Pollution Credit Certificates Theory: An Analysis on the Quality of Solid Waste Management in Brazil

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ABSTRACT

Purpose: This paper aims to introduce an economic instrument called Theory of Pollution Credit Certificates in the management of municipal solid waste in Brazil, in order to create opportunities to achieve the goal established in the above mentioned policy at lowest possible social costs.

Methodology/Approach: The methodology adopted has as a starting point the "constructo" of a scenario in which a city comprised of five brazilian districts produces its urban solid waste made up of 50% organic material. In the proposed scenario, similar to what happens in practice, a fee for collection and treatment of organic material would be charged for two different situations.

Findings: The result showed that the use of Pollution Credit Certificates Theory has a better cost-effectiveness for solid waste management because it allows reaching the environmental goal at a lower cost to society.

Research Limitation/Implication: Subjectivity of the analysis, due to the "constructo" proposition in the studies.

Originality/Value of paper: From the results obtained, we inferred that the use of the Pollution Certificates Theory for the management of brazilian municipal solid waste benefits from economies of scale as it allows in the scenario determined, that districts sell their spaces at the landfill and parallel to this, to promote the practice of composting organic waste in the municipality.

Category: Research paper

Keywords: solid waste management; SWM; pollution credit; certificates theory

1 INTRODUCTION

Solid waste management is a challenge for present and future generations. The option of not generating waste will always be the ideal, but in the current consumerist model, the optimum becomes the attempt to mitigate environmental impacts by adding regulatory and economic instruments to maximize the welfare of society at lower environmental costs (Gupta, Yadav and Kumar, 2015; Johari et al., 2014; Allesch and Brunner, 2014; Barbosa, Oliveira and Santos, 2018; Santos, Rebelo and Santos, 2017; Bravi et al., 2020). The purpose of this study is to evaluate the environmental and economic efficiency of a urban solid waste management system in a municipality through a comparison of total costs to achieve an environmental goal, reducing the destination of organic waste to landfill where each district of the city should focus on fulfilling that goal and achieving the total costs obtained when additionally a system of pollution credits certificates is used whereby the reduction is not necessarily unitary (by district) allowing the exchange of organic waste. The relevance of the actual application of this technique is economically to stimulate social actors to manage their solid waste generated so that they could be also continually encouraged to a further reduction of organic waste for disposal in landfills causing the extension of their useful life. The elaboration of a strategy is fundamental for the organization of the plans (Miezah et al., 2015; Santos et al. 2019a; Barbosa et al., 2020; Santos et al., 2019). A strategy to develop the study in 5 district-city was organized and a representative resident's association was created.

In this study, two districts have a vocation to compost the waste generated in the city, and to improve the rates, only 30% of the organic waste from the municipality could be launched at the municipal landfill with the remainder being composted. Then two ways to accomplish this task were analysed: the first way with a system where each district would send 30% of their organic waste to the landfill; and the second way considering a system where the goal of sending 30% of organic waste would be extended to the whole town having the districts a mandate to negotiate pollution credits certificates in order to reach a pattern according to marginal costs, as determined by the condition of each district. From the calculations of total costs for these two above management strategies addressed, it was possible to conclude that for the same environmental target, the use of economic instruments like Credit Certificates as a management tool makes it possible to lower costs to society, having in mind a better cost-effectiveness.

2 THEORETICAL REFERENTIAL

World Bank statistics estimate that the volume of waste is expected to grow to 2.2 billion tons in 2025 (Word Bank Group, 2012; Espuny et al., 2021). The generation of waste in households, commercial and industrial sphere has been considered a major concern for political, socio-economic and environmental purposes. However, routinely can be seen that many initiatives have been taken as the improvement, expansion and innovation of services and techniques of

collection for the disposal of these wastes (IPT, 2016; Deus, Battistelle and Silva, 2017; Ribeiro et al., 2017; Reis et al., 2021).

Many of the major solid waste found in urban areas, are still discarded incorrectly, endangering the environment and the lives of those who are financially dependents of such waste, as garbage collectors. Brazil still had most of its waste being released into open-air dumps which expose soils, waters and the life of the population in economic (devaluation of homes and real states) and health terms (diseases related to environmental contamination) (see Figure 1) (CEMPRE, 2018).

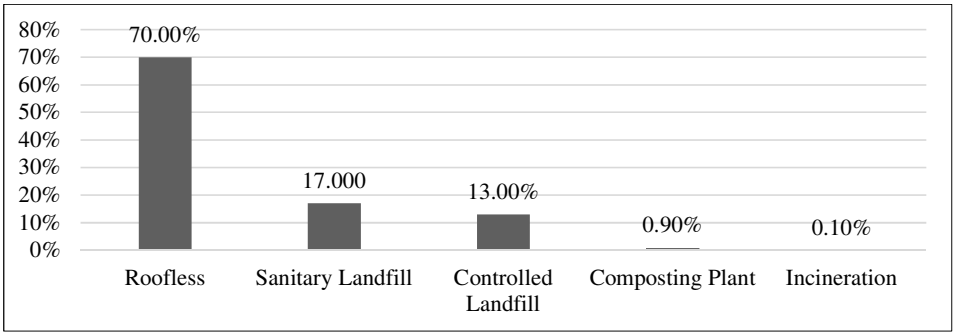

Figure 1 – Forms of Disposal of Solid Waste in Brazil in 2002 (CEMPRE, 2018)

As a solution to the problems of overconsumption and the disposal of materials that may still have some use, municipal administration in Brazil has been charging collection and domiciliary waste management fees making each citizen educated to consume less and reuse more (CEMPRE, 2018). The guidelines applicable to solid waste, establishing the protection of public health and environmental quality; the promotion of the 3R's (reduce, reuse, recycle); and on promoting the treatment and final disposal of the waste properly. This also aims to strengthen existing management systems; reverse logistics (Rathi, 2006; Arena and Di Gregorio, 2014; Gupta, Yadav and Kumar, 2015). The inadequate management and disposal of solid waste cause major environmental impacts, such as problems in urban drainage network (contribution to floods and landslides) soil, air and water contamination, being in addition a transmitter of diseases (Alwaeli, 2015; Bing et al., 2016; Yan et al., 2016).

The problem of solid waste management in today's societies has become complex due to the amount and diversity of waste, the explosion of urban areas, the limited public financial resources in many cities, the impact of technology and the limitations of both energy and natural resources (Zarea et al., 2019; Alwaeli, 2015; Bing et al., 2016; Gupta, Yadav and Kumar, 2015; Félix et al., 2018). In Brazil, the collection, management and disposal of these solid wastes is the responsibility of the municipal government. Often, the waste generated in industries, for example, depending on their classification, are processed and collected by the enterprise itself to a more correct destination and even to the reuse of such waste (SELURB, 2011, 2018, 2019).

The solid waste management generates as a consequence of its application in urban areas, an incentive for recycling of waste and also leads to environmental education to society that will consume thinking about how the product purchased can affect the environment, that is, how sustainable is it (Laurent et al., 2014; Ma, Ho and Fu, 2011; Espuny et al., 2021; Murmura, Bravi and Santos, 2021; Santos et al., 2020). The "Entrepreneurial Commitment to Recycling" is a non-profit association dedicated to the promotion of recycling within the integrated waste management concept. Founded in 1992 and headquartered in Sao Paulo, CEMPRE is maintained by private companies of various industrial sectors and works to educate the society about the importance of reducing, reusing and recycling through publications, technical surveys, seminars and databases. Awareness programs are directed mainly to opinion leaders, such as mayors, directors of companies, academics and non-governmental organizations (CEMPRE, 2018).

The Brazilian cities that deployed this system of garbage collection, as well as other ways of solid waste management have an expense to the collection and provision, charged as a fee for garbage collection, which is paid by all users of selective collection in the municipality in which they live. The orderly and efficient management of solid waste contributes to the understanding of the actions necessary for the proper functioning of public policies regarding the provision of municipal solid waste management services, urban health and quality of life (Dong et al., 2014; Nijkamp and Kourtit, 2017; Abd El-Salam and Abu-Zuid, 2015).

The expenditure on the selective collection is shown in Figure 2 in which it can be realized that the cost per ton in the selective collection is still high. Research by CEMPRE in 2012, concluded that the average cost of selective collection in the surveyed cities was US$ 212 per ton.

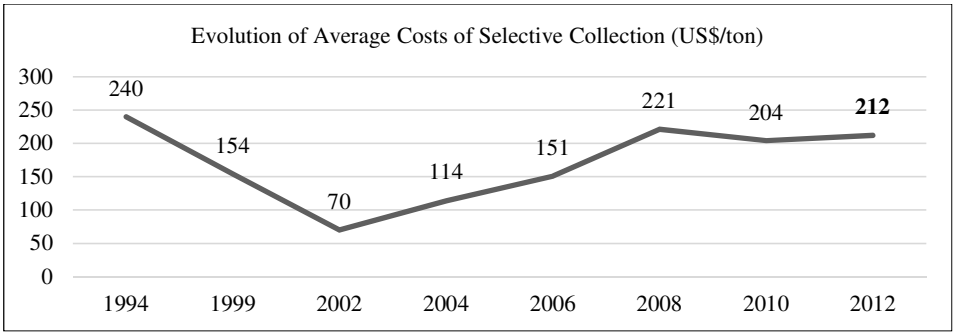

Figure 2 – Costs of separate waste collection from 1994 to 2012 (CEMPRE, 2018)

If the solid waste management is carried out in an orderly and efficient manner fundamental relations involved can be identified and adjusted to data standardization and a better understanding of the actions necessary for the smooth running of public policies concerning municipal services provision of solid waste management. Economic and innovative instruments are being used in

many countries to improve environmental quality and these approaches cover a wide range of possible mechanisms (Zgodavova et al., 2020). In an extreme situation, it can be included fines or penalties that are tied to traditional regulations of "command and control" type (Wang, Yin and Chen, 2019; Halkos and Paizanos, 2016; Leoni, Sampaio and Corrêa, 2017; Abd El-Salam and Abu-Zuid, 2015).

