance in the long run.

- Lifelong learning

Many studies promote lifelong learning. For example, the study of Pecchenino and Utendorf (1999) used the Overlapping Generations Model (OLG) to study the impact of the pension system, pay-as-you-go, in an aging society. The study indicated that without continuing education support, the economy will grow at a reduced rate. This was in accordance with Croix

and Licandro (1999), Kalemli-Ozcan, Ryder and Weil (2000), Boucekkine *et al.* (2003), Gradstein and Kaganovich (2004), and Azarnert (2006) who tested the relationship between mortality and investment in human capital. The study found that there is a correlation in the same direction. If increased longevity is expected, it will lead to an increase in education investment. Education should start at an early age. However, the number of children in a family also affects investment. When families have children, parents must decide to allocate income to invest in education for each child.

According to Lee and Mason (2010) families with low birth rates at present can provide their children with quality education. Considering the global education system, the scholarships are different in each country. Generally, the education system is divided into three types: government grants, private scholarships and funding from the collaboration between the public and private sectors. Gradstein and Laganovich (2004) acknowledged that a government-funded educational system can contribute to economic growth, while Osang and Sarkar (2008) suggested a combination of government and private sectors for the highest social welfare, so it can affect economic growth.

Besides, many studies agree that investing in human capital is not limited to school but includes various kinds of training. Also, Clark, Matsukura, and Ogawa (2013) found that training is likely to increase the skills of workers which increased opportunities for work in the labor market. This is consistent with Prettnner (2013), who acknowledged that human capital investment in parallel with longevity will lead to increased productivity. This increased productivity has been passed on through technological advances and research and development. Finally, it affects economic growth based on the endogenous growth model by lifelong learning.

- Healthy elderly

Another human capital investment in the form of health is very interesting because the healthy elderly will not be a dependency burden for their family if the elderly are still able to work to earn money for themselves. Chakraborty (2004) found good health results in a long life, reduced mortality and increased quality time in work. This is consistent with Issa (2005) indicating that good health can affect economic growth because if the workers have good health, then there are results in the quality of the work. It is to the benefit of the economy at the micro level. In addition, it will also benefit at the macro level, which can reduce the medical expenditure from the government budget.

According to health care studies based on the OLG model by Hashimoto and Tabata (2010) there is a direct relationship between the elderly, health, and economic growth. If there are increases in health care, it will increase the number of healthy elderly people. Finally, this will result in increased employment in the public health sector. However, Aisa and Pueyo (2013) argued the effect is not clear because most employment is in the goods and service sectors, not only in the public health sector. However, the overall employment increases by increasing the number of healthy elderly people.

Likewise, Sangprakulsakul (2014) regarded the level of Thai elderly people in three areas: health, participation, and security. Overall, elderly people were at the medium level. The highest level was health, followed by participation and security, as a result of past operations in Thailand, particularly preparation and health support for the elderly. Therefore, to make the elderly become more experience in all areas the government should support jobs for the healthy elderly to build security and encourage the elderly to participate in society as well.

The four components are linked to each other. The first is the demographic change leading to the aging society. The second is the negative impact of the elderly on the fiscal burden. The third is the economic dimension policy for managing. The fourth is the positive impact of the Thai elderly in the economic dimension. Figure 10 shows the impacts of the Thai elderly in the economic dimension.

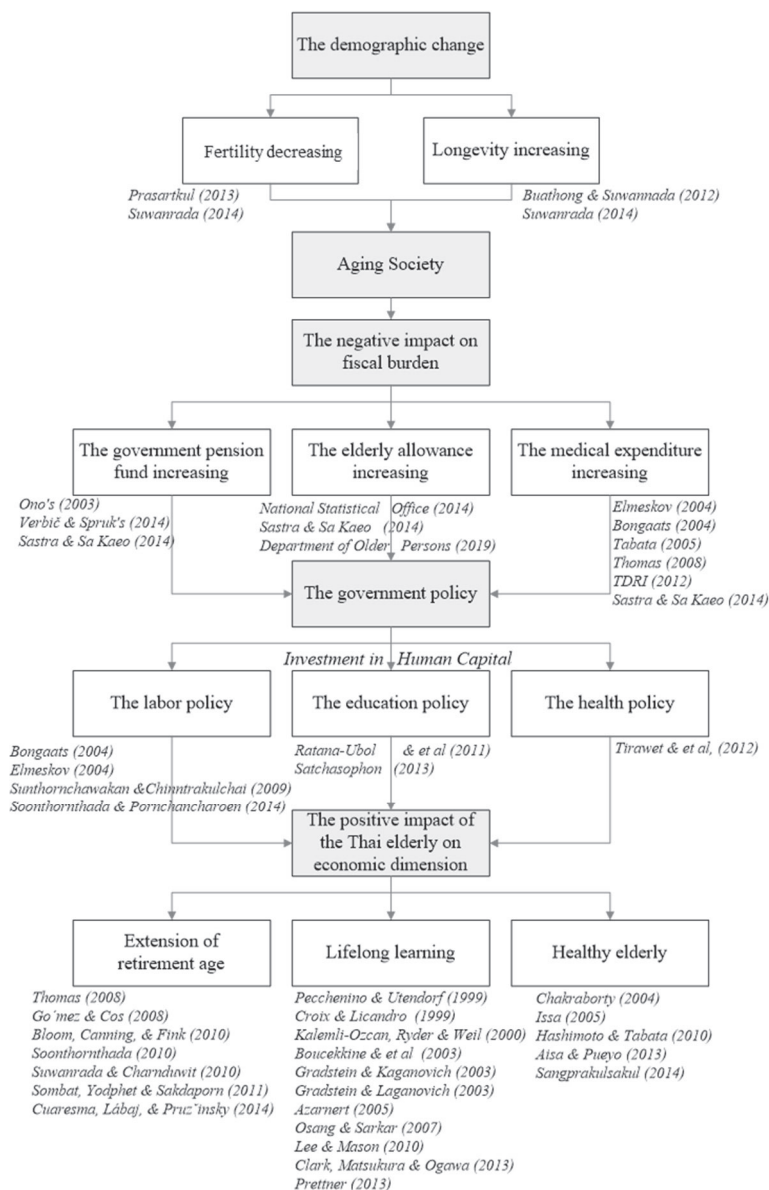


Figure 10. The impact of the Thai elderly in the economic dimension.

Source: Author.

5. Conclusions

The main factors influencing the Thai elderly came from economic and social development. Additionally, medical and public health development lead to rapidly entering an aging society. The demographic change shows that the numbers of the elderly are increasing while the numbers of children and the working age group are decreasing. This situation is causing many countries in the world, including Thailand, to enter the aging society stage inevitably. The aging society will affect the economic dimension. If the elderly have insufficient income or savings to make a living after retirement, it will be a burden on the working population and the government budget to allocate income from taxes to take care of the elderly. Therefore, the government must adjust strategies by turning the crisis into opportunities, such as encouraging the elderly to work longer if they still have the knowledge, and are capable and healthy. Moreover, lifelong learning means the elderly have knowledge and skills all their life. Additionally, the healthy elderly will not be a dependency burden for their family. The government support policies such as labor policy, education policy, and health policy will affect the extension of employment, savings, investment, and future economic growth. This indicates the elderly may not be a burden to society if the elderly can still perform economic activities or give benefits to the economy.

The quality elderly must go through a process called “Investment in human capital.” Lucas (1988), Mankiw, Romer, and Weil (1992) explain that human capital is the knowledge and expertise that is available in labor. Human capital is a type of production factor in terms of producing goods and services. The human capital accumulation, such as investment in education and health will make that labor force skilled and able to perform work efficiently which affects the economic dimension and economic growth finally (Sukpaiboonwat, Plyngam and Jaroensathapornkul 2014, and Sukpaiboonwat 2017).

From the past, most studies are subject-specific and lack coherence in an overview. Therefore, this study analyzes data to give an overview, including causes of the demographic change, the effect on the fiscal budget, and the policies for managing the elderly in the economic dimensions. This paper is a guideline for education to see problems and obstacles as well as solutions to improve and create opportunities for the elderly to have a sustainable society and place in the economy of Thailand. However, this analysis is only preliminary. The next study will be empirical research by collecting data and using statistics to analyze the data to make the education more complete.

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IMPACTS OF MICE ACTIVITIES TO THAILAND ECONOMY

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Abstract

This study aims to analyze the economic impacts of MICE activities in Bangkok in the first half of the year 2019, including Thailand Toy Expo, Bangkok Motorbike Festival, Hotel Art Fair Bangkok, and Low Fat Art Festival. Since the Input-Output Model is a powerful tool for estimating the economy-wide effects of any initial changes in any economic activities, the research applies the IO model to approximate the economic values which were created from the activities. The study estimates the value of the Gross Domestic Product (GDP), job creation, and tax revenues. The results show that the activities generated GDP equal to 4.598 billion THB. Also, the government gained 462.85 million THB from tax revenues. Lastly, the MICE activities created 33,575 jobs in related industries. Due to these positive results in economic status, the government should support the MICE activities.

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1. Introduction

The service industry is an important economic sector for developing the country's economy as the service sector generates huge revenue. Also, it distributes the revenue generated widely to various related business sectors such as tourism, transportation, food, entertainment, retailing etc. In addition, it will provide other benefits such as creating jobs and adding value to products in the economy as well.

MICE are types of tourism which are usually planned in advance. MICE refers to four businesses, namely Meetings, Incentives, Conferences and Exhibitions. The advantages of MICE are different from general tourism. For example, MICE can be arranged throughout the year without a low season. They can be arranged during working days. Organizing meetings at an international level means they are usually booked in advance for a year. MICE also allow operators to anticipate incomes in advance. MICE activities often choose tourist destinations based on the city where the event is held. Therefore, they can distribute income to different cities.

From the above information, it is found that the MICE activities involve quality travel and have higher expenses than other types of tourism. Therefore, the businesses have received attention and can distribute income widely to many other business sectors, both directly related and indirectly related. Thus, MICE will provide direct or indirect economic benefits which can be briefly summarized for the advantages of MICE activities as follows: MICE activities create income for the country from the spending of the MICE attendees which causes the country's balance of payments to improve. The activities additionally create jobs both directly and indirectly causing better income distribution. The activities have effects by increasing the revenues of related businesses both in the community and outside the community. Moreover, they help by generating government revenue, especially income from taxes. The country that has been chosen to be the host must be a country that is well accepted, so the activities promote the image of the host country. MICE activities can stimulate competition in the service industry, which influences the improvement of the service standards, and also helps develop the potential and skills of people in the industry, which leads to the creation of quality work and efficiency. In addition, these result in increasing investment in business sectors.

MICE activities generate revenue of almost a hundred billion baht and MICE international tourists will have high expenses per trip which are

approximately 80,000 baht per trip. Kasikorn Bank Research Center has estimated that MICE will expand to 113,982 million baht or grow at an average of 9% per year. In Thailand, the Thailand Convention and Exhibition Bureau (TCEB) is a government organization established to promote and develop MICE activities in Thailand. Its objectives are to push Thailand to be the center of outstanding MICE activities in Asia. The organization mainly responds by supporting and subsidizing MICE events which will be arranged in Thailand.

Thailand has a high potential for arranging MICE activities due to its many facilities. There are large conference centers spread throughout Bangkok and other regions. Thailand also has supported businesses that promote MICE activities such as convention centers, which have international standards, and a large number of hotels (about 5,000 places with about 300,000 rooms). Additionally, Thailand has many provinces that are among the world's top tourist destinations.

The transportation system is developed to make traveling very convenient, Suvarnabhumi Airport, the international airport in Bangkok, has complete facilities and is the aviation center of Asia. Thailand has expertise in organizing standardized and professional MICE events. Personnel are well trained, which has contributed to the excellent results of all MICE activities held in the area. MICE activities which are arranged in Thailand have been accepted by many Thai and foreigners. Moreover, Thailand has the ability and experience of organizing important meetings at an international level. There are international meetings organized in the main provinces which have contributed to creating the image of Thailand towards the perspective of foreigners and gaining trust to be the venue for future events.

As mentioned previously, Thailand has attractive tourist attractions with different topographical features such as mountains and beautiful beaches causing tourists to come to Thailand to have a variety of options. There are many cultural and economic tourist attractions together with souvenir products and craftsmanship which are considered exquisite and impressive and clearly demonstrate the Thai identity.

Also considered distinctive features that have a positive effect are positive factors such as banquets that occur in conjunction with MICE activities. There are also other factors that enhance competitiveness, such as costs, kindness and the good nature of Thai people. All of these reasons result in more people wanting to organize MICE events in Thailand.

Table 1. Number of participants attending MICE events in major provinces of Thailand from the year 2016 to 2018.

Activities	2016	2017	2018
Meetings	194,884	191,781	240,015
Incentives	152,342	157,621	203,501
Conferences	222,706	222,147	240,924
Exhibitions	180,480	215,992	233,228
Total	750,412	787,541	917,668

Source: Thailand Convention and Exhibition Bureau (TCEB).

The number of participants attending MICE activities in the main provinces of Thailand from the year 2016 to 2018 increased every year. There were 750,412 participants attending MICE activities in the year 2016 which increased to 917,668 participants in the year 2018. Most of the participants attended conferences followed by meetings, exhibitions and incentives, respectively.

Table 2. Revenues from MICE events in major provinces of Thailand from the year 2016 to 2018.

(million baht)

Activities	2016	2017	2018
Meetings	17,676.22	19,738.04	21,768.81
Incentives	9,374.07	9,682.44	11,387.51
Conferences	19,236.76	19,342.26	19,223.34
Exhibitions	15,686.00	18,869.00	19,156.00
Total	61,973.04	67,631.74	71,535.66

Source: Thailand Convention and Exhibition Bureau (TCEB).

Overall revenue from international MICE activities in major provinces of Thailand from the year 2016 to 2018 are shown in Table 2. Noticeably, the revenues continuously increased. There were 61,973.04 million baht in the year 2016 which increased to 71,535.66 million baht in the year 2018. Most

revenue was from meetings followed by conferences, exhibitions and incentives, respectively.

Although the government is willing to support MICE activities, the budget is limited. In order to confirm that it is worthwhile to spend the budget supporting MICE, the analysis and investigation of total economic impacts which are created from all MICE activities is necessary. Therefore, this study aims to evaluate the economic impacts, including Gross Domestic Product (GDP), employment, and government tax revenues which were generated from MICE activities in Bangkok in first half of the year 2019 by using the Input-Output Model in order to encourage the government to support MICE activities in the future.

2. Literature Review

To analyze economic impacts from the tourist sector, researchers used different methods to calculate the total benefits. Stynes (1999) refers to the Money Generation Model by using important variables such as number of tourists, average spending per visitor and industry multiplier to synthesize the spending impacts. However, since 1990 the input-output multiplier method is often used to estimate this advantage (Fleming and Toepper 1990). Since the I-O multiplier can be applied to investigate the linkage effect to all stakeholders in the country (Journal of Travel Research), this mechanism is the best method to examine the influence of the MICE industry.

This section reviews the significance of the inter-industry linkages of economic sectors. Also, linkage analysis allows the comparison of different sectors of the economy in terms of the interdependence of their production structures (Pratt 2011). Various econometric models have been used to measure economic linkages and the impact of tourism in an economy. The Input-Out Model (I-O model) is one of the tools. This study applied the I-O model to analyze the economic impacts of MICE activities in Bangkok. The I-O model is used widely in order to measure the economic impacts of the tourism industry because it is comprehensive and flexible.

The basic structure of the Input-Output Model can be generally applied to tourism impact analysis. Each impact can be divided into different components, depending on the effect that caused the impacts. The impacts which can be determined are the direct, indirect and induced impacts. The direct impacts from the initial spending create additional activity in the local

economy. The impacts result from the money initially spent in the province by the businesses which include money paying for wages, buying materials and supplies, and other expenses. Indirect impacts are the consequences of business-to-business transactions indirectly caused by the direct effects. They are the measure of the increase in business-to-business activity. Lastly, induced impacts are the outcomes of increased personal income caused by the direct and indirect effects. Businesses experiencing increased revenue from the direct and indirect effects will subsequently increase payroll expenditures such as hiring more employees and increasing payroll hours. Then households will spend more with local businesses. The induced impacts are the measurement of this increase in household-to-business activities.

More exclusively, the I–O table rows show ‘who gives to whom’ and the columns show ‘who receives from whom’ (Bekhet 2010). Thus, the linkages using I–O models refer to the transactions among different economic sectors. The model provides a holistic picture of the economic structure of a region. Most researchers emphasize that input-output analysis is used to assess short- to medium-term tourism impacts (Archer and Fletcher 1990).

From the literature, Rasmussen (1956) (Rasmussen 1956) first used the I-O table to estimate impacts from tourism on the economy growth. Moreover, some economists (Lindberg, 2011) used the I-O table with computable general equilibrium models to analyze the economy. The evidence showed that the I-O table can be adopted to calculate how each sector in the economy affected each other sector and how they were distributed over the economy. For instance, Beynon *et al.* (2009) undertook analysis of 11 tourism-related sectors in 79 economic sectors in the Welsh economy. The paper found that transportation, recreation and welfare, guest houses and non-serviced accommodation were considered the key sectors and they achieved greater values in backward and forward linkages than other economic sectors.

3. Methodology

The methodology calculates the impacts of MICE activities from three distinctive sources, which are (1) The activities that are arranged in MICE, (2) The MICE operators and (3) The spending by the MICE visitors and attendees (Hodur *et al.*, 2006). Expenditure from MICE attendees includes all traveling costs to the MICE destination, accommodation costs, food and beverage spending and other spending in terms of leisure or shopping.

Additionally, Fleming and Toepper (1990) exposed the direct positive economic impacts of events in the study areas which were estimated from the primary data gathered in each event. The questionnaires asked about the tourists' spending in the event in terms of incomes, job creation and taxes. This research used the primary data collected from the survey at MICE events to explore the economic benefits. Then we used input-output techniques which can reflect the information on employment, profit, and indirect tax. Moreover, the impacts analysis can be varied due to data provided from the survey such as accommodation and transportation expenses which were generated at the MICE activities.

Further, this study calculated the direct effects, indirect effects and induced effects using the input-output table and evaluated economic benefits by using backward and forward linkage models developed by Miller and Blair (2009). The expenditure data that have been collected by questionnaire in each event demonstrated the economic benefit values, such as total output production, wages/salaries, operating surplus and indirect taxes less subsidies. The backward linkage models are described in Equations (1) to (2), and forward linkage models are described in Equations (3) to (4).

Backward Linkage

$$X = AX + F = (I - A)^{-1}F \quad (1)$$

$$P = BX = B(I - A)^{-1}F \quad (2)$$

Forward Linkage

$Y = (I - D)^{-1}D^{-1}G$	(3)
$Q = BY = B(I - D)^{-1}D^{-1}G$	(4)

Where,

- X, Y denoted the vector of total output production for Backward/Forward linkage
- P, Q denoted the vector of primary input for Backward/Forward linkage
- A denoted the matrix of input technical coefficient
- D denoted the matrix of output coefficient
- B denoted the matrix of primary input coefficient
- F denoted the vector of total final demand
- G denoted the vector of total input used in production

From the backward-forward linkage model, we input the primary data (expenditure information) into the total output production (X in the backward linkage model, Y in the forward linkage model). For input technical coefficient (A) and primary input coefficient (B), we used the transformed I-O data from the Office of the National Economic and Social Development Council (NESDC). After receiving the backward/forward linkage results, we categorized the outcomes into direct, indirect and induced benefits. The direct, indirect and induced benefits imply the economic outcomes which were caused by the MICE activities.

4. Data and Results

As mentioned in the previous section, this study compiles the 2010 national I-O table for Thailand from the NESDC. Tourism is not a sector in the standard I-O table. However, it affects the increasing growth rate of other sectors both backward and forward. This study aims to analyze the economic impacts of MICE activities in Bangkok in the first half of the year 2019. There were four MICE activities in the first half of the year 2019, which were Toy Expo, Bangkok Motorbike Festival, Hotel Art Fair Bangkok, and Low Fat Art Festival. The survey of the expenditures of MICE visitors, attendees and organizers were collected during the periods of the activities. The study distributed 350 questionnaires for each activity. The demographics, expenditures and satisfaction details of international and domestic visitors were gathered. In this study, the 180 x 180 sectors of the 2010 National I-O table were used.

The multipliers of backward and forward linkage were calculated in order to estimate the impact of all MICE activities on the Thailand economy. The main economic industries which related to the MICE activities were selected, such as local transportation, food and beverage, retail, construction, entertainment, personal business etc. The multiplier was the ratio of change in target variables to the change in MICE spending that caused it. For example, Table 3 shows 1.74 in forward linkage of intermediated inputs means every 1 percent increase in MICE spending will increase values of intermediated inputs by 1.74 percent in forward industries of local transportation. The multipliers are shown in Table 3.

Table 3. Multipliers of Backward and Forward Linkage from MICE Activities.

I-O Industry		Intermediated inputs	Wage and salary	Profits	Indirect tax	Value added
Local Transportation	Backward Linkage	1.74	0.25	0.41	0.16	0.95
	Forward Linkage	0.05	0.01	0.02	0.00	0.03
Food and Beverages	Backward Linkage	1.53	0.25	0.47	0.11	0.93
	Forward Linkage	0.05	0.01	0.02	0.00	0.04
Retail	Backward Linkage	0.38	0.06	0.10	0.02	0.22
	Forward Linkage	0.12	0.02	0.04	0.01	0.08
Personal Business	Backward Linkage	1.40	0.21	0.35	0.07	0.74
	Forward Linkage	0.00	0.00	0.00	0.00	0.00
Business Service	Backward Linkage	1.48	0.25	0.39	0.08	0.86
	Forward Linkage	0.31	0.05	0.08	0.02	0.19
Cleaning Service	Backward Linkage	0.87	0.13	0.21	0.06	0.47
	Forward Linkage	0.25	0.05	0.08	0.01	0.17
General Construction	Backward Linkage	1.50	0.22	0.37	0.06	0.76
	Forward Linkage	0.00	0.00	0.00	0.00	0.00
Entertainment	Backward Linkage	0.65	0.11	0.17	0.03	0.36
	Forward Linkage	0.03	0.01	0.01	0.00	0.02
Air Transportation	Backward Linkage	1.82	0.29	0.44	0.15	1.04
	Forward Linkage	0.13	0.03	0.05	0.01	0.10
Bus Transportation	Backward Linkage	1.74	0.25	0.41	0.16	0.95
	Forward Linkage	0.05	0.01	0.02	0.00	0.03
Hotel	Backward Linkage	1.47	0.25	0.40	0.09	0.89
	Forward Linkage	0.03	0.01	0.01	0.00	0.02
Rental	Backward Linkage	0.40	0.08	0.12	0.03	0.28
	Forward Linkage	0.07	0.02	0.03	0.00	0.05

The study estimates the values of the Gross Domestic Product (GDP) contribution, job creation, and tax revenues from the MICE activities. The results are shown in Table 4.

Table 4. Economic impacts from MICE events in the first half of the year 2019 in Thailand.

	Low Case	Base Case	High Case
GDP Contribution (THB)	4,368,248,266.46	4,598,156,069.96	4,987,337,044.08
Job Creation (Jobs)	31,897	33,575	35,877
Government Tax Revenues (THB)	439,708,999.77	462,851,578.17	502,136,961.77

The results show that the MICE activities generated a Gross Domestic Product (GDP) contribution equal to 4.598 billion THB. Also, the government gained 462.85 million THB from tax revenues. Lastly, the MICE activities created 33,575 jobs in related industries. The study estimated the economic impact dividing into a low case and a high case. Under the low case, GDP contribution, employment, and tax revenue generated 4.368 billion baht, 31,897 workers, and 439.71 million baht, respectively. Under the high case, GDP contribution, job creation, and tax revenue generated 4.987 billion baht, 35,877 jobs, and 502.14 million baht, respectively.

The estimation of economic impacts under the base case was calculated from the expenditure of all participants and organizers from the four MICE activities in the first half of the year 2019. The expenditures influenced three components, which were direct effects, indirect effects and induced effects, as follows.

Table 5. The components of economic impacts from MICE events in the first half of the year 2019 in Thailand.

	Direct Impact	Indirect Impact	Induced Impact
GDP Contribution (THB)	2,211,142,520.22	2,268,585,890.39	118,427,659.39
Job Creation (Jobs)	16,257	16,471	847
Government Tax Revenues (THB)	174,074,836.22	276,930,652.05	11,846,089.93

Under the direct impact, the MICE activities created .2211 billion baht GDP contribution. Also, they provided employment to 16,257 workers and generated tax revenues of 1740.7 million baht. Given the indirect impact, GDP was increased by 226.9 million baht. As well they created 16,471 jobs and produced government tax revenues of 276.93 million baht.

The induced effect generated GDP equal to 118.43 million baht. The job creation was 847 jobs and the MICE activities could contribute government tax revenues equal to 11.85 million baht.

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AGING, SOCIAL SECURITY, AND ECONOMIC GROWTH

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Abstract

An aging population is a significant common challenge faced by developed countries; in particular, Japan's population is the world's oldest. An aging population is accompanied by increased social security expenditure, such as medical services, pension benefits, or long-term care, which are the main driving factors of fiscal deficits. Moreover, economic growth is essential, both to support older people and to sustain the income of younger generations. Thus, continual increases in social expenditure are dependent on sustainable economic growth.

This study shows an empirical relationship between social expenditure and economic growth using panel data from OECD countries. Our analysis reveals the complexity of measuring the extent to which a higher rate of aging exacerbates increases in social security expenditure. Additionally, increases in social security tend to result in government budget deficits.

In regard to the impact of increased social expenditure versus economic growth, we assessed the relationship between them using OECD panel data. We proved that the social expenditure factor negatively impacts economic growth when other economic factors are under control. The foregoing findings were also confirmed by using a dynamic panel estimation method.

In conclusion, in discussing the causality between social expenditure and economic growth, we considered six hypotheses: consumption, investment,

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retirement, saving rate, the ineffectiveness of government, and government deficit.

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1. Introduction

Japan is widely considered to have the oldest age structure in the world, which is also regarded as troubling in many other developed countries. An aging population gives rise to significant social security challenges such as pension requirements, the increased cost of healthcare, or broad needs for long-term care, and others, thereby placing expenditure under considerable pressure. Each country has its own system of pensions, as well as providing medical and long-term care for the elderly. However, a common phenomenon in all those countries with aging populations is ever expanding budgets for these provisions. In particular, Japan's high public debt accumulates through yearly deficits, the most prominent factor being increased social security expenditure.