Already the economic instruments generate lower costs. The improvement of the quality management system (Sá et al., 2019; Araújo et al. 2019; Costa et al., 2019; Santos et al., 2021; Sá et al., 2020; Africano, Rodrigues and Santos, 2019) and also reach the environmental target (Teixeira et al., 2021; Silva et al., 2020), despite having a greater requirement for the real application because this requires a higher technical knowledge for surveillance, may increase the cost for the environmental agencies. The integration of management systems as well as the optimization of production helps to reduce waste (Santos et al., 2011; Wang, Yin and Chen, 2019; Santos et al., 2016; Talapatra et al., 2019; Santos et al., 2014; Rebelo, Santos and Silva, 2015).

3 METHODOLOGY

The methodology adopted has as a starting point the "constructo" of a scenario in which a city comprised of five districts produces its urban solid waste made up of 50% organic material. In the proposed scenario, similar to what happens in practice, a fee for collection and treatment of organic material would be charged for two different situations. In the first situation, only 30% of organic waste would be sent to a municipal landfill, due to the need to increase its useful life and 70% of the remaining organic waste would be composted. Every district, in this case should send 30% of their organic waste to a landfill.

In the second scenario, the same 30% of organic waste generated in the municipality would be send to a municipal landfill, however, it would be awarded to each district the right to market certified organic waste credits. Not necessarily every district should send 30% of their organic waste to the landfill, this being a function of the marginal costs of collection and disposal of each district. For both, it was assumed that two of the districts of that municipality, due to a specific characteristic, would have composting systems capability to receive and treat 70% of the organic waste generated in that district. We considered that these two districts endowed with composting units, would be granted by the government the permission to provide services to other districts in the form of collection and treatment of organic waste generated and that they may charge for such service. Thus, districts, represented by their respective resident's associations, in this situation would have a central to receiving organic waste generated by households in their districts by sending part of its waste to landfill and composting plants for part of the two existing districts in this county. For a better visualization of the proposed scenario, Figure 3 shows a fictitious political map of the town.

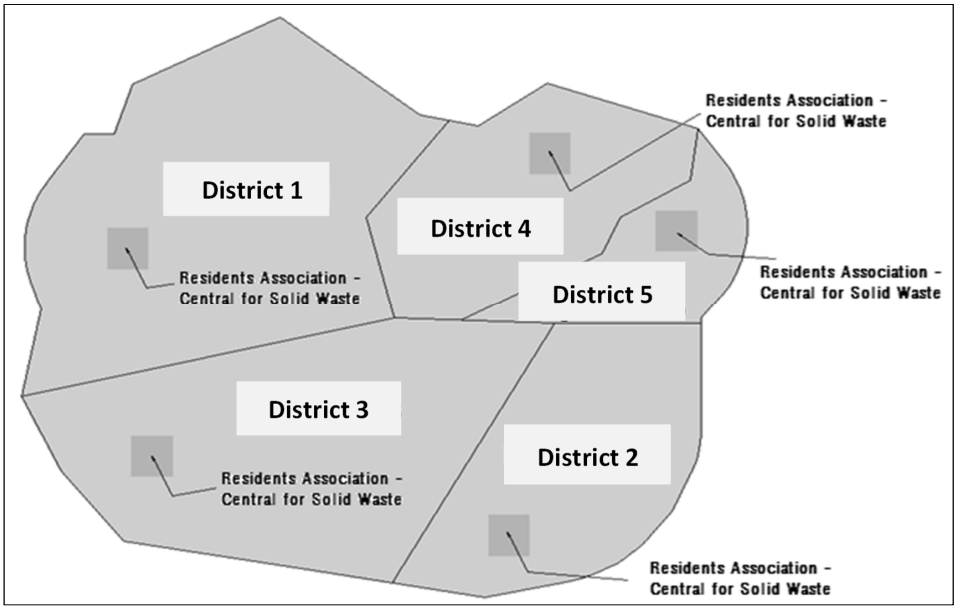

Figure 3 – Political Map of the Town Fictitious

According to this scenario, it would be possible to compare the collection and treatment costs of organic waste disposal in landfills and the application of the Theory of Pollution Certificates initially proposed by John Dales in 1968, the consortium composting units administered by independent and resident associations. Table 1 shows the production of organic waste established for each district in this scenario.

Table 1 – District Population and Production of Organic Waste [t/Day] in the Fictional Town

District	Population	Production of Organic Waste [t/day]
1	10,000	4.0
2	20,000	8.0
3	15,000	6.0
4	30,000	12.0
5	5,000	2.0
Total	80,000	32.0

In the first scenario, we considered that the districts would have the collection and disposal of its organic waste regulated by the government so that only 30% of this waste could be destined for landfill with the remainder sent for composting in districts geared to both. Every district should necessarily send 30% of organic waste to landfill.

Table 2 – Waste Production and Marginal Costs of Collection and Disposal of Organic Waste

District	70% of Organic Waste Production [t/d]	70% of Marginal Cost of Collection and disposal of Organic Waste [US$/t]
1	2.80	42.00
2	5.60	52.50
3	4.20	35.00
4	8.40	56.00
5	1.40	63.00
Total	22.40	248.50

In the second scenario, we assumed that two of the districts of this city would have ability and permission granted by public authority to act as a collecting agent and handlers of 70% of organic waste of this market and that districts would be free to send to landfill quantities of organic waste that minimize the costs of collection and arrangement and thereof provide the maintenance of the goal (to send 30% of the total organic waste to landfill).In this situation, we considered that the districts with the largest area (districts 1 and 3) would be geared to achieving waste composting and therefore could provide service to other districts, including garbage collection. In parallel, in this configuration, the residents' associations in each district would be organized and representative enough to maintain in their respective districts an Organic Waste Central (OWC) for which residents would send their waste daily. The data for the assumptions that formed the basis for estimating the marginal costs of collection and disposal of organic waste presented in Table 2 were taken from the scenario in which a city composed of five Brazilian districts produces.

4 RESULTS

The calculation of the total costs of collection and disposal (composting) of organic waste, considering the government standard which requires each district to allocate 30% of their organic waste to landfill and the remaining waste for composting into the districts with the largest area (districts 1 and 3) is shown below. Total cost of the district (TCD) = 70% of organic residue production [t/d] x 70% of the marginal cost of collection and disposal of organic residue [US$/t].

TCD1 = 2.8 [t/d] x 42.00 [US$/t] = 117.60 [US$/day] (1)

TCD2 = 5.6 [t/d] x 52.50 [US$/t] = 294.00 [US$/day] (2)

TCD3 = 4.2 [t/d] x 35.00 [US$/t] = 147.00 [US$/day] (3)

TCD4 = 8.4 [t/d] x 56.00 [US$/t] = 470.40 [US$/day] (4)

TCD5 = 1.4 [t/d] x 63.00 [US$/t] = 88.20 [US$/day] (5)

The distribution of total costs from the perspective of the first scenario, using the government standard can be depicted from Figure 4.

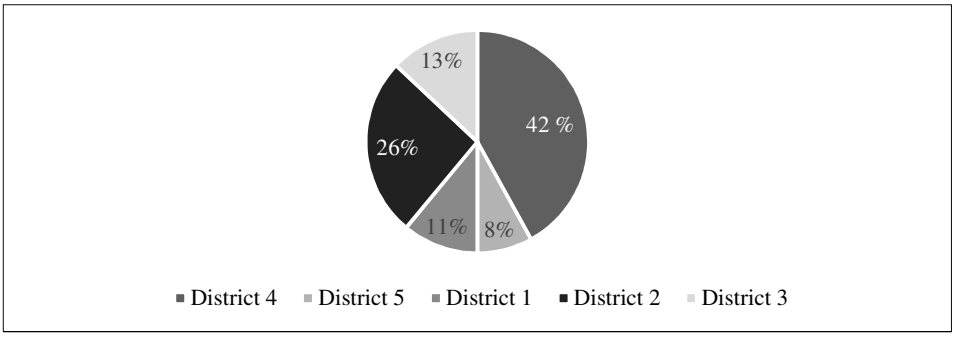

Figure 4 – Distribution of Collection and Disposal Cost of Organic Waste by Brazilian Districts Without a Trading Among Them

In the second scenario in which by a governmental decision only 30% of organic waste should be destined for landfill, but not necessarily by district, we chose to evaluate the applicability of the Pollution Certificates Theory in terms of costs and compliance to environmental goals. In this sense, it was established that the governmental authority would distribute credits of organic waste among districts, in proportion to their emissions, and still allow those credits to be traded. Despite the value of these credits vary according to the laws of supply and demand, for purposes of calculation we considered the amount of US$ 45.00 per tonne of organic waste to be composted. In this sense, it was possible to construct Table 3 indicating the amount of Organic Waste Credit Certificates allocated by the government to the district evaluated.

Table 3 – Quantity Allocated of Organic Waste Collection and Disposal Credit Certificates

District	Quantity of Credit Certificates of Collection and Disposal of Organic Waste
1	1,200
2	2,400
3	1,800
4	3,600
5	600
Total	9,600

From the data in Table 3 it was possible to calculate the total cost for each district with application of the Pollution Certificates Theory as follows: District 3 has to compost 70% of its generation of organic waste, spending for this 4.2 [t/day] x 35.00 [US$/t] = -147.00 [US$/day]. Now, as the district has

1,800 certificates and would have to send to landfill 1,800 kg of organic waste per day, it has to compost 30% of its further generation of organic waste spending for these 1.8 [t/day] x 35.00 [US$/t] = -63.00 [US$/day] for it to sell their certificates.

This district sells their 1,800 certificates for the value of 1.8 [t/day] x 45.00 [US$/t] = +US$ 81.00. The final balance of the district is: -147.00 [US$/day] -63.00 [US$/day] +81.00 [US$/day] = -129 [US$/day]. Therefore this district sends zero tonnes of organic waste to landfill and 6.0 tonnes of organic waste for composting. District 5 receives 600 certificates from the government and therefore has to compost 1.4 [t/day] of organic waste; instead of composting the waste itself, district 5 buys 1,400 Collection and Disposal Certificates from District 3 and spends thefore 1.4 [t/day] x 45.00 [US$/t] = -63.00 [US$/day]. The balance of district 5 shall be -63.00 [US$/day]. So, this district will send zero tonnes of organic waste for composting and 2.0 tonnes of organic waste to the municipal landfill.

District 4 receives from government 3,600 certificates and, therefore has to compost 8.4 [t/day] of organic waste. Instead of composting the waste itself, district 4 will purchase 400 Collection and Disposal Certificates of the remaining sales as proposes district 3 and spends this way 0.4 [t/day] x 45.00 [US$/t] = -36.00 [US$/day]. The balance of this district is not yet completed for District 4 still needs 8,000 certificates for not being obligated to compost. District 1 composts 70% of his generation of organic waste and spends 2.8 [t/day] x 42.00 [US$/day] = -117.6 [US$/day]. Now the district has 1,200 certificates and would have to send to landfill 1,200 kg of organic waste daily. Then, the district composts additionally 30% of its generation of organic waste spending 1.2 [t/day] x 42.00 [US$/t] = -50.40 [US$/day], in order to sell its certificates; district 1 sells its 1,200 available certificates at a value of 1.2 [t/day] x 45.00 [US$/t] = +54.00 [US$/day].

The final balance of District 1 is equal to -117.60 [US$/day] -50.40 [US$/day] +54.00 [US$/day] = -114.00 [US$/day]. This district will send zero tonnes of organic waste to landfill and 4.0 tonnes of organic waste for composting. District 4 participates as a buyer of certificates, again, since district 1is selling its credits. In this way, district 1 buys 1,200 certificates and spends with this purchase: 1.2 [t/day] x 45.00 [US $/t] =-54.00 [$/day]. Now, district 4 has 3,600 + 400 +1,200 = 5.200 certificates and, as there's no more sellers, it will have to compost 6.8 tons of his generation of organic waste per day, spending, thus: 6.8 [t/day] x 56.00 [$/t] = -380.30 [$/day]. The final balance of district 4 is then -36.00 [US$/day] -380.30 [US$/day] -54.00 [US$/day] = -470,3 [US$/day]. This sends then, 5.2 tons of organic waste to the landfill and 6.8 tons of organic waste for composting. District 2 receives 2,400 from the government certificates and therefore has to compost 5.6 [t/day] of organic wastes. The district will have to compost 5.6 tonnes of organic waste per day, due to the absence of collection and disposal of organic waste certificates. With this action, the district has to spend 5.6 [t /day] x 52.50 [US$/t] = -295.00 [US$/day] and therefore, based on

that, the district balance shall equals -295.00 [US$/day] and this district will send 2.4 tonnes of organic waste to landfill and 5.6 tonnes of organic waste for composting. Table 4 shows the total cost of each district after the application of the Pollution Credit Certificates Theory into organic solid waste considering that 30% of these residues are destined for the municipal landfill, although not necessarily each district must allocate 30% of their organic waste to this landfill.

Table 4 – Total Cost to Send Solid Waste to Landfill and Composting by Consideration of the Pollution Certificates Theory

District	Final Quantity of Certificates	Waste sent to Landfill [t]	Waste sent to Composting [t]	Final Cost [US$/day]
1	0	0	4.0	-114.00
2	2,400	2.4	5.6	-294.00
3	0	0	6.0	-129.00
4	5,200	5.2	6.8	-452.80
5	2,000	2.0	0.0	-63.00
Total	9,600	9.6	22.4	-1052.80

From the data in Table 3 it was possible to calculate the total cost for each According to the results obtained in terms of total cost of collection and disposal of organic waste in the fictional town, for the environmental established target of 30% of organic waste destined to landfill, we can realize that the management strategy based on the Theory of Certificates pollution achieved 5.8% savings as compared to the scenario without negotiation among the districts. Table 5 shows these results as well as the percentage of total costs reduction for the district with the trading of organic waste certificates of reductions between the districts involved.

Table 5 – Total Cost Comparison for the Two Scenarios Studied

District	Total Cost without Negotiation [US$]	Waste sent to Composting [t]	Cost Reduction [%]
1	117.60	114.00	3.10
2	294.00	294.00	0
3	147.00	129.00	12.30
4	470.40	452.80	3.70
5	88.20	63.00	28.60
Total	1117.20	1052.80	5.80

5 CONCLUSION

From the results obtained, we inferred that the use of the Pollution Certificates Theory for the management of municipal solid waste benefits from economies of scale as it allows in the scenario determined, that districts sell their spaces at the landfill and parallel to this, to promote the practice of composting organic waste in the municipality. This benefit is expressed by means of obtaining lower overall costs of collection and disposal combined with the scope of environmental target of only 30% of organic waste produced in the municipality with the allocation thereof into a landfill.

Thus, in the formation of the organic waste market with technical Certificates of Pollution Credits, the districts will decide the amount of organic waste (through composting systems) they will recycle due to the variation of their costs. In short, each district can make based on their own costs, the decision to send the generated organic waste for composting or send it to the same organic waste deposit in the municipal landfill.

As possibilities for future studies further coverage of the values is suggested floating values of organic waste certificates, considering the shifts in supply and demand normal in any market, in addition to a greater coverage in terms of types of waste, not only applying to municipal solid waste, but also to industrial, commercial and construction site waste.

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CONFLICTS OF INTEREST

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Determinants of Performance and Structural Relationships of Rice Processing Industry Performance: Resources Based View Approach

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ABSTRACT

Purpose: Attention to the capacity of rice milling companies is very important because this company is the main business actor that creates added value. This study aims: (1) to identify the determinants of the performance of the rice milling industry based on the Resources Based View (RBV) framework and (2) to formulate the structural relationship that occurs between the resources of rice milling companies on business performance.

Methodology/Approach: RBV framework and formulate the structural relationships that occur between company resources and business performance Through the SEM-PLS method.

Findings: Structurally, the results of the analysis show that the performance of rice mills is directly determined by reputation with the largest path coefficient of 0.856 and is then followed by marketing differentiation 0.184 and human capital 0.1822, while tangible assets directly have a negative relationship (-0.236) but indirectly through the latent variable the reputation as a mediator has a greater (0.558) and significant positive relationship.

Research Limitation/Implication: The research has empirical implications that not all RBV dimensions can predict the performance of the rice industry, especially organizational variables. This illustrates that in reality in the manufacturing industry, organizational function variables do not really affect the produced.

Originality/Value of paper: This article becomes an important for policymakers in Aceh Province to develop the rice milling industry based on the RBV.

Category: Research paper

Keywords: performance; rice milling; RBV; SEM-PLS

1 INTRODUCTION

The potential of Aceh Province as a large grain producer has not been accompanied by its ability to produce large amounts of rice as well. This is related to the status of competitiveness of the Rice Industry in Aceh, where this is greatly influenced by the capacity of business actors involved in the rice/rice production value chain.

The development of rice milling production capacity is still facing obstacles. This can be caused mainly by internal factors from the entrepreneur/company. Nonetheless, as well as external factors such as infrastructure and government regulations are likely to have an influence as well.

Attention to the capacity of Rice Milling Companies is very important because this company is the main business actor that creates added value. However, there is currently no knowledge regarding the relationship between the capacity of rice millers and business performance (such as productivity, profitability, and efficiency). Related to this, the RBV perspective – as pioneered by Barney (1991), Peteraf (1993), Penrose (1959), Teece, Pisano and Shuen (1997) can answer the problem of business structure, conduct and performance. With this resource-based view perspective, it is formulated in a structural relationship that the source of competitive advantage comes from internal companies where every company has different resources and different business strategies so that the resulting performance is different.

The RBV framework according to Penrose (1959) states that company performance is a combined effect of the administrative and entrepreneurial attributes of its managers. The administrative attribute is seen from the decision making and resource allocation behaviour, while the entrepreneurial attribute refers to the formation of a portfolio of opportunities and finding ways to exploit them. This is the basis of this research model, where the main aspects studied are the main variables determining company performance and how to exploit them for the benefit of achieving the best possible company performance.

The RBV literature generally considers the performance of a firm influenced by the combination of own resources and capabilities (Kaleka, 2002). Resources are broadly divided according to Rothaermel (2015), into two categories: namely Tangible (labour, capital, land, building, plant, equipment) and Intangible (culture, knowledge, brand quality, reputation, intellectual property).

The RBV framework argues that company resources, including all assets, capabilities, organizational processes, company attributes, information, knowledge, etc., produce a sustainable competitive advantage. These resources are controlled by the company, which enables the company to understand and implement strategies that increase its efficiency and effectiveness.

According to Madhani (2010), RBV is useful in identifying the basis on which the company's resources and capabilities serve as a source of sustainable competitive advantage. Thus, resources and capabilities are the fundamental

basis of every source of profit. Valuable resources are called strategic assets. RBV asserts that ownership and control of strategic assets determine, which organizations will gain more profits and enjoy a competitive advantage over others.

Resources can be considered as inputs that enable a company to carry out its activities. Internal resources and capabilities determine the strategic choices companies make when competing in their external business environment. These company's capabilities (such as the rice milling industry in Pidie District, Aceh Besar, and North Aceh) also allow some companies (rural small rice milling industry) to add value to the customer value chain, develop new products, or develop new markets. RBV leverages the existing resources and capabilities within the organization to develop a sustainable competitive advantage. According to the RBV approach, not all company resources are strategic and therefore a source of competitive advantage. Competitive advantage only occurs when there are situations of resource heterogeneity and resource immobility.

In the context of the performance of the rice processing industry, the proportion of added value to rice and processing is one of the drivers of the regional economy. The empirical study of the rice value chain is widely used in terms of business management, financial and industrial value chains such as Ritthaisong, Johri and Speece (2014), Nkuba et al. (2016), Suoth (2017) and Pavithra et al. (2018). RBV approach needs to be considered in the rice business value chain between regions. Bahri et al. (2020) found that the importance of understanding rice industry companies to create added value. Comprehensive information on value chain structure and performance will provide direction for local investment options/opportunities.

This study aims (1) to identify the determinants of the performance of the rice milling industry based on the Resources Based View (RBV) framework and (2) to formulate the structural relationship that occurs between the resources of rice milling companies on business performance.

2 METHODOLOGY

The research was conducted from March to May 2020, with the research locations in Aceh Province represented by Aceh Besar District, Pidie Regency, and North Aceh Regency. The first stage of research sampling for farmer respondents used a non-probabilistic method with purposive sampling. Sampling of farmer respondents using a non-probalistic sampling method that is deliberately based on consideration of several characteristics that are in accordance with the characteristics needed to answer the research objectives (Juanda, 2009). The criteria for the sample of farmers consist of: having competence and work experience of at least 1 (one) year in the value chain, knowing the structure of production costs, and rice trading volume.