Future prosperity is conditional on sustainable economic growth, but the pressures from social security spending and government deficits could possibly reduce economic growth. The primary objective of this study is to determine the extent to which social security expenditure on aging populations affects economic growth. As might be expected, the many diverse economic growth factors complicate the analysis of the engine of economic growth. This study measures the direct relationship between social security spending and economic growth while controlling various supply side and demand side economic variables, by using panel data from Organization for Economic Cooperation and Development (OECD) countries. A significant relationship between social security spending and economic growth would indicate reduced economic growth is consequential to aging populations, unless past economic growth structures are revised in the future.

This study is structured as follows: Section 2 contains the basic strategy and the relevant studies; Section 3 demonstrates the statistical relationship between an aging population and social security expenditure. The econometric analysis reveals the degree to which a progressively aging

population influences increased social spending; Section 4 presents the main empirical results found in the relationship between social spending and economic growth using the OECD panel data set. Conclusions and discussions are presented in Section 5.

2. Strategy and Related Literature

2.1 Strategy

The aims of this paper are to confirm and investigate the influence of social expenditure increases on economic growth. To achieve this, the strategy employed in the empirical analysis contains two steps.

The first step is to confirm the relationship between aging populations and social expenditure, defined by OECD standards as comprising cash benefits and direct in-kind public provisions. Herein, we focus on the extent to which the progressive rate of aging causes increases in social expenditure and affects the government budget balance.

The second step is to investigate the relationship between economic growth and social expenditure. Importantly, a distinction should be made between the demand and supply sides when investigating economic growth factors. On the demand side of the economy, consumption, net-exports, and government expenditure are major factors affecting economic growth. However, by assuming that substituting social expenditure as a variable of the total government expenditure in the first step above, the selection of dependent variables in the empirical analysis requires circumspection. Furthermore, on the supply side of the economy, factors such as labor inputs or capital growth are requisite in economic growth analysis.

Why should this two-step analysis be adopted? If economic growth rate is the dependent variable and aging and demand factors – including government expenditure and supply factors – are regressors, the model is not suitable, as aging is strongly correlated with other regressors, such as government expenditure and labor inputs. In summary, the simultaneous inclusion of aging indicators and other economic variables is erroneous. An appropriate analysis of the relationship between aging and economic growth requires this two-step strategy to avoid endogeneity bias and multicollinearity among regressors.

In the next section, we present our investigation into the relationship between aging and social spending, in particular the extent to which aging affects the rate of social expenditure in various countries. In addition, we will measure the influence of social expenditure on the national government's budget balance. The subsequent chapter contains our empirical analysis of economic growth and social expenditure.

2.2 Literature

The impact of aging on public spending has general acceptance in the literature. The seminal paper on the discussion of an aging society and the fiscal response is Culter *et al.* (1990). Following the publication of this acclaimed study, interest in the subject of aging came to the fore in economic and social sciences. Another prominent study, Gruber and Wise (2001), concluded that in OECD nations, older citizens were supported by government spending. Other studies include the well-known Annual Ageing Report by the European Union (e.g., EU 2018) and several recently published empirical studies, for example, Mello *et al.* (2016) or Žokalj (2016). Mello *et al.* (2016) found that older individuals were more likely to support increases in spending on pensions, and Žokalj (2016) identified significant and positive impacts from pensions and social protection expenditure.

The literature is commensurate on the subject of aging and economic growth. An earlier, authoritative and skillful study by Bloom *et al.* (2003) deftly summarized the pessimistic, optimal, and neutral views. More recently, the remarkable work by Maestas *et al.* (2016) estimated the economic impact of aging on state output per capita and found that a 10% increase in population aged 60 years and over resulted in a 5.5% decrease in the GDP per capita growth rate. Furthermore, Bloom *et al.* (2008) found that an aging population had a negative short-term impact. However they were unable to draw long-term conclusions. Additionally, Bloom *et al.* (2011) suggest that OECD countries are likely to experience a decline in the rate of economic growth. Moreover, Sheiner (2014) proposed that population aging would lead to a reduction in per capita consumption because of a reduction in wages. As to Korean research, Lee *et al.* (2017) projected that population aging continuously reduced the future economic growth rate by 2.7% per annum.

A large amount of research has been aimed at gauging the relationship between government expenditure and economic growth, producing

contradictory results. Although a number of studies have shown that an increase in social expenditure as a share of GDP was associated with a decline in economic growth, other studies argued that a rise in social expenditure had a positive impact on economic growth. Landau (1983) found a negative relationship existed between government expenditure and GDP growth rate. Also, Folster and Henrekson (2001) and Kato (2005) found a robust negative relationship existed between government size and economic growth.

On the contrary, Devarajan *et al.* (1996), Kelly (1997), Khan and Bashar (2015), Furceri and Zdzienicka (2012), and Alper and Demiral (2016) described social expenditure as a contributor to economic growth, and Dreger and Reimers (2005) suggested a long-term positive relationship between health expenditure and economic growth. Alam *et al.* (2010) similarly reported that efficiently increased social expenditure would affect economic growth positively. Carter *et al.* (2013) suggested that outlays on health and social security had minimal influence on per capita economic growth.

3. Aging and Social Expenditure

3.1 Basic Statistics

In reference to the introduction, while Japan is singled out as the most aged, population aging in other developed countries is also progressive. Figure 1 shows the ratio of 65 years and over population to total population (hereafter referred to as the “aging ratio”) in 36 OECD countries in 2018. This aging ratio for Japan is 28.1%, and the average of 36 OECD countries is 17.2%. As for other countries, six countries are over 20 %, and 16 countries are over 19% (excluding Japan). By way of reference, the average aging ratio of the 36 countries in 1980 was 10.8%, while Japan’s was only 9.1%. Furthermore, the average ratio of the 75 years and over population to total population (hereafter referred to as the “deep aging ratio”) in the 36 countries was 7.9% in 2018, compared to 4.0% in 1980. Of course, Japan displayed the highest deep aging ratio of 14.2% in 2018.

Social expenditure is defined by the OECD as the basic measure of social security spending including for old age, health, family, and others. Figure 2 shows the ratio of social expenditure to GDP in 36 OECD countries in 2015. France recorded the highest ratio at 32.0%, followed by Finland at 30.4%, and Belgium at 29.2%. Conversely, the ratio for Japan, the most aged

country, is 21.9%. The simple average of this ratio has increased to 20.4% from 17.7% in 2000. By isolating expenditure on old age which is for pensions, home-help and residential services for the elderly from the total social expenditure, the 36 countries average was 7.6% in 2015 compared to 6.2% in 2000. Similarly, by differentiating health expenditure, which is for patient care, medical goods, and prevention from the total social expenditure, it was 5.7% in 2015 compared to 4.7% in 2000.

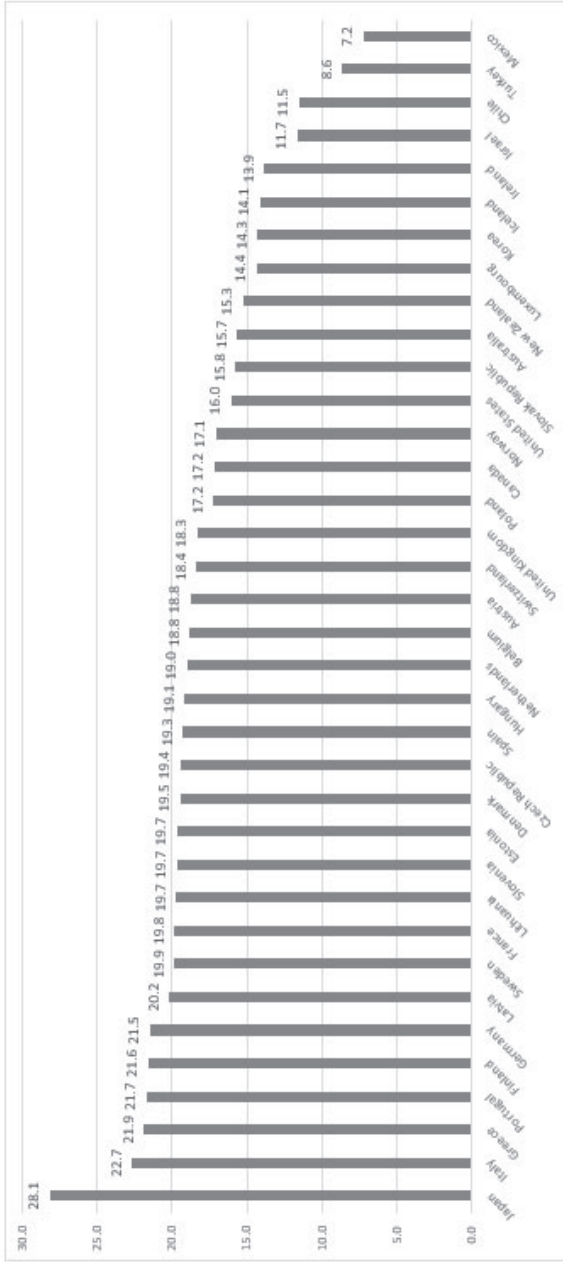


Figure 1: Ratio of 65 years old and over to Total Population in 2018 (%).

Source: OECD Database

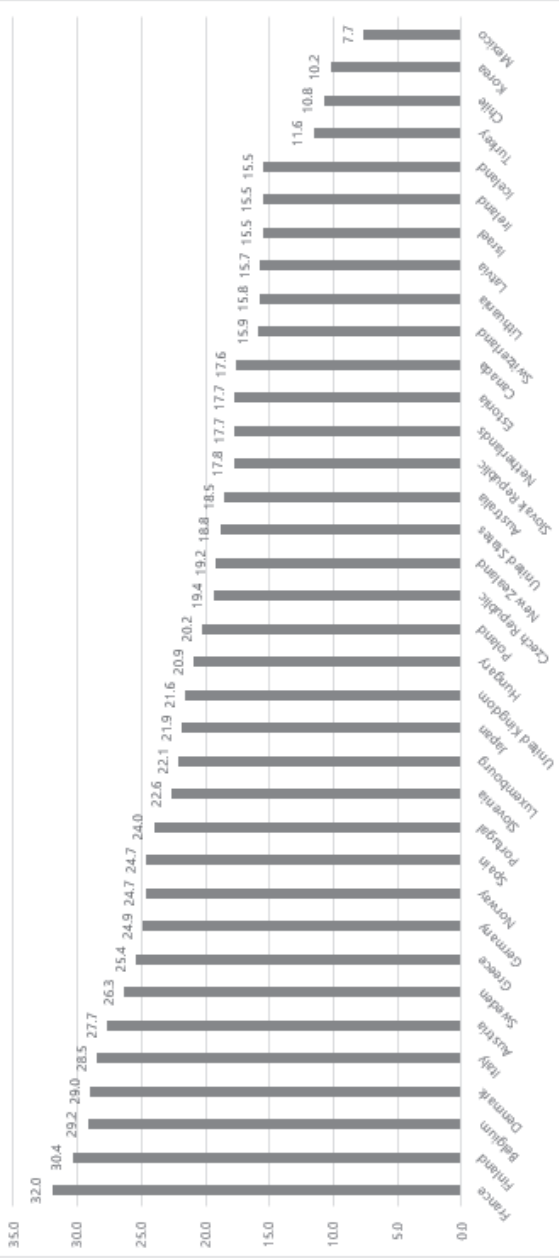


Figure 2: Social Expenditure to GDP in 2015 (%).
Source: OECD “Social Expenditure”

3.2 Estimation Results

We confirmed the impact of aging on social expenditure, through a regression in social expenditure, measured by its ratio to GDP on an aging index by using panel data from OECD countries between 1989 and 2018, this basic result is shown in Table 1. The coefficient of aging ratio is statistically significant, and the value of the coefficient is 0.8842 in the fixed effect model in case 2. To identify the strongness of degree of aging, we measured two aging indexes, which were the ratio of the population aged 65–74 years to the total population (hereafter referred to as the “active aging ratio”) and the deep aging ratio, and estimated social expenditure for both ratios. The calculated coefficients differ considerably. In case 5, although the coefficient of the active aging ratio is 0.3966, that of the deep aging ratio is 1.2316, which means that the impact of deep aging on social expenditure is three times greater than that of the active aging ratio. These results indicate that it is necessary to distinguish between active aging and deep aging for the purpose of identifying their impact on social expenditure.

Due to the fact that total social expenditure includes that for young families or human investment, only expenditure for old age and health was selected. Table 2 shows a statistically significant coefficient for the aging ratio was, for example, 0.7387 in case 2, whereas the active aging ratio coefficient was 0.5010 and the deep aging ratio was 0.9033 in case 5.

Table 1: Aging and Social Expenditure.

Dependent var: Total Social Expenditure to GDP						
	case1	case2	case3	case4	case5	case6
const.	1.6329 (0.4820)	6.0616 (0.4664)	5.6670 (0.7622)	3.0951 (0.5478)	7.8048 (0.5484)	7.3569 (0.7933)
65 and over	1.1981 (0.0330)	0.8842 (0.0320)	0.8945 (0.0316)			
65-74				0.5357 (0.1268)	0.3966 (0.0930)	0.4158 (0.0920)
75 and over				1.8173 (0.1191)	1.2316 (0.0698)	1.2410 (0.0697)
Method	Pool	Fixed	Random	Pool	Fixed	Random
Hausman stat.	-	-	3.8732	-	-	10.908
Adj.R ²	0.521	0.868	0.397	0.532	0.871	0.411

Note: All estimates are 1% statistically significant.

A number sample are 1213.

The foregoing results show that deep aging has a stronger impact on social security finance than active aging. The deep aging ratio of developed countries is predicted to increase and result in greater pressure to increase social expenditure. However, there is some difficulty in comprehending these differences by applying simple ordinary least squares (OLS) regression, thus, by calculating the average. For example, in Japan, the most aged society, social expenditure is only slightly higher in comparison with other OECD countries. Therefore, quantile regression is an applicable method for comprehending variety and diversity in OECD countries.

Figure 3 illustrates the results of the quantile regression. The "OLS" straight line in Figure 3 represents the result of the pooling regression, also observed in case 1 of Table 1, whereby the estimated gradient is 1.1981. Conversely, the estimated coefficient of the 5% quantile line is 0.9708, and that of the 95% quantile line is 1.4510. Assuming the aging ratio to be 20%, the 5% quantile line forecasts the ratio of social expenditure to GDP to be 17.1%, whereas the 95% quantile line forecasts a ratio of 33.8%. These results indicate that the difference between the 95% and 5% lines of social expenditure is likely to almost double. In summary, aging results in pressure to expand social expenditure, however to varying and differing degrees, which may differ from country to country.

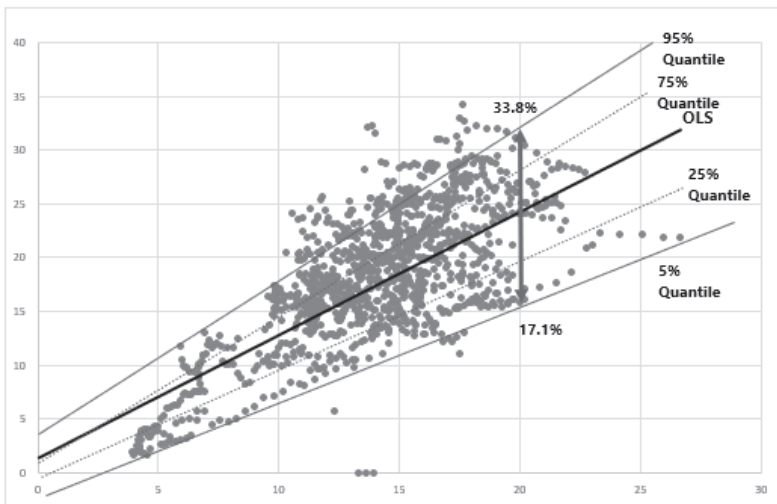


Figure 3: Social Expenditure and Aging Ratio.

Source: OECD database

3.3 Social Expenditure and Government Deficit

The aim of this section is to confirm whether an increase in social expenditure is an important factor contributing to the government deficit (or surplus). General governments are responsible for several functions, for example, modifying market failures, redistributing income, and stabilizing the economy, whereas they also play an inherent role in implementing social security, including pension payment, health insurance, and others. Therefore, the governments of each of the OECD countries incur huge expenses as a result of progressive aging. Additionally, since 2000, deficits have become a general feature of government. For example, the general governments of 22 of the 36 OECD countries recorded deficits in 2017.

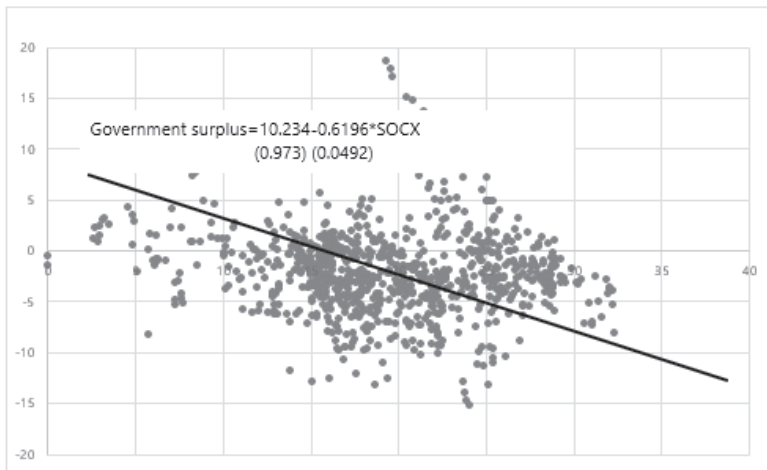


Figure 4: Government Surplus and Social Expenditure.

Figure 4 illustrates the results of the regression in government surplus on social expenditure, whereby both variables are measured by their ratio to GDP as defined by the OECD standard. This regression calculation performed in a fixed effect model by using unbalanced panel data from 1995 to 2018 and the total number of samples was 776. The estimated coefficient of social expenditure is -0.6196 and the standard error is 0.0492, and the result indicates that social expenditure has a negative and significant influence on government surplus.

4. Economic Growth and Social Expenditure

4.1 Outline of Estimation Method

Aging is the result of either or a combination of low fertility and increased life expectancy, but its effects are not only seen in changing age structures, but also in declining young populations and labor forces –resulting in negative impacts on economic activity. This represents the first step in considering the relationship between aging and economic growth.

Conversely, it should also be taken into account that social expenditure also affects economic growth through pressure exerted through spending on an older population accompanied by the government deficit. In almost all countries, the social security system is described as the redistribution of income from young workers to retirement age persons. In Japan, both public pensions, and medical care insurance are managed through a pay-as-you-go system. Hence, aging precipitates generational redistribution funded by insurance payments and payroll taxes, which burden young workers' earnings. The aforementioned factors are indications of the possible negative effect of social expenditure on economic growth.

These indications are confirmed as follows: We regressed the economic growth rate, not only for social expenditure but also for other economic factors, included as independent or control variables. The data were obtained from the OECD database, consisting of 36 OECD countries, from 1980 to 2018.

The equation is estimated in the following:

$$g = \beta_0 + \beta_1 SOCX + \beta_2 X_1 + \beta_3 X_2 + u \quad (1)$$

where g is GDP growth rate in real terms, $SOCX$ is the coefficient of social expenditure to GDP (ratio), X_1 is the supply side factors and X_2 is the demand side factor influencing GDP growth rate. This equation primarily calculates the $SOCX$, but there are many other factors that influence economic growth. Hence, we have selected employment and capital deepening as supply side factors and included the globalization index – defined as the ratio of the amount of exports to GDP – as a demand side factor. We named equation (1) the level equation.

Economic growth is measured by year-on-year changes, whereby SOCX is measured by the current value of the current year. In this, the dependent variable of equation (1) is the degree of change, however, because SOCX is as an independent variable denoting its current value, change is therefore not measured. In addition, the change in both the employment and capital deepening variables are also measured year-on-year. Due consideration of the characteristics of these variables, the difference equation, equation (2), is needed as follows:

$$g = \beta_0 + \beta_1 \Delta SOCX + \beta_2 X_1 + \beta_3 \Delta X_2 + u \quad (2)$$

4.2 Estimation Results

We estimated both equations, eq. (1) and eq. (2) by using unbalanced panel data as described above. Table 2 comprises the results of the level equation, eq. (1), in 9 cases. In every case in Table 2, the coefficient of social expenditure is negative, from which it may be concluded that social expenditure has a negative impact on economic growth. Comparing the fixed effect model of case 2 with the random effect model in case 3 using Hausman test statistics, it can be concluded that the fixed effect model is appropriate. As seen in the result of case 2, the high value of the social expenditure coefficient is -0.2780 and is statistically significant.

The control of other factors is needed by the inclusion of other economic variables affecting economic growth from both the supply and demand side. In case 5, which is performed by the Hausman test by including the rate of employment as the supply side factor and the export ratio as the demand side factor as control variables, we calculated the coefficient of social expenditure as -0.2142, and the coefficient of employment as 0.6036. In case 8, which includes the additional control variable of capital deepening, the coefficient of social expenditure is -0.2995 – negative and statistically significant.

Table 2: Economic Growth and Social Expenditure (1)

Dependent var. GDP growth rate (real term)		case1	case2	case3	case4	case5	case6	case7	case8	case9
const.		5.4526*** (0.2629)	7.883*** (0.5261)	6.444*** (0.4009)	3.8369*** (0.2803)	6.5392*** (0.5525)	4.8354*** (0.4041)	4.6687*** (0.3718)	9.6384*** (0.6417)	5.6213*** (0.4084)
SOCX		-0.1407*** (0.0134)	-0.2780*** (0.0280)	-0.1988*** (0.0220)	-0.1157*** (0.0135)	-0.2142*** (0.0284)	-0.1527*** (0.0196)	-0.1353*** (0.0145)	-0.2995*** (0.0280)	-0.1676*** (0.0165)
Employment					0.5899*** (0.0326)	0.6036*** (0.0327)	0.6016*** (0.0319)	0.5216*** (0.0380)	0.3903*** (0.0374)	0.4899*** (0.0353)
Export to GDP					0.9961*** (0.2658)	-0.9673 (0.6296)	0.3398 (0.4068)	0.5545** (0.2448)	-1.7369*** (0.6339)	0.3380 (0.2875)
Capital Deepening								-0.0906*** (0.0345)	-0.2678*** (0.0353)	-0.0148*** (0.0328)
Method		Pool	Fixed	Random	Pool	Fixed	Random	Pool	Fixed	Random
Hausman stat.		-	-	16.3870	-	-	27.5720	-	-	97.730
Number of samples		1210	1210	1210	1112	1112	1112	711	711	711
Adj.R ²		0.089	0.176	0.073	0.328	0.3990	0.3150	0.4033	0.5072	0.4900

Note: *** means 1%, ** means 5% statistically significant.

Table 3 shows the estimation results of eq. (2), or difference equation. The coefficient of social expenditure is negative in all cases – the same as for the level equation. In particular, in case 8, which is estimated by the fixed effect model, the estimated coefficient of social expenditure is -0.8097 – also negative – whereas the coefficients of both the employment and export ratio are positive and statistically significant.

In summary, the negative coefficient of social expenditure was demonstrated in the above model and leads to the conclusion that social expenditure is a negative influence on economic growth when the model estimations were controlled by including other economic factors.

Table 3: Economic Growth and Social Expenditure (2)

Dependent var: GDP growth rate (real term)									
	case1	case2	case3	case4	case5	case6	case7	case8	case9
const.	2.9059*** (0.0826)	2.9060*** (0.0770)	2.9882*** (0.1914)	2.2514*** (0.0834)	2.2997*** (0.0792)	2.3914*** (0.1636)	1.4591*** (0.1294)	1.9323*** (0.1359)	1.6220*** (0.1446)
ΔSOCX	-1.0705*** (0.0713)	-1.0710*** (0.0671)	-1.0700*** (0.0670)	-1.2119*** (0.0814)	-1.2374*** (0.0769)	-1.2337*** (0.0767)	-0.8466*** (0.0812)	-0.8097*** (0.0785)	-0.8319*** (0.0776)
Employment				0.5198*** (0.0311)	0.4935*** (0.0310)	0.4965*** (0.0306)	0.5850*** (0.0336)	0.5161*** (0.0344)	0.5564*** (0.0033)
ΔExport to GDP				4.4784** (2.3689)	2.2261 (2.2838)	2.5710 (2.2701)	11.513*** (2.4042)	10.01*** (2.4121)	10.895*** (2.338)
Capital Deepening							-0.1264*** (0.0326)	-0.0072 (0.0350)	0.0705** (0.0327)
Method	Pool	Fixed	Random	Pool	Fixed	Random	Pool	Fixed	Random
Hausman stat.	-	-	0.0600	-	-	1.9488	-	-	39.181
Number of samples	1173	1173	1210	1102	1102	1112	709	709	709
Adj.R ²	0.161	0.272	0.178	0.424	0.501	0.436	0.466	0.522	0.460

Note: *** means 1%, and ** means 5% statistically significant.

On the supply side, the employment rate contributed to a positive impact on economic growth, but capital deepening had a negative effect on cases as per the level equation. It is therefore difficult to come to precise conclusions regarding the effect of capital deepening. In contrast, the export ratio showed a positive effect in eq. (2), which infers the globalization index's positive contribution to economic growth. Overall, we conclude that expanding social expenditure will result in a reduction of economic growth.

4.3 Dynamic Panel Model

The economic growth rate is continuously influenced by its own lag value, necessitating its inclusion as an independent variable. In this case, OLS estimation is to generate bias estimators, and we therefore chose to use the generalized method of moments (GMM) estimation proposed by Arellano and Bond (1991). Table 4 and Table 5 show the results of the GMM estimation for the dynamic panel data equation and included a lagged economic growth rate as the explanatory variable with controlled variables such as employment, export index, and capital deepening.

Table 4: Dynamic Panel Estimation Table 5: Dynamic Panel Estimation

Dependent var: GDP growth rate (real term)		
	case1	case2
GDP(-1)	0.0497*** (0.0093)	0.0816 (0.0732)
SOCX	-0.2768*** (0.0713)	-0.3020*** (0.0417)
Employment	0.6610*** (0.0147)	0.4323*** (0.0291)
Export to GDP	-0.9770*** (0.1126)	-0.2783 (1.829)
Capital Deepening		-0.2921*** (0.0565)
Method	GMM	GMM
Number of samples	1074	688

Note: *** means 1%, and ** means 5% statistically significant.