Furthermore, the overseas rice milling industry companies used the snowballing method. This method, the sample is obtained from the respondent's information which was first obtained and continued until the data is obtained according to the research design (Naderifar, Goli and Ghaljaie, 2017).

The survey was conducted using non-probability sampling, namely by purposive sampling, the number of respondents managing 36 refineries/rice mills. In analysing structural relationships Hair, Ringle and Sarstedt (2013) offer the SEM-PLS method. The data were processed using Smart PLS 2 software for SEM-PLS.

2.1 Description of Industry Performance Determinants

Referring to Ritthaisong, Johri and Speece (2014) and Rothaermel and Deeds (2001), there are nine latent variables used to generate the RBV analysis framework. Each latent variable has 36 indicators of variable construction which are tabulated into nominal and interval/Likert scales. Specifically, the construction of each latent variable and the construction of the measured variables are described in the following description table.

Table 1 – Variable Description

Variable Latent	**Measurable variables**
X1 (Human Capital)	X11 Working Days/Year (Day)
	X12 Length of employment of employees (Year)
	X13 Number of Employees (Person)
	X14 Number of experienced employees (Person)
	X15 High school employees (Person)
	X16 There are professional HR (Likert Scale 1-4)
X2 (Tangible Asset)	X21 Milling Machine Capacity (Ton/Hour)
	X22 Polish Machine Capacity (Ton/Hour)
	X23 Packing Capacity (Ton/Hour)
	X24 Dryer Capacity (Ton/Hour)
	X25 Vehicle Capacity (Ton)
	X26 Warehouse Capacity (Ton)
X3 (Reputation)	X31 Working Capital (IDR / Rupiah)
	X32 Cost of Buying Grain (IDR / Rupiah)
	X33 Bank Relationship (Likert Scale 1-4)
	X34 Old Business (Year)

Variable Latent	Measurable variables
X4 (Low Cost Strategy)	X41 Waste for Fuel (Likert Scale 1-4)
	X42 Pressing the price of raw materials (Likert Scale 1-4)
X5 (Market Differentiation)	X51 Quality of packaging (Likert Scale 1-4)
	X52 Packing volume variation (Likert Scale 1-4)
	X53 Large quantity contract special price (Likert Scale 1-4)
	X54 Sells cheaper than competitors (Likert Scale 1-4)
X6 (Organization)	X61 There are Company Procedures (Likert Scale 1-4)
	X62 There is a contract (Likert Scale 1-4)
	X63 There is an employee data system (Likert Scale 1-4)
	X64 There is a company establishment document (Likert Scale 1-4)
	X65 There are clear performance indicator (Likert Scale 1-4)
	X66 There is a personnel SOP (Likert Scale 1-4)
	X67 There is a recruitment standard (Likert Scale 1-4)
	X68 There is a career path (Likert Scale 1-4)
	X69 There is a staff regeneration (Likert Scale 1-4)
	X610 Special Marketing Unit (Likert Scale 1-4)
X7 (Side Product)	X71 Production-Bran (Ton)
	X72 Production-Groats (Ton)
X8 (Performance)	X81 Advantage (R/C) (Ratio)
	X82 Profit/Working Capital (Ratio)

Notes: A Likert scale assumes that the strength/intensity of an attitude is linear, i.e. on a continuum from strongly agree (4) to strongly disagree (1), and makes the assumption that attitudes can be measured.

2.2 Model Hypothesis SEM-PLS

The RBV focuses on internal resources and capabilities to identify the determinants of a firm's competitive advantage and performance (Ramon-Jeronimo, Florez-Lopez and Araujo-Pinzon, 2019). The hypothesis of this research is based on Spanos and Spyros (2001) that the contribution of company assets in creating profits is indirectly carried out in the form of corporate strategy and then creates what is called the "utility effect". Value creation for buyers, either in the form of product differentiation or produced at a lower cost (low-cost production).

Furthermore, based on Galbreath (2005) dividing company resources as follows: (1) Tangible resources which include (a) financial assets and (b) physical assets; (2) Intangible resources include (a) intellectual property assets, (b) organizational assets, and (c) reputation assets, (3) intangible resources which are skills that

include management capabilities (soft skills) and abilities. technical (hard skills). For these two opinions, the three major parts of the model, namely company assets, strategy, and performance are made in the structural relationship model as shown in Figure 1.

Resources or company assets consist of Human Capital (HC), Tangible Assets (TA), Reputation, and Organizational. The company's strategies are the Low-Cost strategy (LC) and Market Differentiation strategy (MD). Both of these have an influence on the performance variable. In addition, there are additional variables in the form of side products or side products, which also have an influence on the performance of rice mills.

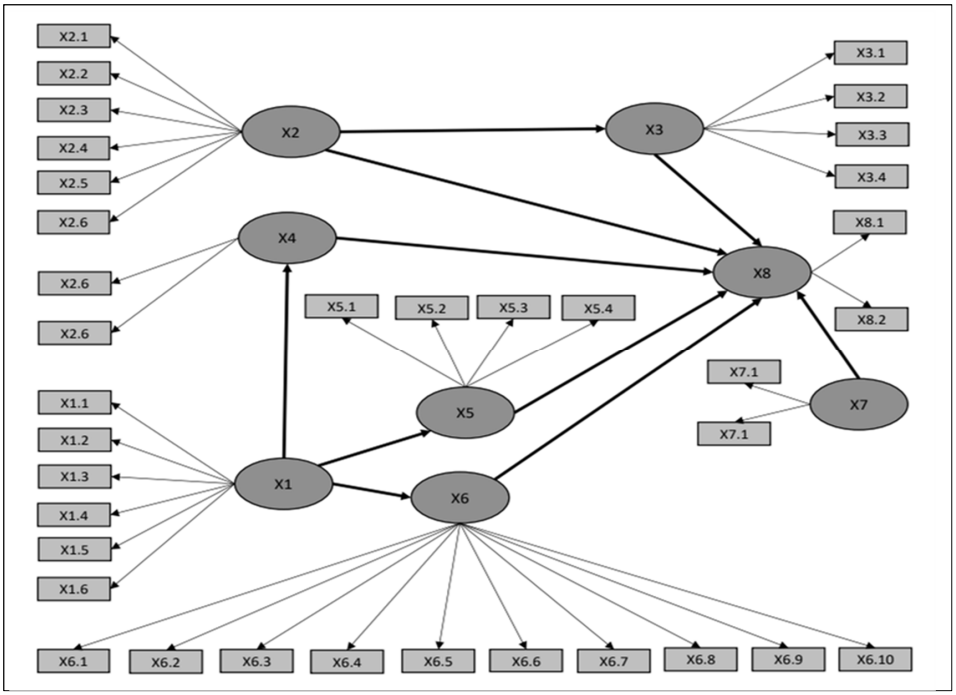

Figure 1 – SEM-PLS Model Relationship Between Assets, Strategy, and Performance of Rice Mills

3 RESULTS AND DISCUSSION

3.1 Formatting Mathematical Equations

Based on data processing from 36 Rice Refineries, the best model is produced as in Table 2, where there are 8 latent or construct variables and 25 measurable variables. This result is a model that is reduced from the original model that included 36 measured variables. The measured variable of the reduction model is a variable that has a loading factor of more than 0.7.

Judging from the AVE criteria, Composite Reliability, R Square, and Cronbach alpha, the model has good quality, so it can be used as a prediction tool. The latent variable X1 (Human Capital) is reflected in the measured variables X11 (Days of Work/Th), X13 (Number of employees), X14 (Experienced employees), and X15 (Number of high school employees).

X2 (Tangible Asset) is reflected in the measured variables X21 (Milling machine capacity), X22 (Polish machine capacity), X23 (Packing Capacity), X24 (Dryer capacity), X25 (Vehicle capacity), X26 (Warehouse capacity). X3 Reputation is reflected by the measured variables X31 (Working capital), X32 (Cost of Buying Grain), X33 (Bank).

X4 (Low-Cost Strategy) is reflected in the measured variable X41 (Waste for Fuel), X42 (Pressing the price of raw materials). X5 (Market Differentiation) X51 (Packaging quality), X52 (Variation pack volume). X6 (Organization) is reflected by the measured variables X61 (There is Company Procedure), X62 (There is a contract), X63 (There is an employee data system), X64 (There is a Company Establishment Document).

X7 (Side Product), reflected by the measured variable X71 (Bran-Production), X72 (Groat-Production). X8 (Performance) is reflected by the measured variables X81 (R/C profit), X82 (Profit/working capital). Based on data processing based on hypotheses, eight latent variables or constructs and 25 measurable variables were selected, where these variables were identified as factors that determine the performance of rice refineries.

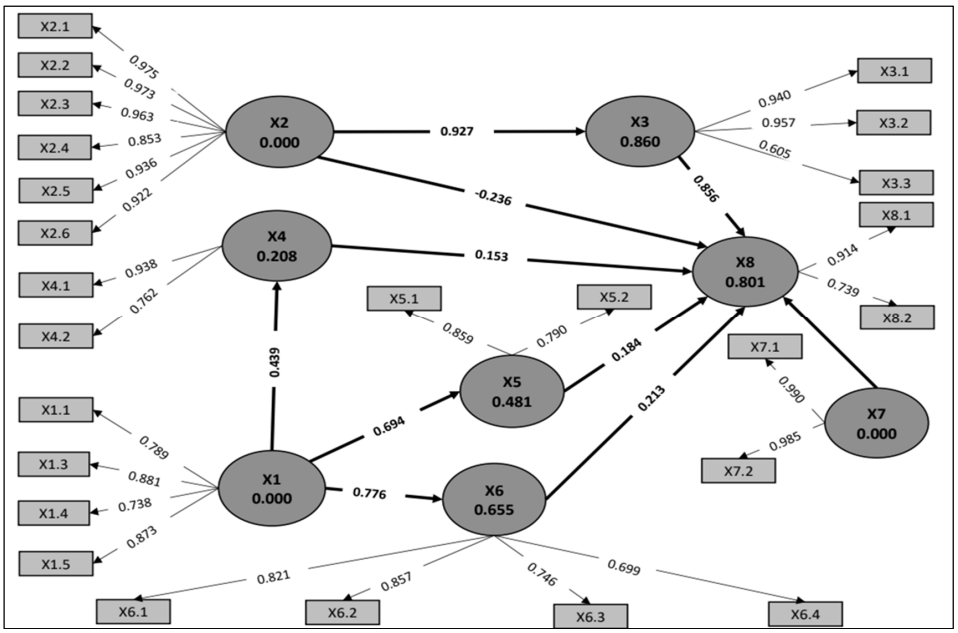

Figure 2 – Results of Data Processing With SEM-PLS: Relationship of Assets, Strategy, and Performance of Rice Mills