Dependent var: GDP growth rate (real term)		
	case1	case2
GDP(-1)	0.2054*** (0.0139)	0.1790*** (0.0304)
ΔSOCX	-1.5988*** (0.0566)	-1.0631*** (0.0753)
Employment	0.3522*** (0.0213)	0.4277*** (0.0525)
ΔExport to GDP	0.5590 (1.3173)	8.6003*** (1.524)
Capital Deepening		0.0494 (0.0319)
Method	GMM	GMM
Number of samples	1065	686

Note: *** means 1%, and ** means 5% statistically significant.

We obtained negative and statistically significant estimated coefficients of social expenditure from Tables 4 and 5, and we observed in the foregoing section, that social expenditure has a continuous negative impact on the current economic growth rate, and, furthermore, that a lagged dependent variable has a positive and statistically significant coefficient. Our observations herein bear out that this conclusion is robust.

5. Conclusions and Discussions

5.1 Interpretation of the Negative Impact of Social Expenditure

From the verification of the negative impact of social expenditure on economic growth, it can be deduced that government deficits along with increased social expenditure have a negative impact on economic growth rate.

There is an expectation that increased social expenditure could result in increased economic growth through government spending increase, and that it plays a role as a built-in stabilizer during recessionary periods, as stressed by the standard macroeconomic textbook. However, our empirical results have led to the opposite conclusion.

The reasons why an increase in social security has a negative effect on economic growth can be explained as follows:

1) The maintenance and management of social security systems require contributions and payroll taxes from both individuals and firms, or societies. As social expenditure increases in an aging society, the burden on firms or organizations also increases, leading to a possible reduction in private consumption.

Although alternative paths lead to the securing of income through social security to encourage more consumption by the older population, an increase in insurance and payroll taxes may result in a negative influence totally.

2) Analogous to the aforementioned, private investment is reduced by an increase in social insurance contributions by firms. Investment is more important to secure sustainable future economic growth. Therefore, reducing investment affects not only short-term demands but also the supply side in the long-term.

3) A longstanding debate centers around the difference between retirement and pension benefits. That is, as social security expenditure including pension payment increases, the labor participation rate of older persons is bound to decrease.

4) The increases in pension payments or the securing of the health care environment in retired life, reduce the need to save money at a young age, and thus, private saving rates would be reduced. This logic has been broadly followed in studied multiple empirical analyses, for example, Feldstein (1974) contains ample references to this field of study. A decrease in the saving rate affects capital accumulation, an indispensable driving factor in maintaining long-term economic growth.

5) Social expenditure helps to improve income inequality through income redistribution, and this is one of the specific purposes of the government.

However, income redistribution skews the government's cost of business, and if a government operates with inefficiency, the total economy may become more inefficient.

6) Lastly, an increase in social security expenditure leads to a budget deficit, upsets the government's budget balance, and impacts economic growth negatively.

Although there may be other possible reasons, the fact that aging has had a negative impact on the basis of social spending on economic growth in the past is confirmed by the above analysis.

5.2 Conclusions and Discussions

The aim of this study is to confirm the influence of aging on economic growth, and in our results, we were able to conclude that there is the possibility of reduced economic growth in an aging society through social expenditure expansion. Social expenditure is an important mechanism to support the older members of society, however, maintaining a social security system is an expensive burden, in particular in that progressive aging tends to drive greater social expenditure. From the first analysis, it emerges that it is not a simple matter of increased expenditure, but that deepening aging exerts greater pressure to increase social security than active aging. Furthermore, our quantile regression analysis confirms that there are various and diverse reasons for the expansion of social security that depends on the situation in different countries, but the increase in social expenditure itself is resilient.

The second empirical analysis measured the degree to which social expenditure influences economic growth directly by using panel data analysis. The results clearly confirm social expenditure to be a negative factor in economic growth in those cases where other economic factors were controlled. In this empirical study, we furnished a level equation and a difference equation, coming to almost identical conclusions. In addition, to discuss the causality between social expenditure and economic growth, we considered six hypotheses: consumption, investment, retirement, savings rate, ineffectiveness of government, and deficit.

Aging is an inevitable situation for developed countries, and we should regard this as a serious situation. Although both preserving social security and maintaining economic growth are necessary for an aging society, from

the above empirical analysis, we have found incontrovertible evidence that expanding social security spending results in lower economic growth. To solve this problem, firstly, we recommend that the effectiveness of the social security system be reconsidered. In the future, simply expanding social security would be ill-advised, and would require a rethink of the management of the social security system. Secondly, we recommend investigating methods to accelerate economic growth. The key concept is productivity using new technology, such as AI or robots, but those discussions are beyond the scope of this study.

Finally, Japan is, in the relevant sense, the typical model of a future aging society. In Japan, social security spending continuously increases and we are concerned about lower economic growth. The applicable method that is chosen to deal with these severe problems will be a model in future deep aging countries.

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PHOTOVOLTAIC MINI-GRIDS IN REMOTE
RURAL AREAS OF DEVELOPING COUNTRIES:
RESEARCH ON STRATEGIES TO IMPROVE
OPERATIONAL SUSTAINABILITY
INSIGHTS FROM A FACT-FINDING MISSION
TO A REMOTE AREA OF NAMIBIA

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Abstract

In the desert-like and sparsely populated northeastern area of Namibia, two village mini-grids have been in operation for a considerable time: the mini-grid located in Tsumkwe for eight years, the one in Gam for five years. The grids deliver 230V AC electricity day and night. The target groups are key village customers like schools, hospitals, municipal administration, post offices, telecoms, tourist lodges, small shops and businesses, and about 430 households living in the core areas of the two communities. In spite of the obvious success, the two mini-grids have also had to overcome difficulties in the past.

PROCEED, a multidisciplinary application-oriented research project running from April 2019 to March 2022, is dedicated to the task of evaluating the learning experiences gained during the long-term operation of the two mini-grids, identifying new problems and possible solutions. The overall goal is to show how mini-grids can be operated efficiently, profitably, sustainably, and for the benefit of the local population. In addition, ways to a successful village development are to be shown, in which inhabitants use electricity in an entrepreneurial way for productive use. In this way, additional job opportunities are created, and this will

contribute to increased village prosperity. Since the PROCEED project is only at the beginning of its activities, final statements cannot yet be made. Nevertheless, this paper pursues two distinct objectives which are of basic importance for further research on the economic issues:

- Evaluation of first field observations related to the question of sustainability (section 3)
- The reflection of different basic components as prerequisites for the sustainability of mini-grids enabling a systematic follow-up of the topic (sections 4 and 5).

To round off the paper, selected strategic core statements are presented finally in section 6.

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Keywords: *Mini-grids; Sustainability; Village Development; Risk Mitigation; Risk Management; Rural Electrification;*

1. The Basic Problems of Mini-grid Operation

1.1 Reasons for Inefficiencies of Mini-grids

For a successful socioeconomic development in remote rural areas of developing countries, small and isolated power plants (called mini-grids) are needed urgently to overcome the lack of energy in these regions. In a recent publication from June 2019, the World Bank identified a global need for mini-grids to provide power for about half a billion people (ESMAP *et al.* 2019). In spite of this need, there is a common doubt about the reliability of mini-grids and their technology (Wagemann and Manetsgruber 2016; Franz *et al.* 2014). In many cases, they did not perform to expectations or even collapsed prematurely, before the originally planned lifespan. However, a closer look shows that the weaknesses of mini-grids should be explained rather in terms of poor management and operation as well as insufficient financial modeling than by the quality of the components or the technological concept itself (Wagemann and Manetsgruber 2016).

This almost categorical statement may surprise at first, but can be justified by case studies, project evaluations, and discussions with experts.

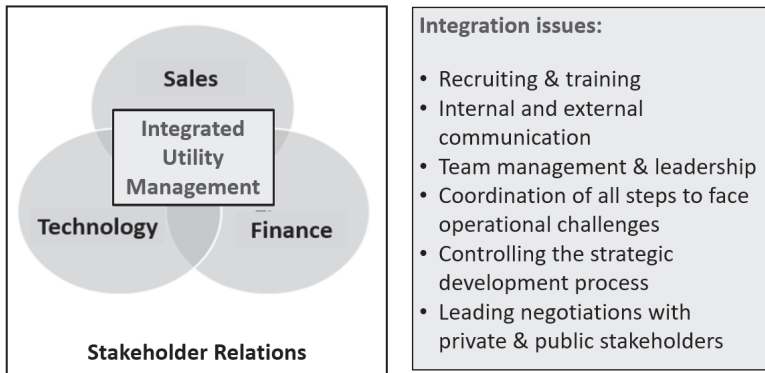


Figure 1: Fields of responsibility for the integrated management of mini-grids.

The technical components of mini-grids are produced almost exclusively by Western industrial countries and meet their quality standards. The configuration and installation of mini-grids are also almost always carried out by engineers from solar companies based in these Western industrial countries, who are familiar with this task and do not want to endanger their corporate image. If problems emerge, they arise almost exclusively during the time after the transfer of ownership to an institution in the target country. Experience has shown that this often leads to one or more of the following problems, which will be presented in sections 3 and 4.

- The chosen performance capacity of the mini-grid (electricity generation and/or storage) proves to be unsuitable for the supply area.
- The owner of the mini-grid does not have sufficient expertise in the energy business or concerning mini-grids.
- The operator's personnel are not trained and qualified to the required extent for their tasks.
- Overloading or incorrect operation of the system causes damage that leads to high repair costs or makes expensive replacement investments (*e.g.*, batteries) necessary.
- The socially justified electricity tariffs cannot cover the costs, let alone allow reserves to be accumulated.
- Technically necessary replacement investments cannot be financed by the financial reserves of the operating company.

- Negotiations with authorities for building permits or for compensation payments for losses due to low electricity tariffs are conducted too late or without sufficient results.

Discussions with experts from the solar industry and the analysis of project reports show that in almost all cases these non-technical issues are the underlying cause for the failure of mini-grids (Manetsgruber *et al.*, 2015). However, the reverse conclusion leads to a very positive consequence: A really improved management can be the key to achieve more sustainable mini-grids. Professional management does not necessarily need to be a ‘profit killer’, but it requires the insight that mini-grids are not simple ‘technical plants’ and that their management needs to be understood more comprehensively. In this sense, mini-grids should be seen as an independent business area in which the managing director has to integrate four demanding tasks: Technology Management, Sales Management, as well as the often neglected fields of Financial Management and Stakeholder Relations Management (cf. Fig. 1). Finally, it should be mentioned that all of these management tasks are connected with the need for qualified further study for decision-makers and of course, aligned with sufficient training on the shop floor level.

1.2 The Central Dilemma or Why Electricity from Mini-grids Is Often Costly

To generate electricity, solar power plants naturally require sufficiently intense solar irradiation. Due to the fact that PV module prices have been decreasing over recent years, the generation of PV based electricity is in most cases cheaper than by fossil fuel driven generators such as diesel aggregates (diesel gensets). However, favorable weather conditions do not always prevail, and electricity is also needed outside the sun-intensive times of the day (the so-called ‘dark times’). This is why mini-grids need solutions for ‘times when daylight is not strong enough’ and for the ‘hours of the night.’ Together, those times will be referred to as the ‘dark times.’ As the following two options show, delivering power during the ‘dark times’ is technically manageable but causes additional expenses.

- Option I.: Storage of electricity by batteries

To store electricity, for the time being, mini-grids are usually equipped with lead-acid batteries (Franz *et al.* 2014; Boamah 2020; Adelman 2015). Unfortunately, lead-acid batteries are susceptible to sulfation and have a

natural lifetime that is much shorter than that of the other system components of a mini-grid. Furthermore, as large battery arrays are needed to ensure sufficient energy provision, these expensive tools become by far the largest cost driver. Depending on the given circumstances, the costs of storing electricity can be four times, or in unfortunate cases even more, higher than those of generating the power (Boamah 2020; Adelman 2015). While the costs for electricity generation can be reduced to 0.15 to 0.10 €/kWh, stored electricity, including the costs of generation, can cost even more. Here are some of the main reasons:

- To prevent the effects of, for example, two-day periods of bad weather, the battery bank must be sufficiently large so that sufficient reserve power can be stored. The number of batteries thus becomes a trade-off between battery costs and the costs of using a diesel Geneset (purchase, fuel, monitoring costs). With regard to gensets, see the following Option II.
- Experience has shown that the service life of lead-acid batteries can be around ten years if they are used well, but this depends on good control of the system. Deep discharges must be avoided and the water level checked. A sense of responsibility and technical qualification of the personnel are of great importance here, but this is often not the case in practice under the conditions described here for remote areas in developing countries. (Example Tsumkwe: The first battery array which was acquired in 2011 had already failed after about 1.5 years; the second set of equipment acquired in 2013 is still in operation but is starting to show clear signs of aging now after six years.)
- The price for new batteries in an African country may differ significantly from the price in an industrialized country. In addition to shipping costs, customs duties, other additional costs often incurred with the import and the costs for transport from the port across the country (approximately 900 km in the case of Gam) as well as possible loss or damage must also be taken into account.
- Depending on the location and type of building which houses the battery arrays and also in the event of extremely high solar radiation, it may be necessary to cool the rooms concerned. In this case, additional acquisition costs as well as costs for electrical operation are incurred.

These four reasons illustrate why, especially under unfavorable conditions, battery costs can make up such a large cost block.

- Option II.: Diesel generators as back-up

A mini-grid requires an appropriate number of batteries to balance power peaks in the load profile of daily power usage. In addition, peak demand and power consumption in ‘dark times’ can be compensated for by operating diesel generators (diesel gensets).

However, it must be taken into account that a diesel genset is associated with quite high running (or operating) costs of roughly 26 USD-ct/kWh – 44 USD-ct/kWh depending on the diesel price per liter, which must be amortized via the electricity revenues during its lifetime. Secondly, in the event of sudden failure of this genset or to carry out necessary repairs, a replacement system has always to be available. (However, as a rule, used older systems are installed for this purpose). Thirdly, however, diesel is very expensive, especially in remote areas, and thus burdens the profitability of mini-grids considerably with additional costs. Fourthly, the use of the genset must be monitored, resulting in personnel costs, and its operation is also associated with effort and expenses for cleaning and maintenance. For the reasons described above, electricity storage according to Option II also leads to a considerably higher cost burden than electricity generation.

A tariff reflecting the additional costs of delivering electricity during the ‘dark times’ would be a disproportionate social burden above all for the private households, whose members come home after work in the evening and switch on their electrical devices. Irrespective of technical issues, such a tariff structure is not reasonable for socio-political reasons and would also have no prospect of permission from the relevant authorities.

It is clear from the circumstances described that mini-grids have to cope with a difficult situation if they have to supply customer groups such as private households with low incomes. This handicap to profitability (and thus to financial sustainability) increases in correspondence to the consumption of ‘stored electricity.’ To put it very simply: A high number of households with such an adverse load profile in relation to commercial and institutional electricity consumers tends *ceteris paribus* to increase the number of batteries required and the associated storage costs.

If, in addition, private households are granted a cheaper tariff for socio-politically understandable reasons, the financial sustainability of a mini-grid (i.e. its profitability) will be even more difficult. This is the fundamental core dilemma that makes its survival in so many cases dependent on subsidies.

In addition to the ‘core dilemma’ described above, there are a number of other non-technical problems that need to be overcome. Compared with the strategic dimension of the dilemma described above, the other non-technical problems rather have an operative character. For the sake of a better overview, these points are presented here in key terms.

1.2.1 Personnel Problems

Emerging issues in the field of mini-grid operation:

- Lack of qualified local caretakers and technicians familiar with mini-grids
- Resulting costs to train new caretakers
- Loss of self-trained personnel due to payment inequalities between rural and urban areas
- Sub-optimal motivation due to low wages, lack of incentives and promotion prospects

An option to solve the qualification problem could for example be a training cooperation with a mini-grid installation company. Furthermore, measures could be considered to gradually improve staff retention (employer loyalty).

1.2.2 Conflicts With Power Consumer Groups

Emerging issues in the field of power marketing and customer relations:

- Tariff structure (e.g., private vs other customer groups) and level of tariffs felt an unjustified burden
- Non-connection of groups living too far away from the mini-grid
- Off-switching of certain customer groups (e.g., households) in case of energy shortage
- Possible power breakdowns at times of high peaks of power consumption
- The relatively cumbersome kind of prepaid system (purchase of tickets) for private customers (households and businesses)
- Delayed payments of electricity bills by public users (local authorities)
- Power theft by bypassing or manipulating the meter
- Vandalism due to conflicts or envy of non-connected residents

- The problems and difficulties mentioned above can often be overcome, or at least considerably moderated, by qualified and thoughtful management of the mini-grids and effective and open communication with the employees, the inhabitants of the community and/or the village power committee in charge (Steurer *et al.*, 2014)

2. Description of the PROCEED Research Project

2.1 Background and Objectives of the Project

In Namibia, a sparsely populated state in South-West Africa, about half of the rural population has no access to electricity. The respective settlements and communities are mostly located far away from the national power grid, so that a connection to the central power supply would entail enormous installation and maintenance costs per inhabitant. Alternatively, so-called "mini-grids" can be considered as a less cost-intensive option. Mini-grids are small power plants with a local grid connecting a certain number of customers. The electricity can be supplied using diesel generators but during the last two decades, these diesel aggregates have increasingly been supplemented or even been replaced by renewable energy (solar, hydro, and wind power).

In northeastern Namibia, near the border with Botswana, two of the mini-grids described above are located in the communities of Tsumkwe and Gam. As part of a multi-year research project called PROCEED (4/2019-3/2022), these systems and the acceptance of the power supply by the users will be subjected to a comprehensive investigation. In this context, not only the technology and economic efficiency of the systems will be investigated, but also the use of the energy by different user groups. The aim of this project is to gain additional insights into the technical and economic sustainability of the plants and to identify options for improvement. Also of importance are measures to enable and train the inhabitants to use energy in a value-adding way by operating independent, small businesses. The objective of improving income opportunities is usually regarded as a socio-political development need. Furthermore, a side-effect is that this approach helps to stabilize the demand for electricity. Otherwise, the sustainability of the mini-grid may be jeopardized, and with it also the village development. The significance of the project is not limited to these two facilities, but the experience and knowledge gained will be used for the development, management and use of further mini-grid projects. In this respect,

cooperation with Namibian institutions is of importance, in particular the Namibian Energy Institute (NEI), financed by the Ministry of Mines and Energy, and the South-African Centre for Renewable Energy and Energy Efficiency (SACREEE) based in Windhoek. Last but not least, the cooperation with CENORED, the operator of the two mini-grids, is essential within the framework of the project.

The mini-grids at Gam and Tsumkwe (Namibia)

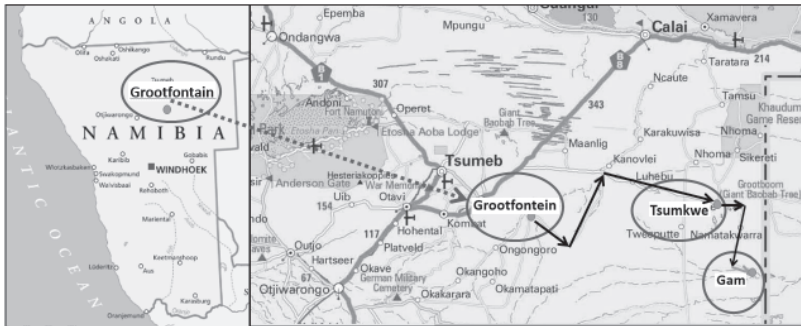


Figure 2: The very remote location of the two mini-grids in the focus of the presented project.

The Neu-Ulm University of Applied Science cooperates with the Ingolstadt University of Technology (the project leader), the University of Bayreuth and the Namibian University of Science and Technology in Windhoek for the interdisciplinary realization of the project. From 2019 to 2022, the BMBF will fund the project with 1.2 million EUR (approximately 1.32 million USD).

2.2 The Socioeconomic Structure of Tsumkwe and Gam

- Tsumkwe:

Until Namibia's independence in 1990, Tsumkwe had been a military camp of South Africa. It has about 2,500 inhabitants and consists of widely scattered houses and huts. Despite its small size, it is important as a supply post for about 40 villages. The village is home to a number of public institutions such as the municipal administration, schools, a hospital, a post

office, telecom radio, ministry outposts, and a learning and development center. The town has small shops and bars, a petrol station and a country house for tourists.

- Gam:

Gam was established in 1994 as a first reception camp for returning refugees from Botswana who fled, in particular, during the riots of Hereros and Namas between 1904 and 1908. Today the settlement has about 2,000 inhabitants but only a few public facilities like municipal administration, school and hospital. Its development was, and is, handicapped by the migration of the inhabitants to other places or regions. The village is socio-economically less developed than Tsumkwe with even fewer jobs and earning opportunities.



The front line of the solar field at Gam (cutout) [Photo: Harald Schütt]

2.3 Comparison of the Two Mini-grids

2.3.1 Overview of the Mini-grids' History and Market Perspective.

Mini-Grid Location	Tsumkwe MG	Gam MG
Mini-Grid Runtime	2011 – 2019 [8 years]	2014 – 2019 [5 years]
Power Customers	260 (on a far spread area)	224 (on a far spread area)
Investment budget	N\$ 30.8 million* [EU + Namibian authorities]	Tbd
First Ownership Second Ownership	Regional council (2011) CENORED (2017)	Regional council (2014) CENORED (2017)
Tariff structure (2019): - Households - Public entities & business	1.98 N\$/KWh = ~ 0.14 US\$ ** 4.00 N\$/KWh = ~ 0.28 US\$ **	
Tariff regulation	- Tariffs, limited for social reason - Considerable deficit covered by the regional council	

* In 2011 corresponding to ~ US\$ 4.0 million at a rate of 0,13 ** 2019: at a rate of 0.07

Figure 3: The two mini-grids in comparison (Part I). [Based on the exchange rate of 14 N\$/US\$ as of 2017 or 0.07 US\$/N\$.]

Exchange rates used for the currency conversion:

Investment budget: 7.5 N\$/US\$ or 0.13 US\$/N\$ at the time of the investment (2011).

Tariff structure: 14 N\$/US\$ or 0.07 US\$/N\$ as of 2017.

2.3.2 Overview of the Min-grids' Technical Features.

Mini-Grid Location	Tsumkwe	Gam
Power generation:		
• PV	303 kWp	292 kWp
• Diesel	300 kVA (Diesel in use: ~4hrs/day - as back-up)	no Diesel back-up
Capacity Usage	System already overloaded; soaring demand	Still underutilized but rising demand
Battery Storage	3.8 MWh	2.6 MWh
Load Restriction	5 AMV	10 AMV

Figure 4: The two mini-grids in comparison (Part II).

The abbreviation kWp (Kilowatt peak) indicates the output of a photovoltaic system under standardized conditions (called rated output). The rated output is usually higher than the actual output because the weather and operating conditions generally deviate from the standard.

3. Results of the First Field Trip to Namibia

The first field trip to the mini-grids at Tsumkwe and Gam in July 2019 focused mainly on observing the current technical state of the two mini-grids. For this reason, at the moment detailed commercial data like cost structures and development of revenues are not available. Nevertheless, important statements can be drawn based on the information gained during the long site visits with the technicians of CENORED. Furthermore, the history of the two mini-grids and their development from their installation until 2016 is described in detail in a publication by Ileka *et al.* (Steurer *et al.*, 2014).

3.1 Overview on the Economic Situation of the Two Mini-grids

3.1.1 The Situation at Tsumkwe

The situation in Tsumkwe is considerably influenced by two relevant cost drivers:

- The overloading of the mini-grid leads to increased use of the diesel genset with connected high costs for fuel (see section 1.2).
- The daily operation of the diesel genset needs to be supervised by a technician which results in a not-insignificant amount of permanent direct costs.

By far the largest share of the electricity generated is consumed by private households, which only have to pay a 'social tariff' (50% of the 'normal tariff'). Even during the middle of the day, the consumption of commercial and public customers who pay the standard rate accounts for only about 10% of the consumption of private households.

The costs incurred (in particular for diesel, personnel, cleaning and maintenance) clearly exceed the revenues, as stated by the engineers of the operating company.

Details of cost and revenue structures have not yet been obtained but need to be analyzed in order to monitor economic development and to design steps towards sustainability.

3.1.2 The Situation at Gam

Although Gam is considerably further away and the socioeconomic structure is weaker than in Tsumkwe, the mini-grid there is in a more favorable situation with regard to its running operation costs.

- Since the plant is considerably oversized, the demand for electricity during the 'dark times' (see section 1.2) can be satisfied by power from the batteries. For this reason, running a diesel genset is not necessary there. For this reason, the genset available at the site was even dismantled and reconstructed at Tsumkwe in order to replace the older system there.
- Since no diesel genset has to be monitored, no costs for fuel are incurred there. Only pro rata costs for the supervision of the site and some travel costs have arithmetically to be covered: Every third day

the technician responsible for the Tsumkwe site drives the 110 km to Gam to carry out a site inspection.

While the mini-grid in Tsumkwe can hardly cover its running costs of operation, these costs are much lower in Gam. As far as no major repairs are required, only pro rata costs for the just mentioned technician coming from Tsumkwe have to be covered as well as the costs for cleaning and maintenance. Otherwise, it has to be pointed out, that the comparatively low running operation costs are only due to very high initial investments including a solar field and a battery array, which turned out to be oversized.

3.2 Further Relevant Insights and Derived Recommendations

Based on the publication of (Ileka *et al.*, 2017) and the observations from the first field trip as well as the discussions, five selected insights concerning sustainability will be discussed now.

3.2.1 Selection of a Suitable Business Model

The two mini-grids were funded by non-repayable grants and, after installation, were placed under the control of the respective Regional Councils. In 2017, CENORED was commissioned to operate these facilities and also the ownership was transferred to CENORED. As compensation, the regional councils received company shares in CENORED.

During the site visits it became clear that the operation of the mini-grids had improved significantly since the transfer to CENORED. The official supervision in the previous years had been carried out by personnel who had little expertise with mini-grids and also did not have an entrepreneurial interest in managing the business. During this period, the maintenance of the plant was neglected in order to save money. In Tsumkwe, for example, the battery array had to be completely replaced after only one and a half years.