Table 2 – Overview Quality Criteria Variables SEM Models PLS

Overview Inner Model						Overview Outer Model	
AVE	**Composite Reliability**	**R Square**	**Cronbach's Alpha**	**Communality**	**Redundancy**	**Measured Variable**	**Loading Factor**
Variable Laten: X1 Human Capital							
0.677	0.893	0	0.839	0.676	0	X11 Working Days/Year	0.789
						X13 Number of Employees	0.881
						X14 Employee Experience	0.738
						X15 High school employees	0.873
Variable Laten: X2 Tangible Asset							
0.880	0.978	0	0.972	0.880	0	X21 Milling Machine Capacity	0.975
						X22 Polish Machine Capacity	0.973
						X23 Packing Capacity	0.963
						X24 Capsitas Dryer	0.853
						X25 Vehicle Capacity	0.936
						X26 Warehouse Capacity	0.922
Variable Laten: X3 Reputation							
0.722	0.882	0.860	0.802	0.722	0.617	X31 Working Capital	0.940
						X32 B-buy grain	0.957
						X33 Bank	0.605
Variable Laten: X4 Low Cost Strategy							
0.731	0.843	0.208	0.659	0.731	0.140	X41 Waste for Fuel	0.938
						X42 Pressing the price of raw mat.	0.762

Overview Inner Model						Overview Outer Model	
AVE	**Composite Reliability**	**R Square**	**Cronbach's Alpha**	**Communality**	**Redundancy**	**Measured Variable**	**Loading Factor**
Variable Laten: X5 Market Differentation							
0.682	0.810	0.481	0.536	0.682	0.325	X51 Quality of packaging	0.859
						X52 Packing volume variation	0.790
Variable Laten: X6 Organization							
0.613	0.863	0.655	0.788	0.613	0.396	X61 Existing Company Procedures	0.821
						X62 There is a contract	0.857
						X63 There is an employee data system	0.746
						X64 There is Perus_Doc	0.699
Variable Laten: X7 Side Product							
0.975	0.987	0	0.974	0.975	0	X71 Production-Bran	0.990
						X72 Production-MEN	0.985
Variable Laten: X8 Performance							
0.690	0.815	0.801	0.573	0.690	0,153	X81 Advantage (R/C)	0.914
						X82 (Profit/working capital)	0.739

The model obtained produces a path coefficient for each of the hypothesized relationships. In Table 3, it can be seen that of the 11 relationship paths, 9 pathways have significant coefficients. The largest coefficient is X2 TA → X3 REPUTATION (0.927), followed by X3 REPUTATION → X8 PERFORMANCE (0.856).

The X1 (Human Capital) construct has a significant direct relationship to the X8 (performance) construct and has a significant total effect value (0.2068) which is the total direct and indirect path coefficient on performance.

Table 2 – Path Analysis Results

Path description	Direct Path		Total Effect	
	Coefficient	T Statistics (|O/STERR|)	Coefficient	T Statistics (|O/STERR|)
X1 HC → X4 LC	0.457	9.615 **	0.457	9.615 **
X1 HC → X5 MD	0.694	18.728 **	0.694	18.728 **
X1 HC → X6 ORG	0.809	43.556 **	0.809	43.556 **
X1 HC → X8 Performance	0.182	2.273 **	0.207	2.409 **
X2 TA → X3 REPUTASI	0.927	67.833 **	0.927	67.833 **
X2 TA → X8 Performance	-0.237	1.435 Ns	0.558	4.235 **
X3 Reputation → X8 Performance	0.856	3.970 **	0.855	3.970 **
X4 LC → X8 Performance	0.153	3.589 **	0.153	3.589 **
X5 MD → X8 Performance	0.184	3.770 **	0.184	3.770 **
X6 ORG → X8 Performance	-0.213	2.040 **	-0.213	2.040 **
X7 Side Product → X8 Performance	0.0652	0.502	0.065	0.502
Effect Value of The Path				
X1 → X8	0.182			
X1 → X5 → X8	0.128			
X1 → X4 → X8	0.070			
X1 → X6 → X8	-0.172			
X2 → X8	-0.236			
X2 → X3 → X8	0.794			

Notes: ** = T Stat >1.96, Significant on 5%; * = T Stat > 1.65, Significant on 10%.

The total effect value of the path coefficient X1 to X8 is 0.207. Tangible Asset has a negative insignificant relationship (-0.236) to performance, but the total effect value is significant and positive (0.558).

Judging from the market differentiation strategy construct path coefficient with a value of 0.184, this is slightly larger than the low-cost strategy on performance which is 0.153. Meanwhile, the organizational strategy has a negative effect on -0.213.

The X2 construct (Tangible Asset) has a negative direct relationship (-0.236) and is not significant, but has a significant and positive (0.558) indirect relationship (through the reputation construct). This shows that the X2 extract influences performance through a moderating variable in the form of the Reputation construct as measured by the ability to provide / own working capital, sufficient cost of buying grain, and a relationship with the bank. This means the

entrepreneur's ability to obtain/provide costs associated with the main operation of a rice refinery, namely the purchase of raw materials in the form of unhulled rice.

Regarding the relationship between human capital and DP and LC strategies, this study is in accordance with what was written Spanos and Spyros (2001) that company assets, in this case, human capital, affect performance indirectly, but through its ability to implement company strategies. In this study, human capital includes the following aspects: clear performance indicators for employees, the total number of employees, employee experience, and a number of employees with high school education. Thus, the implementation of the company's strategy is highly dependent on the human capital aspects of the company.

From a theoretical perspective, this study solves the problem comprehensively by proving that the RBV model approach can predict the performance of the processing industry. In detail, the uniqueness of this study lies in proving the performance model of the processing industry, where the results reveal that all antecedent variables are divided into three sub-models that can determine the amount of performance achievement. The three sub-models are: 1) tangible asset variables affect performance through reputation variables; 3) the Human Capital variable through a low-cost strategy has a significant impact on performance; 4) the human capital variable through marketing differentiation has a significant impact on performance.

These four sub-models serve as a framework for shaping the performance of the processing industry. The proving results of the research model confirm that Reputation acts as a full mediator variable of the Tangible Asset variable, and the low-cost strategy with product differentiation is proven to act as a full mediator variable of the Human Capital variable.

The full mediator creates dependence on antecedent variables to influence processing industry performance. This evidence is in accordance with research Sankaran, Kumar and Das (2020), which revealed that human capital affects the added value of manufacturing in the framework of endogenous growth.

The direct effect from the financial aspect shows that rice refineries are capital intensive businesses, especially in providing capital for the purchase of grain.

Empirically, the RBV model becomes the basis for drafting concepts to improve the performance of the rice milling company. In the findings of this RBV model, it is evident that not all dimensions of the RBV can predict this performance, especially the organizational variables. This illustrates that in fact in the manufacturing industry, organizational function variables do not really affect the amount of performance produced.

4 CONCLUSION

Answering the problem of what are the determinants of industrial performance, through the RBV approach with the SEM PLS model, it can be seen that the tangible asset factor through the mediation of the reputation variable is the most important factor in determining the performance of rice milling companies. This reputation variable is measured by working capital ownership and credit from the bank and the purchase value of the grain. If seen from this, the rice milling business model is a capital intensive business and requires the availability of adequate cash flow. This cash flow management is the determining factor for the success of the company in achieving its best performance.

Company capital in the form of human capital has a real direct relationship to performance. The total effect is greater because it is coupled with a real indirect relationship through Low Cost and Market Differentiation strategies. Meanwhile, company capital in the form of Tangible Asset has a direct and insignificant relationship to performance.

The total effect value of the tangible asset variable is 0.5578 greater than the total effect value of the human capital variable of 0.2068, this right shows that the rice processing industry its performance is more dependent on the company's tangible assets, which in the process is largely determined by the entrepreneur's reputation variable in managing finances.

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CONFLICTS OF INTEREST

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Quality 4.0 for Processes and Customers

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ABSTRACT

Purpose: Considering the speed of technological development towards the Industry 4.0 era the change is necessary for managerial aspects in industrial companies. In this paper an attempt is made to understand the influence of Industry 4.0 technologies on the Quality 4.0 concept better.

Methodology/Approach: Two aspects were analysed in order to achieve the goal – the influence of Industry 4.0 on quality management and the influence of Quality 4.0 on customer satisfaction. The paper is based on a literature review and a pilot study based on questionnaires prepared for research purposes.

Findings: It was found out that the emergence of new technologies is beneficial for Quality Management processes and customer satisfaction. Moreover, the influence is greatly described by the amount of data now available for analysis. However, as the concept of Quality 4.0 is in its infancy, the necessary change is still required.

Research Limitation/Implication: As the research was conducted in the Czech Republic, the results are limited according to the territory. Also, the study was based on the literature review available from SCOPUS and WoS databases in English, thus further studies of available literature in other languages might be needed.

Originality/Value of paper: Although the quality tools that are used in Quality 4.0 are already known and accepted the influence of advanced technologies on quality management is not clear. In this paper an attempt is made to understand the influence.

Category: Research paper

Keywords: TQM; lean six sigma; industry 4.0; quality 4.0

1 INTRODUCTION

In the contemporary world with the constantly increasing speed of change and technological advancement, many companies face the challenge of changing the existing methodologies and practices accordingly. With its first introduction in 2011, the term Industry 4.0 became an inseparable part of industrial life, thus influencing not only industrial processes but also the management of organizations of all types. This has led to the fact that nowadays managerial systems that have been used and proved their consistency are currently changing in order to be better integrated into the technological environment. As one of the important aspects of any business, quality management is also changing towards the Industry 4.0 era.

The quality management that integrates Industry 4.0 technologies is lately called Quality 4.0. However nowadays there is no universally accepted term for Quality 4.0, this term usually includes the usage of quality tools combined with new technologies characteristic for Industry 4.0, such as Big Data, Internet of things, etc.