A business model for public property with entrepreneurial orientation and responsibility

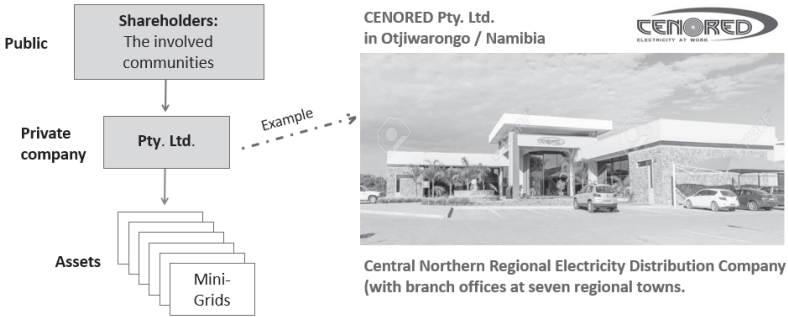


Figure 5: The business model of CENORED Pty. Ltd. (Namibia).

Since the municipalities of the towns with mini-grids have corresponding shares in the operating company, the municipal representatives have an insight into the business and its development through the shareholders' meeting. This results in an advantageous business model in terms of company law, which can combine private-sector dynamics with public control. (See Figure 5.)

3.2.2 Know-how Pooling for the Mini-grid Business

The operating company manages several municipal power plants and supplementary electrification measures in central and northern Namibia. As a result, the company has both technical and commercial expertise in the energy sector. Since the takeover of the two mini-grids in 2017, additional know-how for the operation of mini-grids has been built up. As part of the PROCEED project, the companies IBC Solar and Alensy Energy Solutions will also be exchanging experiences with CENORED and carry out training on special topics there.

The considerable advantage of an operating company with regional responsibility for a number of power plants and mini-grids lies in the fact that this company has expertise at its disposal, the development of which would not be worthwhile from an economic point of view if it were only to look after a single property. This positive scaling effect is also known by the term 'PUMA-Principle', derived from 'Poly-Utility Management Agency' (Steurer *et al.* 2014).

Strategic planning of business development: Both mini-grids were installed with a roughly equal photovoltaic performance, Tsumkwe with 303 kWp (*) in 2011 and Gam with 297kWp in 2014. It can be assumed that at that point in time the responsible authorities assumed a similar demand development for electricity in both municipalities. [* kWp = "Kilowatt peak" indicating the output of a photovoltaic system under standardized conditions (called rated output). See also section 2.3.2.]

In 2019 it was obvious that this estimation was a wrong one. The mini-grid in Tsumkwe is considerably overloaded, while the opposite is the case for Gam. In fact, the consumption of electrical energy is so different that Gam was able to hand over its two unneeded diesel gensets to Tsumkwe and scrap the old ones there.

To a certain extent, the difference in energy consumption between the two villages may be due to the approximately 20 percent difference in the population, as the number of inhabitants has changed over the years due to migration. However, the main reason for the marked difference in the development of energy consumption is probably the considerable deviation concerning the income situation.

Of interest is the question of how the original demand estimates were carried out. This is related to the question to what extent the current problems (overload in Tsumkwe versus underutilization in Gam) could have been avoided by careful consideration of socioeconomic developments.

This inaccurate demand forecast significantly affects the economic viability of the mini-grid in Tsumkwe. This is because the overload in Tsumkwe is compensated for by the diesel genset on average four hours per day leading to daily diesel consumption of roughly 300 liters. The power generation by diesel is thus of a similar order of magnitude compared to the solar array, which clearly does not speak in favor of a reasonable design of the system, both ecologically and economically.

This example shows how important it is not only to precisely analyze the load profile when planning an installation but also to systematically forecast the development of demand. The consideration of socioeconomic factors is of decisive importance and should be carried out by specialists familiar with this subject. Of importance is a realistic assessment of future migration and sociographic structure, the development of incomes as well as the question of further preferences regarding the purchase and use of electrical

equipment. The data obtained will be the basis for the systematic strategic development of the future electricity supply.

3.2.3 Leading and Motivation on the Shop Floor

In the period before the ownership transfer of the mini-grids to CENORED, the systems were operated in a very unsatisfactory manner. This was not only due to a lack of knowledge, but even unnecessary costs were accepted in order to gain personal advantages. Thus, according to Ileka *et al.*, the operating personnel sometimes used the diesel genset longer than was necessary in the evening in order to be paid overtime (Ileka *et al.* 2017)

As described in Section 3.1, the current work of the operating personnel is both more qualified and more careful, and the installations as a whole make an orderly impression. Nevertheless, it remains astonishing that during the fact-finding mission the solar modules of both mini-grids were considerably dusty, an impact of the very dry and dusty soil in this part of Namibia.

However, it has to be considered that with dust covered modules the efficiency of the plant decreases by about 10 to 30 %. This circumstance may not have a negative effect in Gam because of its underutilization, but certainly would in Tsumkwe, where the plant is overloaded. Consequently, this means that the diesel unit in Tsumkwe has to be used for much longer for the same amount of energy generation.

Currently, the modules are only cleaned every three months by a special service provider and this leads to additional expenses. The money for the cleaning company as well for some of the diesel consumption could be saved just by assigning the supervising of employees to clean a suitable number of modules daily.

This is not simply a matter of small savings, but of the basic attitude of the staff with regard to responsibility for the installations. Not only through control, but also by a suitable remuneration system it can be made clear that any kind of indifference towards deficiencies is not tolerated and vice versa that responsibility and readiness for action are rewarded.

Experience shows, however, that the success of such a system does not depend solely on the type and amount of incentives, but also on the quality of management and control. Since the responsible branch office of the operating company is located several hundred kilometers away from the mini-grids, this places very high demands on staff management.

A high level of attention and identification with the company's success is particularly important in the context of a comprehensive risk management system that includes all business levels (Ileka *et al.* 2017). Especially for capital-intensive companies, comprehensive risk management is an important step towards sustainable management.

3.2.4 Ensuring a Stable Demand

Sustainable local living conditions are not only of great importance for socio-political reasons but also for the financial sustainability of the mini-grid. There are at least three main and not improbable circumstances which could endanger the financial well-being of the residents and thus may reduce the demand for electricity.

- General income losses due to a macroeconomic recession
- Regional income losses caused e.g., by poor harvests (drought)
- Migration of electricity customers due to inhospitable living conditions

Both villages are located far away from developed infrastructures and commercial or industrial centers. The next major town, Grootfontein, is at a distance of 300 km from Tsumkwe and about 400 km from Gam. The possibilities of earning a sufficient income through employment or a small business activity appear to be very limited. In addition, agricultural activities are currently affected by increasing drought. Cattle ranchers need to purchase hay, for example, from far away at town markets with the effect of an unpleasant reduction of the family income.

One of the few opportunities to improve the socioeconomic situation of the inhabitants lies in the area of 'productive use of energy.' The aim here is to identify options and measures with which interested residents can tap into an improved income situation through the use of electrical energy as part of an independent business opportunity.

For this reason, it will also be the task of the PROCEED project team to examine promising opportunities for business development. In the positive case, appropriate measures can be initiated by means of an additional parallel project (Mayer-Tasch *et al.* 2013).

4. Analytical Reflections Towards Sustainability

4.1 Basic Statements on the Term and Concept of Sustainability

Dealing with the sustainability of mini-grids requires a concretization of this abstract concept and, in addition, the concrete prerequisites necessary for sustainable operation must be named and classified.

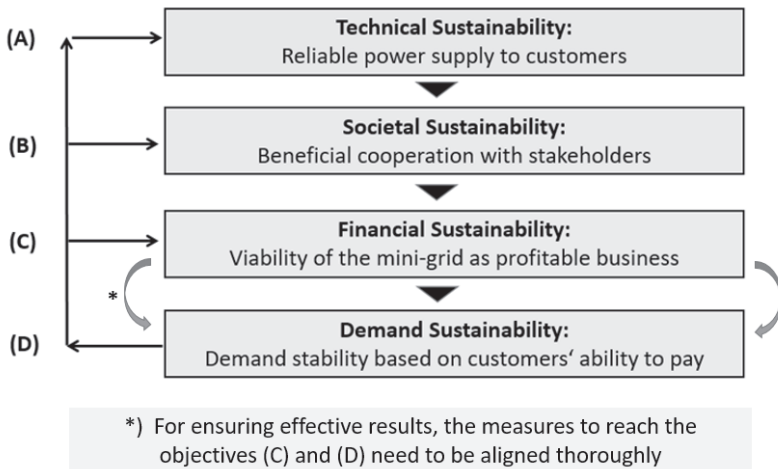


Figure 6: The interlinked components to achieve mini-grid sustainability.

According to the approach advocated here, the sustainability of mini-grids is to be understood as the entrepreneurial task of maintaining the generation, distribution, and sale of electricity over a technically appropriate life cycle (e.g., 10, 15 or 20 years).

Explanation Of The Sustainability Components:

- **(A) Technical Sustainability** concerning the mini-grid's technical ability to meet customers' electricity demand at a 24/7 level
- **(B) Societal Sustainability** concerning stakeholder relations by avoiding friction losses due to conflicts with electricity customers and all other stakeholders (e.g., communities, regional councils, national authorities)

- **(C) Financial Sustainability** concerning the financial viability of the mini-grid in the sense of profitability for the mini-grid management company, including the accumulation of reserves
- **(D) Demand Sustainability** concerning a sufficiently stable or even a gradually rising demand for electricity based on an improving standard of living for local electricity customers

The four described components build on each other, however, they also affect each other mutually.

4.2 Reflection on the mini-grids in Tsumkwe and Gam

The statements made here are based on the information obtained during the first field trip of the project in July 2019 and will require a careful review in the further course of the project within the coming years.

4.2.1 *Technical Sustainability: Reliable Power Supply*

The plant in Tsumkwe is technically functional and – also thanks to the diesel aggregates – currently meets the electricity demand of the connected customers with only a few exceptions. However, this situation may deteriorate due to changes in the customers' electricity requirements. Altogether, this mini-grid has now been in operation for about six years and is thus reaching a considerable runtime for such a plant, especially under consideration of the given circumstances.

- **Increase in electricity demand:** Experience has shown that, caused by growing familiarity with electrical appliances and by positive economic development, the demand for power by private households increases due to the purchase of additional consumer appliances.
- **Decrease in electricity consumption:** Vice versa, a reduction in electricity demand by a community, especially from private customers, can be expected when:
 - the income situation is deteriorating e.g., caused by an economic recession
 - the number of power customers decreases because of the rural exodus. Such a loss of power customers of course would reduce the mini-grid's revenues and thus put in question the financial sustainability.

As well as in Tsumkwe, the plant in Gam is technically functional but, as already mentioned above, there is quite a large overcapacity for electricity generation. Paradoxically, about 220 new applications of potential new customers who intend to get connected to the local power grid have not yet been dealt with. Of course, the imminent question is whether the cost for these additional connections (mainly the cost of grid extension) would be lower than the additional mid-term revenues and thus would justify the connection for social reasons and also commercially.

4.2.2 Societal Sustainability: Reliable Stakeholder Relations

On the basis of the information obtained about Tsumkwe and Gam, we did not recognize obvious indications of hard conflicts or even relationship disruptions with important stakeholders such as electricity customers, local government or national authorities etc. However, this initial assessment still requires careful examination, especially with regard to the following two points:

- Existing relationships with stakeholders beyond the community border (service providers, suppliers, relevant national and/or regional authorities, etc.)
- Potential conflicts with electricity customers regarding
 - the reliability of power supply in particular at consumption peaks
 - power restrictions for certain customer groups in case of power bottlenecks
 - the tariff structure and the mode of payment
 - upcoming future developments like changes in demand, power restrictions for certain customer groups as well as possible tariff adjustments

The following circumstances may constitute causes of relationship disruptions with electricity customers in Tsumkwe and Gam:

- In both Tsumkwe and Gam, a distinction is made between the so-called ‘essential customers’ (hospital, police, community administration etc.) and the ‘non-essential customers.’ In the event of bottlenecks, the latter mentioned clients are cut off from the power supply.
- For the ‘non-essential customers’ in Gam, the maximum amperage (current strength) is limited to 10A. In Tsumkwe, however, the limit was reduced even down to 5A due to the tighter supply situation.

- For customers in Tsumkwe, the above paradox may be hard to accept, especially as the residents of Tsumkwe have generally a better income situation and could afford and use additional electric equipment.

4.2.3 Financial Sustainability: Reliable Profitability and Accumulation of Financial Reserves

Since mini-grids perform a task that is part of the public domain, mini-grids are often not regarded as enterprises depending on profitability. Accordingly, it is assumed that in order to secure a low tariff, the operators should not aim for a profit, but only for simple cost recovery. With this, the collapse of a mini-grid has already been sealed. Therefore, here is a strict clarification: if mini-grids as independent economic entities are to perform their task sustainably, then they are dependent on achieving healthy profitability and thus being able to build up sufficient reserves. These reserves must reach such a volume that future replacement and expansion investments as well as other irregular costs can certainly be borne. In the case of small sized but capital-intensive mini-grids, the amount of financial reserves must not be too tightly calculated. It is advisable to combine not only technical and market-related tasks but also financial planning with a consistent risk management (Franz *et al.* 2014).

Preliminary remarks on the concept of financial sustainability

In order to assess the financial sustainability of mini-grids, it is necessary to consider the development over time of the earnings and expenditures of the respective plant. For this purpose, the individual mini-grid has to be regarded as a profit center for which a comprehensive cost and performance accounting has to be carried out.

The economic result of the profit center will depend largely on the amount of capital costs which have to be covered by the profit center. For this reason, a distinction is made here between three starting situations with a different level of capital cost resulting consequently in three different requirements for financial sustainability.

The profitability ladder: distinction between different profitability levels

Depending on the cost of capital to be borne, very different starting conditions as described below must be taken into account for a realistic analysis of mini-grids' profitability. Accordingly, a further distinction is

made between three profitability levels, which represent financial requirements with different degrees of severity.

- **Basic level: Profitability P1**

Financial sustainability is achieved, whereby the operator does not have to earn any capital costs for the initial equipment and installation of the mini-grid. ("The operator does not need to bear any initial investment costs.")

- **Intermediate level: Profitability P2**

Financial profitability is achieved, whereby the operator must generate an agreed share of the capital costs for the initial equipment and installation of the mini-grid and/or a leasing fee. ("The operator bears the costs of the initial investment to a certain extent, e.g., 50% or pays a regular leasing fee.")

- **Top level: Profitability P3**

Financial profitability is achieved, whereby the entire capital costs including financing costs for the initial equipment and installation of the mini-grid must be covered by the operator. ("The operator has to bear the complete sum of initial investment costs.")

Financial profitability in accordance with profitability level P1

Regarding the profit center, financial requirements according to P1 correspond with the situation given for the plants in Tsumkwe and Gam as the mini-grids were funded by non-repayable grants. Consequently, the operator did not have to bear the costs of the initial investments.

To ensure the profitability at level P1, it is not at all sufficient just to achieve a simple break-even of earnings and expenditures. It is rather necessary, to achieve a sustained positive result, that reliably covers or exceeds the following cost positions:

- Current operating costs (personnel, raw materials, fuel, maintenance and repair, etc.)
- Costs of further training for the responsible staff as well as the costs of introductory training for new recruits
- Pro-rata administrative costs of the operator's central functions (CENORED)

- Reserves for other unexpected events and related expenditure
- Appropriate profit contribution for the operator (entrepreneurial incentive for further professional management)

The sum of these positions corresponds with the necessary sales revenues and may be called ‘sustainability target turnover.’ Without reaching this amount of sales, the mini-grid could not be operated sustainably based on its own cash flow but needs to be cross-financed.

But to be sustainable it requires, next to efficient operation, also a reliably high utilization and a tariff structure that can be adapted according to business management aspects. However, due to the adverse income situation in rural areas, such a tariff is for social and political reasons usually not realizable. This political position was also decisive for the tariff structure for Tsumkwe and Gam.

Assessing the sustainability of the mini-grids in Tsumkwe and Gam

Since CENORED began operating the plant in 2017, the overall condition of the two mini-grids, as well as the technical and economic performance, has clearly improved (e.g., the connection of additional customers at Tsumkwe). Regardless of this, it cannot be ruled out, however, that CENORED has so far financed the two plants transversely. This at least was the statement of the engineers of CENORED explaining the plants to the project team, but further details could not yet be obtained.

The fact that CENORED has already cross-financed the mini-grid at Tsumkwe indicates clearly that the plant does not yet meet the financial requirements of P1 and therefore it is still far away from a sustainable operation. This is also indicated by the fact that soaring demand makes the expansion of the Tsumkwe PV capacity necessary, but the investment cannot be paid out of the operational revenues, and for this reason funding is still an open question.

A similar financing gap also exists with regard to the replacement of batteries that are already showing weaknesses. The lifetime of these batteries seems to be coming to an end in the coming year or the year after next, which is likely to raise a further considerable financial issue.

In order to be able to bear all expenses incurred as a profit center (in particular replacement and expansion investments), additional cash flow will be needed. In the long term a gradual increase in electricity tariffs or

alternatively, further state support may be a question of sustainable operation.

Increase of electricity tariffs: Regardless of the important social aspects, it should be kept in mind that according full-cost accounting for the electricity from decentralized PV mini-grids is almost without exception more expensive than electricity from national grids due to technical reasons and economies of scale. [See section 1.1]

State support: To an appropriate extent, state support can be regarded as economically and socially justified for reaching mini-grid sustainability within a private-sector business model. Concerning this matter, the following facts should be taken into account:

- Mini-grids, if sustainably run, help in foregoing a central power supply for the very remote areas. Especially in the case of territorial states such as Namibia - the very comprehensive costs of grid expansion and the inevitable grid losses can be saved by the state if instead a private-sector, decentralized power supply is operated. Because of this, mini-grids possess a 'relief effect' by indirect financial discharge of governmental budgets. According to Ileka *et al.* (2017) the connection costs were estimated to reach the sum of N\$ 150 million, equivalent to nUSD 21 million (exchange rate as of 02.01.2010).
- Additionally, the government saves the money for the enlargement of central power plants feeding the national grid with the necessary additional demand.
- Electrification and development of rural areas can contribute to the reduction of migration from the land and thereby mitigate costs of social issues caused by too rapid urbanization often along with increased unemployment and criminality.

In order to avoid the energy losses associated with transmission (grid losses), the distribution of power is in both communities restricted to an area with a radius of about 500 meters. Unfortunately, Tsumkwe and Gam are additionally hampered by a village structure with widely scattered houses. This fact increases the connection costs per house and limits the number of customers. In the event of a more favorable village structure, Gam could supply a number of customers additionally due to its overcapacity, thereby increasing its revenues.

Considerable individual measures: In order to come gradually closer to the financial sustainability of the two mini-grids, the operator should consider the following options:

- Further technical optimization of the mini-grids to reduce operating costs.
- Generate additional revenue through the connection of further households to improve capacity utilization of the mini-grid in Gam (may require expansion investments in the meantime).
- Negotiation of an agreement with the Ministry for Mining and Energy regarding regular subsidies made valid by the socioeconomic importance of the 'relief effect' as described above.
- A gradual adjustment of electricity tariffs according to the developing solvency of local households.

Socially acceptable tariffs: In order to avoid conflicts and excessive social burdens for low-income households, an increase in electricity tariffs should be carried out in a socially acceptable manner. For example, households with a low or no income could receive a limited number of free vouchers. (Vouchers for electricity have to be bought in advance and entitle the user to consume the prepaid kilowatt hours.) Of course, the amount of free vouchers should be limited to a fixed number of kilowatt hours ensuring a basic supply of electricity. However, this requires reliable cooperation with the local community administration so that these free tokens are reliably only distributed to socially disadvantaged households.

4.2.4 Demand Sustainability: Reliable Purchasing Power of User Groups

Having access to electricity opens up a wide range of new opportunities for the inhabitants of the places concerned. Experience has shown that private households naturally start to take advantage of this opportunity to meet their immediate family needs. These include, above all, adequate lighting of rooms, radio playing, charging mobile phones and often the operation of small television sets.

At the same time, there are various opportunities to use energy for business purposes. With this concern, the use of energy often goes along with people's already existing working contexts, such as electric lighting in a small shop, electric hair clippers in a simple hairdressing salon, the cooling of drinks in a bar or of perishable goods at the grocery store.

Nevertheless, there are far more opportunities to profit from electricity which are unfortunately often not recognized and used. Ideally, a craftsman, a farmer, and also a service provider can profit from various kinds of electrical equipment, either to increase the efficiency of his work or to start completely new activities. The challenge is to identify those ideas which can lead to the production of marketable good and services without big investments. But experience shows that in an environment typically viewed as here, start-ups need to be accompanied and coached through a practice-oriented process of systematic business development.

The successful start of such a business can help to raise the family income and may even offer working places for other residents. At the same time, all sales of goods beyond municipality borders evoke an inflow of additional money into the small economic cycle of the community. This money, at least in parts, increases the local demand and consumption and as a result supports other sales and with this a growing prosperity. Through this process, business development also supports the overarching objective of village development (Mayer-Tasch *et al.* 2013; Boamah 2020; APET 2018). In such village development projects, it is advisable to involve cooperation partners who benefit from the participation. In addition to NGOs, for example, this may involve certain institutes of colleges or universities for which a field of applied education and research will then be opening up.

5. Theses on Mini-grids Aiming at Profitability Level P2 or P3

Profitability P3 represents the highest level of the profitability ladder. P3 corresponds with the requirement to build a mini-grid without financial state support and to operate it as business profitably and for a sufficiently long time to ensure a complete amortization. Existing cases in developing countries were almost exclusively installed to deliver power to commercial users. Comprehensible areas of application can include the supply of electricity to companies such as mines, a large construction site or an agricultural enterprise. If one single company is the power consumer, then this is referred to as a 'stand-alone' power system. Of course, such a system can also offer electricity to several customers and then it corresponds to a mini-grid with the requirement to achieve P3. When using solar energy, the following factors are of importance to run such a mini-grid sustainably (Franz *et al.* 2014).

- Regular exposure of the solar field to intensive enough sunlight
- Low costs of electricity storage due to electricity consumption mainly during bright times of the day
- Load profiles of the power customers without extreme peaks of consumption
- Electricity tariffs enabling the operation company to accumulate reserves and to cover the capital costs
- A long enough operation time with stable demand to achieve a complete amortization of the investments

Since these requirements may only be met in very few cases, the profitability level P2 could be targeted as an intermediate solution. Nevertheless, the following two requirements will be necessary:

- All customer groups pay the same tariff without privilege for disadvantaged groups, due to the fact that the power consumption of commercial or public customer groups is significantly higher than that of private households paying a social tariff.
- Electricity should be consumed mainly during the light hours of the day, as then the costs for electricity storage are kept within reasonable limits.

Whether a mini-grid can achieve profitability P2 will also depend on the part of capital the private investor has to bear. A further concretization of this model will be part of the next stage of the PROCEED project.

6. Strategic Options for Improved Sustainability

In the following section recommendations on strategic measures that contribute to improving the sustainability of mini-grids, are made. These recommendations are selected and structured in such a way that their meaningfulness can be reconstructed on the basis of the experiences and statements described in this paper.

6.1 Entrepreneurial Orientation

To transfer the operation of publicly funded mini-grids to an entrepreneurially oriented, private-sector company with practical experience in the energy sector.

6.2 Public Institutions As Shareholders

To achieve public control over the operating company by rendering shares in the company to the relevant communities equipped with mini-grids. To ensure a beneficial coordination and feedback between the management of the operating company and the shareholders as well as their technical experts.

6.3 Pooling of Expertise

To cooperate with companies in the solar industry for the exchange of experience and for effective technical and commercial employee training. To assign the pool of experts for the following tasks:

- Top-down: To carry out a cost-effective supervision and control of an optimal number of mini-grids located in the regional vicinity
- Bottom-up: To introduce improvement proposals to the executive board and to analyze thoughtfully the future demand for electricity under consideration of the socioeconomic development of the concerned communities.

6.4 Systematic Risk Management

To develop a comprehensive technical and commercial risk management, including effective training of the management, the HQ employees and the local supervisors of the mini-grids.

6.5 Arrangements for Compensatory Payments

Arrangements for compensatory payments should be installed in order:

To agree with the responsible public institutions on regular compensatory payments to cover unbearable losses in earnings caused by socially justified low tariffs.

To adjust these compensation payments regularly to a level that enables the operating company to build up financial reserves.

To use these reserves to finance replacement and expansion investments and other unscheduled costs.

6.6 Incentive-based Reward System

To avoid mismanagement as clearly shown by the low level of the cleaning services applied it is important to develop a remuneration system for top management, middle management and operational employees that rewards good performance in a motivating way. Experience typically shows that the right incentives are much more important than any complicated set of rules or the installation of steering committees or other organizational administrative entities.

7. Conclusions

The mini-grids in Tsumkwe and Gam are among the largest of their kind in Africa (Steurer *et al.* 2014) and have already reached a considerable lifespan. These examples show that mini-grids can be successfully operated over a longer period of time. The experience gained during this period, its evaluation within the framework of the PROCEED project and the recommendations to be expected from this project should help to further improve the operation of mini-grids. If it is possible to increase the efficiency and sustainability of mini-grids and reduce gradually their dependence on additional state compensation payments, this would be a positive signal for consequent successful electrification of remote rural areas. The successful operation of mini-grids achieving profitability and sustainability could have an important lighthouse effect and serve as a model for further private-sector electrification of villages.

For the reasons described above, profitable and sustainable mini-grids with socially oriented tariffs will require a business agreement between the private operator and the relevant competent authority. A detailed framework will be needed to show how public compensation payments will bridge the gap between (1) cost-covering tariffs plus an appropriate profit margin on the one hand, versus (2) the socially fixed tariffs set by governmental authorities on the other hand. The details of such an agreement should be fixed in a legally binding contract specifying the obligations and rights of both sides. Certainly, such a framework should also include binding on (1) regulations on reporting and transparency as well as (2) a strategic plan on costs and compensation payments for the upcoming years connected with a mechanism for planning adaptations which might become necessary.

The key role of the sustainable electrification of remote communities can be illustrated by its importance for village development. Without electricity,

there will be no successful village development. And without successful village development, there will be no stable eco-environment necessary for sustainable and successful mini-grids.

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