Although the quality tools that are used in Quality 4.0 are already known and accepted the influence of the advanced technologies on quality management is not clear. The confluence of quality tools and Industry 4.0 technologies is considered to be beneficial (Chiarini, 2020), but the shift in quality management is not yet settled.

In this paper, an attempt is made to understand the influence of Quality 4.0 on quality management and to identify the key aspects of the conjunction of Industry 4.0 and existing quality approaches. As quality methodologies here, Total Quality Management (TQM) and Lean Six Sigma (LSS) were analysed as they have always been connected with technologies (especially for data gathering) and they are often (however not always) considered to be interrelated and interconnected as a part of the same organizational system (Salah and Rahim, 2019). Moreover, TQM is based on the principles of ISO 9001, the common patterns might be discovered and thus, the analysis of TQM was performed in this paper, along with the tools used to optimize them. However, this issue requires further verification.

2 METHODOLOGY

This paper is based on a systematic literature review supported by questionnaires developed by authors with the purpose to better understand the concept of Quality 4.0 and to offer a Quality 4.0 framework for successful implementation of Industry 4.0 tools for quality management in industrial companies.

The research is aimed to answer 2 research questions and to form the Quality 4.0 framework model based on the answers. The research questions are:

RQ1: How does Industry 4.0 influence quality management?

RQ2: Could Industry 4.0 technologies improve customer satisfaction from the quality point of view?

The search for the answer to the research questions was conducted in 3 stages.

First, the literature review with the purpose to systemize the existing information on Quality 4.0 was conducted and the relevant articles were chosen. The search comprised the following terms "Quality 4.0", "TQM and Industry 4.0" and "LSS and Industry 4.0". The result was 12 articles found in research databases. The following step was the choice of exclusion criteria for the search. The exclusion criteria included articles written not in English, articles not connected with the research topic, non-availability of the article. Only articles published in scientific journals and conference proceedings were included. The search was conducted in Scopus and WoS databases. As the result, only 7 articles were included in the final literature review analysis part. Based on the systematic literature review the key aspects of Quality 4.0 were proposed connected with the change of quality management towards Quality 4.0 and the customer satisfaction.

The second stage was the pilot study aimed at a better understanding of the situation from the point of view of existing companies. Thus, an attempt to understand the current customer satisfaction was conducted based on the following and considering customer requirements. Then, the possibility to improve customer satisfaction was analysed from the theoretical point of view based on the systematic literature review. In this part, a survey that gathered 113 answers from companies in the Czech Republic was applied. To gather the data, the survey was developed and sent to 300 companies and as 113 answers were obtained the response rate is 37.7%. The choice of companies was random. The companies of different sizes took part in the survey, 40.5% were large companies, 21.6% were medium companies and 37.8% were small companies. Companies that participated in the survey were from manufacturing (42%), services (20%), sales (13%) and others, as well as companies working in several sectors of economy.

The third stage was aimed at estimating the influence of Industry 4.0 on existing quality management practices. The companies in the Czech Republic were asked to estimate the influence of Industry 4.0 technologies and the acceptance of different technologies was estimated. The data was gathered in another survey where40 companies participated. The gathered data was used to answer the RQ1 and provided additional information for the understanding of Quality 4.0.

Further, the gathered data was systemized and analysed from the point of view of the stated research questions.

3 LITERATURE REVIEW

The amount of technologies is growing, so is the amount of customer demands and speed of market competition. This sets a problem for industrial companies of

how to adapt to everchanging complexity and to stay on the market. Different companies are looking for different ways to improve competitiveness and increase income. One of the ways is to adapt the existing quality management to the developing environment.

Contemporary studies of Industry 4.0 increase together with the interest towards the new concept. Industry 4.0 is interesting not only for managers from the managerial point of view but also for scientists from the theoretical point of view and conceptualization. This has led to the increasing number of attempts to develop theories on adaptation (Rossini et al., 2019), make an assessment (Yeen Gavin Lai et al., 2019), analyse (Leyh, Martin and Schaeffer, 2017), propose the implementation (Sony, 2017) and conceptual framework (Salkin et al., 2018), etc. This is because society has realized the necessity of change in development both in everyday and industrial life.

One of the most important managerial skills for every company that is connected with company success is quality management. Quality management is aimed at achieving high-quality results (Carvalho et al., 2021). Many companies are successfully using TQM and LSS that let them improve their manufacturing processes and services. In the contemporary world quality management is changing together with the world to be better integrated with technologies of Industry 4.0 and to create a new Quality approach that could be called Quality 4.0.

3.1 Industry 4.0

The constantly changing environment and the development of technologies have led to the emergence of a new concept of understanding the industrial processes as the next industrial revolution. This concept was called Industry 4.0.

Every industrial revolution brings the attempts of improving the existing manufacturing processes to better meet the market requirements (Yeen Gavin Lai et al., 2019). The current stage of the industrial revolution is connected with "machine intelligence, pervasive computing, affordable storage and robust connectivity" (Radziwill, 2018). With Industry 4.0 the improvements are provided by the development of Internet technologies allowing better data processing, Cyber and artificial intelligence concepts. "The fourth industrial revolution is a new level of organization of production and creation of high-tech products" (Ustinova, 2018).

With the rapid growth of the Internet, the necessity of better interaction with technologies and their advanced usage has appeared, such as data storage and processing. Considering the decreasing cost of technologies, the availability of change is accepted by the industrial world (Radziwill, 2018). Nowadays all kinds of products are "becoming 'smart'" (Rauch, Dallasega and Matt, 2016). This gave an impulse towards the faster development and the formation of a new industrial environment known as Industry 4.0.

New fourth Industrial Revolution or Industry 4.0 has been announced by the German Government in 2011 at Hannover Fair (Salkin et al., 2018). Currently, the definition of Industry 4.0 varies depending on the country and/or industry. The common concept is to shift from a centralized way of production to a self-controlled and flexible way (Leyh, Martin and Schaeffer, 2017). The main idea of Industry 4.0 is to develop a Smart Factory (Yeen Gavin Lai et al., 2019) where the processes could be interconnected in a smart way.

With the growing individualized demand, product advancement and great interest towards the efficient usage of the resources, the need to coordinate and connect actions and information for industries is becoming increasingly important (Salkin et al., 2018). This gives momentum to the development of technologies that will be able to communicate and make simple decisions. The systems should be able to self-control and maintain good working conditions. The growing integration of these systems served as the reason for industrial change thus introducing the Industry 4.0 era.

Industry 4.0 has eight important technological developments: adaptive robotics, big data analytics, simulation, cyber-physical systems, industrial Internet, cloud systems, additive manufacture and networking (Salkin et al., 2018).

Apart from the technological aspect, Industry 4.0 also comprises a managerial aspect (Yeen Gavin Lai et al., 2019). It is important for managers and company leaders to shift their understanding of the technological world and to become more open-minded and forward-thinking. As the development is fast and it is complicated to predict what will gain more popularity and what will fail, it is becoming of increasing importance for managers to be able to foresee the development and welcome innovation to maintain the company's success, or to inspire the progress.

Moreover, as (Chiarini, 2020) indicate Industry 4.0 can influence also quality management. Thus, it is important to understand that the change affects many aspects of management in enterprises and requires a thorough understanding of the processes so that the introduction of Industry 4.0 shapes the development of the company positively and smoothly.

3.2 Lean Six Sigma

Lean Six Sigma appeared in 2000th as a junction of two successful methodologies – Lean and Six Sigma. Lean Six Sigma has the principle that: the activities that are critical to quality for the customer and have delays in time could be improved (George, 2002).

Lean as a term appeared from the book "The machine that changed the world" and became widespread due to the enormous success of Toyota company on the market in difficult times. Nowadays several definitions could be found on Lean depending on the field, application, etc. but all of the definitions have a common understanding of the Lean process as a smooth process with seven kinds of

wastes being eliminated. “Lean management thinking is used to differentiate between waste and value within an organization” (Sony, 2017). These kinds of wastes are overproduction, over-processing, waiting, transportation, inventory, unnecessary motion, defects (Yeen Gavin Lai et al., 2019). Some authors also include unutilized talent in wastes (Gay, 2016).

Six Sigma first appeared in the Motorola company in 1980 (Adams, Gupta and Wilson, 2003). The main principle in Six Sigma is to control variability and decrease defects. The number of defects that is considered to be reasonable in Six Sigma is 3.4 per million opportunities. Six Sigma has a DMAIC circle as one of the main tools and that tool became also one of the basic tools of LSS.

Following the Six Sigma approach, LSS inherited tools from TQM while increasing the statistical component and introducing Lean tools and the Six Sigma belt system. Until now, the application of LSS is the most relevant and successful approach in many companies. However, considering the speed of development in the contemporary world, a need has appeared to adapt these concepts to the rapidly changing conditions of Industry 4.0.

3.3 Total Quality Management

Total Quality Management appeared also in Japan in the 1950s. It became the most popular approach to quality management (Dahlgaard-Park, 2011). It is aimed at constant improvement via quality increase. TQM is a management approach aimed at quality increase. The basic principles of TQM were gathered in ISO 9000 (Huffman, 2008). In 1989 the first book mentioning TQM has appeared, however similar approaches had been discussed in other books (Dahlgaard-Park, 2011).

In the book published in 1989, TQM is understood as an approach, that can be applied to ameliorate the “effectivencess and flexibility” of an organization as a unit (Dahlgaard-Park, 2011; Oakland, 1989). However, there are still different understanding of TQM the basic principles are similar: long-term orientation, although some results can be seen in a short-term perspective; inspiration and support of initiatives and teamwork, documentation of processes. Total Quality Management is a quality management approach that is aimed at continuous improvement (Tortorella, Silva and Vargas, 2018). In the given paper TQM is considered as an organizational approach that is aimed at quality improvement via tools, characteristic for this approach, especially connected with the usage of technologies for data gathering and data processing. The usage of TQM has already proved itself as being beneficial in many organizations. The approach itself does not provide any income but if to follows it properly the expensive processes can be found out and eliminated.

TQM approach is connected with data gathering and processing from the point of view of data assessment and analysis. Thus, the integration of contemporary technologies and the change in data processing might sufficiently influence TQM tools and principles.

3.4 Quality 4.0

The emergence of new technologies is unavoidably connected with the methods that are used for quality control and assurance in an organization. This change in quality management influenced by the active shift towards Industry 4.0 technologies is called lately Quality 4.0. It is connected with the transparency provided by the influence of connectedness, intelligence and automation to quality tools (Chiarini, 2020).

However, Quality 4.0 is currently an emerging term and no standard has yet been accepted, several authors have already considered its influence in the industrial environment. Sütőová, Šooš and Kóča (2020) state that Quality 4.0 enhances the emergence of technologies and influences the quality in a positive way. However, Quality 4.0 is often considered to be connected with the effect of technologies on TQM (Carvalho et al., 2021; Chiarini, 2020; Nenadál, 2020), in this paper, LSS is also considered as an important part of Quality 4.0.

In his work (Radziwill, 2018) has presented several aspects of change in quality management following the American Society for Quality (ASQ). Future of Quality Report, that are the necessity of continuous learning for quality professionals, the shift in information transparency between organizations and supply chains and the expansion of customer requirements (Radziwill, 2018).

Quality 4.0 brings several benefits to quality management as an increase in speed and transparency, adaptation to new circumstances and continuous improvement between companies, and augmentation in awareness skills and intelligence (Milunovic Koprivica et al., 2019). Moreover, industrial transformation has direct influence on customer satisfaction, as it improves the customization of the product (Sütőová, Šooš and Kóča, 2020). The tendency to move towards the situation when computers using the benefits mentioned above will be able to assess and predict failures could have an important impact on quality management.

4 RESULTS AND DISCUSSIONS

4.1 Influence of Industry 4.0 on Quality Management

According to the literature review, the influence of Industry 4.0 is beneficial and could provide improvement to the existing quality management practices. However, as the initial search for the key terms resulted in 12 articles, it is not possible to state that the existing analysis is sufficient for the proper understanding of the confluence of Industry 4.0 and quality management. At the same time, some of the key points of influence of Quality 4.0 on the existing practices are summarized based on the literature review and are explained.

One of the most important peculiarities of Industry 4.0 is the amount of data that could be stored and processed. This data would influence many aspects of quality

management and change them towards Quality 4.0, so the proper collection and storage of data are compulsory aspects for successful management. The technologies also could allow collecting data for quality management purposes in a more efficient way (Chiarini, 2020; Zonnenshain and Kenett, 2020). Quality management has always been data-driven and modern technologies could nothing but benefit the existing practices.

Another aspect that could be named here is the increase in process transparency. As some of the main failure factors of LSS are considered to be the difference between the project aim, the main goals of the company and the customer demand; lack of clear vision and a plan; the resistance to culture change (Albliwi et al., 2014), the quality management changed towards Quality 4.0 principles with increased transparency could be beneficial for many companies and help them to avoid unnecessary costs and failures. Smart sensors and Radio Frequency Identification (RFID) also impact process transparency (Chiarini, 2020). As the smart factory is based on the interconnection of the processes with transparency being one of the key success factors in the development, the communication not only between processes and projects in one organization but also interorganizational communication will be influenced greatly by this aspect. From the quality point of view, transparency would provide easier access to the information thus improving the connection with the data available for analysis and decision on future actions. Transparency is inseparably connected with the quality control phase, which is characteristic for both LSS and TQM, as it could lead to the reduction of errors and defects in processes (Chiarini, 2020).

Apart from transparency, credibility could also be improved with the usage of these technologies (Emblemsvåg, 2020). As these two factors could be connected in several ways, an increase in transparency usually has a positive impact on credibility. The customer and partner's understanding of the processes through the ability to better monitor and if necessary influence the flow should also have a positive impact on the quality management. Thus, the quality tools implemented in the process could be monitored and modified if necessary without losses, which should increase the credibility of both partners and customers as well as the suspicious workers participating in the process.

The prediction aspect of Quality 4.0 (Chiarini, 2020) also plays an important role in new quality management. One of the important aspects of quality management is to be data-driven (Zonnenshain and Kenett, 2020). Usage of Big Data and data analytics, especially with the usage of artificial intelligence, allows to store and process large amounts of data and to manage processes more effectively based on this data. Using the increased amount of data, managers would be more able to choose a proper strategy and implement a certain strategy. In LSS prediction aspect could influence improve phase and in the TQM act phase as the results could be better predicted based on the data. Quality 4.0 brings new technologies to optimize the quality management, when the automation and artificial intelligence could be used to improve the processes (Santos et al., 2021). The machine learning and artificial intelligence have great potential for the modelling

and simulation of different processes and procideres, that could provide managers with necessary insights and benefit the process improvement. Thus, artificial intelligence could help to recognize mistakes in the process, communicate with

All the aspects mentioned above could also help to improve the situation in project-based industries as in these industries the legalism plays an important role the quality management, using the TQM and LSS are usually difficult to be introduced (Emblemsvåg, 2020). Thus, the augmented transparency, prediction and data collection, the simulation could influence the situation allowing the Quality 4.0 principles to be used in separate projects.

As many companies use the Industry 4.0 technologies in the Czech Republic to some level and the majority of them (93%) find them useful, the influence of these technologies on quality management such as TQM and LSS are particularly interesting. In the pilot study, it was found out that the majority of companies, although consider LSS and Industry 4.0 an effective combination, the most widespread answer was as 3 out of 5 (where 5 is the most effective). At the same time 56.5% of respondents consider the influence of Industry 4.0 on LSS although being considerable, not very big (3 out of 5).

All the aspects mentioned above are inseparably connected with both new technologies of the Industry 4.0 era and quality management. Summarizing the information mentioned above it could be stated that the influence of contemporary technologies will change the quality management to become more autonomous and self-controlled. The data could be gathered by sensors and RFID, could be stored and analysed using Big Data technologies and simulated via simulation tools, thus creating a possibility of creating not only a smart factory where all the processes are interconnected but also smart quality management where some of the decisions on quality and/or quality tools could be made by the system created with the help of Internet of Things and Cyber Physical Systems. Thus, the answer to RQ1 is that the technologies are shifting the existing quality management generally by the increasing amount of data and data processing techniques.

4.2 Influence of Quality 4.0 on Customer Satisfaction

From the Quality 4.0 management customers could also benefit greatly. First of all, with the increased transparency the customer would be able to participate more in a process and customer requirements could be better satisfied. This will inextricably lead to customer credibility improvement and as a result customer loyalty could also be improved. Moreover, such technologies as 3D printing have already been using for customized products (Santos et al., 2021). Big Data is used for data collection and processing and augmented reality is used to demonstrate the interior spaces.

As it could be seen in Figure 1, the information gathered via questionnaire shows that 43.1% of companies follow the customer requirements in the maximum way

possible. Although the amount of those who do not follow customer requirements at all is considerably law 0.9% (only one company chose this option), the improvement in this field could continue to serve as the benefit in the market competition.

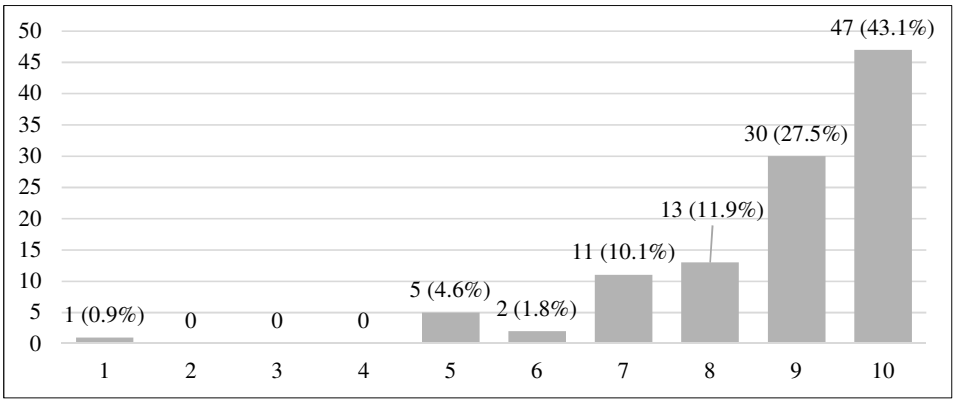

Figure 1 – How Much Do You Follow the Customer Requirements (1-min, 10-max)?

As Figure 2 depicts, almost 20% of respondents answered that they consider customer requirements fully for their products. Moreover, out of 113 respondents, 97 answered that they consider customer requirements for their product not fully but in the major part. Considering the fact that the majority of answers, as could be seen in Figure 2, are on the range from 5 till 9, while only 6 answers out of 113 were on the scale from 1 to 4, it could be concluded that the consideration of the customer requirements is an important issue for quality management in the Czech Republic.

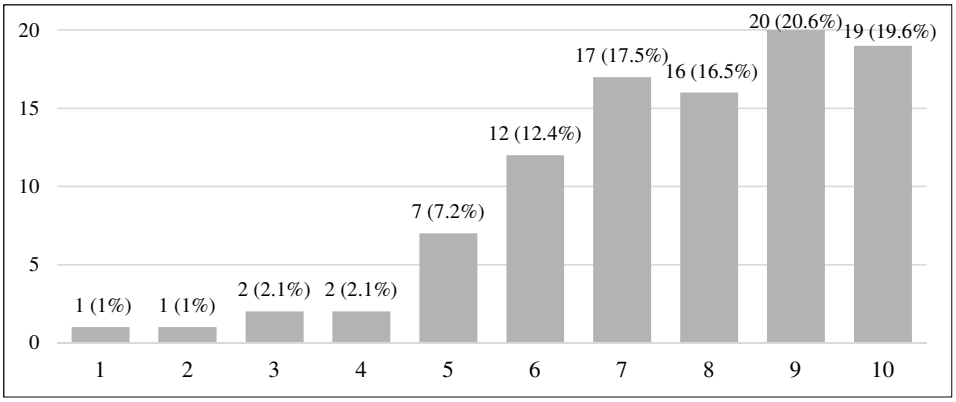

Figure 2 – How Much Do You Consider Customer Requirements for Your Product (1-min, 10-max)?

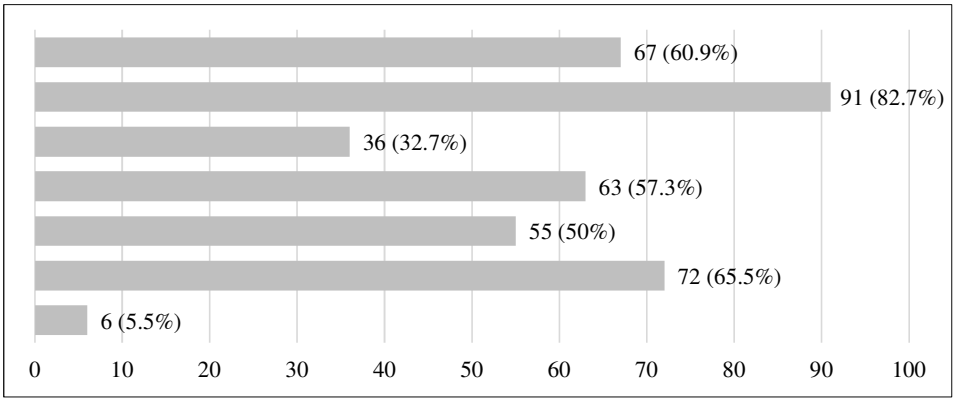

Figure 3 – Competitive Advantage

Another important aspect is that customer orientation is an advantage of a company against concurrence. That could be seen in Figure 3, where 65.5% of respondents choose this option as a competitive advantage.

This leads to the conclusion that the customer relations are a crucial issue for the companies' success, thus the change in customer relations could influence the company greatly. In his paper (Chiarini, 2020) has summarized the works stating that Industry 4.0 technologies will affect customer satisfaction by eliminating defects and adopting the product better to customer needs. The customer needs and requirements will be better processed using the emerging technologies and thus the final product will satisfy the customer better. To sum everything up, the potential connected with the Industry 4.0 technologies should contribute to a positive development of the customer relations and strengthen of the positive cooperation.

5 CONCLUSIONS

As Industry 4.0 technologies influence industrial life-changing the future of existing practices and theories there is a need to better understand the direction of the change in all the fields. This paper is aimed at understanding the change of quality management towards Quality 4.0. The paper was structured as a mixture of literature review and questionnaire analysis to better understand and analyse the situation.

In order to answer the aim of the paper two research questions were identified at the beginning of the research, namely how does Industry 4.0 influence quality management and if Industry 4.0 technologies could improve customer satisfaction from the quality point of view? The questions were answered via systematic literature review and pilot survey based on the questionnaire.

It was found out that the influence of Industry 4.0 on quality management is generally due to the amount of data and its availability. Through the data, transparency, credibility, prediction and control are provided. As the amount of

data is growing and the technologies allow to analyse and store it better, the quality specialists have an opportunity to improve their tools to provide better success for their companies. Apart from Big Data and Big Data analytics, other important technologies for quality management, that promise the biggest amount of benefits are simulation, that, using the machine learning could be further advances. Artificial intelligence, that might support both production and services, could also provide quality managers with benefits necessary for Quality 4.0.

Another aspect is customer satisfaction with is considered to be one of the most important factors for company success and its connection with the quality management change. It was noted that technological advancement could improve the relationships between companies and their clients as the personification of products and increase in credibility might be improved with Quality 4.0. Moreover, as quality tools, in general, could be ameliorated, the number of defects could be decreased – this could also be considered as an opportunity to augment customer satisfaction.

Thus, the influence of technological advancement towards the Industry 4.0 era promises a positive impact on the quality tools as it provides better data for both processes and customers. However, the issue of Quality 4.0 is still in its infancy and the necessary changes would require some recourses from companies, the benefits from technologies for LSS and TQM could provide competition advancement for industrial firms.

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Conceptualization, A.E. and P.B.; Methodology, A.E.; Formal analysis, A.E.; Resources, A.E. and P.B.; Original draft preparation, A.E.; Review and editing, A.E.; Supervision, P.B.; Funding acquisition, A.E.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Integration of Waste Assessment Model and Lean Automation to Improve Process Cycle Efficiency in the Automotive Industry

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ABSTRACT

Purpose: This study aims to improve Process Cycle Efficiency (PCE) by reducing waste in the assembly production line. This research is a case study conducted in a four-wheel vehicle manufacturing company to create a Lean production system.

Methodology/Approach: This study uses the Waste Assessment Model (WAM) and Lean Automation integration methods carried out by 5 expert judgements in the selected four-wheeled vehicle industry.

Findings: Based on the WAM method, this study found the biggest waste on the assembly line, namely transportation with a percentage of 20.44%. Improvements made with Lean Automation can increase the value of PCE from 56.76% to 63.62%.

Research Limitation/Implication: This research is limited to one model, namely Multi Purpose Vehicle (MPV). This research provides benefits for companies related to waste reduction. For similar companies, this research can be input for manufacturing practitioners in improving manufacturing performance to compete in the global market. This Lean production can reduce manpower which has an impact on saving production costs.

Originality/Value of paper: This paper provides added value related to the application of Lean terminology which aims to improve industrial automation-based manufacturing companies.

Category: Case study

Keywords: assembly line; lean automation; process cycle efficiency; value stream mapping; waste assessment model

1 INTRODUCTION

Indonesia, Thailand, Malaysia and the Philippines are known as the "ASEAN-4 cluster" and are the dominant automotive players in Southeast Asia (Irawati and Charles, 2010). Based on ASEAN Automotive Federation (2020) shows that the total production of four-wheeled vehicles in ASEAN reached 4,158,953 units in 2019. Indonesia is a country that has developed rapidly as an exporter of four-wheeled vehicles and is the world's leading automotive producer (Syah, 2019). After starting vehicle assembly in the 1920s, for the first time Indonesia has produced more than 1 million vehicles. Thus making Indonesia the 17th largest vehicle producer in the world (Natsuda, Otsuka and Thoburn, 2015). Currently, competition is an ongoing challenge faced by industrial companies, especially four-wheel vehicle manufacturers. Manufacturers of four-wheeled vehicles strive to continuously improve the efficiency of the production system by reducing non-value-added activities (NVA) (Swarnakar and Vinodh, 2016; Garza-reyes et al., 2017; Chaurasia, Garg and Agarwal, 2019). This is one of the best ways to be able to compete in the global market.

The automotive industry is one of the industries most actively involved in efforts to improve quality, productivity, labour efficiency and continuous improvement activities (Habidin et al., 2016; Psomas and Antony, 2019). Several research studies clearly show significant opportunities for efficiency improvements in the automotive industry through the implementation and higher utilization rates of Lean management (Kaneku-Orbegozo et al., 2019; Prabowo and Adesta, 2019).

According to Liker and Meier (2006), waste is one of the biggest problems in the manufacturing industry. One way to identify waste is to use the Waste Assessment Model (WAM) method (Marifa et al., 2018). The advantage of this model is the simplicity of the matrix and questionnaire that covers many things and can contribute to achieving accurate results in identifying the root causes of waste. WAM is often integrated with the Lean method as an improvement method. Lean is a Lean production concept that is suitable for creating an effective and efficient production system (Prayugo and Zhong, 2021). The Lean approach can eliminate waste to improve manufacturing performance (Setiawan and Hasibuan, 2021). Lean is a sustainable strategy to reduce waste.

Several studies related to Lean have a great effect on the manufacturing industry, including reducing manpower, reducing lead time, saving production costs, increasing productivity and increasing customer satisfaction. The purpose of this research is to increase the efficiency of the cycle process by reducing the waste in the assembly production line. This research is a case study in the Automotive Industry. The method used is the Waste Assessment Model (WAM) to determine the greatest waste and Lean Automation as a method of improvement.

2 LITERATURE REVIEW

2.1 Waste Assessment Model (WAM)

WAM is a model developed to simplify the search for waste problems and identify ways to eliminate waste. This model states the relationship between the seven wastes (Henny and Budiman, 2018; Paramawardhani and Amar, 2020). Waste Relation Matrix (WRM) is a matrix used to analyze the measurement criteria (Tannady et al., 2019). Waste Matrix Value (WMV) is the conversion of each symbol into a score in the form of a percentage which serves to simplify the matrix. The Waste Assessment Questionnaire (WAQ) is a tool to identify and allocate waste that occurs in the production line. The waste value on the WAQ is obtained from the WRM that has been done previously and is used for the initial WAQ assessment based on the type of question. WAQ consists of 68 different questions.

2.2 Lean Concept

Terminology of Lean Manufacturing is a system efficiency approach by reducing waste (Leksic, Stefanic and Veza, 2020; Rifqi et al., 2021). A good production system needs to identify non-value added activities in the production chain. Non-value added activities should be eliminated to reduce production lead time (Siregar et al., 2018; Rizkya et al., 2020). Manufacturing organizations effectively use Lean tools and techniques to identify and eliminate waste through continuous improvement (Zahrotun and Taufiq, 2018). While Lean Automation refers to the incorporation of Lean production with digital automation technology into the operationalization of practice (Dănuţ-Sorin, Opran and Lamanna, 2020; Tortorella, Narayanamurthy and Thurer, 2021; Tortorella et al., 2021). This method is supported by the Value Stream Mapping (VSM) tool, where previously we need to map current conditions and prepare for future conditions (Lacerda et al., 2016; Seth, Seth and Dhariwal, 2017; Narkea and Jayadevab, 2020; Setiawan, Tumanggor and Purba, 2021). The VSM technique serves as a powerful tool in enabling organizations to implement Lean manufacturing models (Romero and Arce, 2017; Nallusamy and Adil Ahamed, 2017; Ikatrinasari, Hasibuan and Kosasih, 2018).

3 METHODOLOGY

This research uses the WAM method and Lean approach. This study uses primary data and secondary data. Primary data was collected through field observations. The data is obtained directly to observe the real conditions in the company such as the four-wheeled vehicle assembly process which is then described on the VSM map. Primary data was also collected through interviews and distributing questionnaires to 5 expert judgement who had at least 5 years of experience in assembling four-wheeled vehicles with a minimum position as

manager. Secondary data is obtained through the company's annual report such as production capacity, number of workers and processing time. This study uses systematic steps to get the best results. This research step is divided into 3 stages, namely as follows:

Stage 1: Define the problem phenomenon that occurs in the production line. Determine research objectives based on the phenomenon of the problem. Conducting a literature review on WAM and Lean. The literature review is used to gain an understanding of research methods.

Stage 2: Collecting data and identifying the flow of the four-wheeled vehicle assembly process using VSM. Identifying 7 wastes is done by distributing questionnaires to obtain information from the company regarding waste that occurs in the assembly process using the WAM method. This stage requires accurate data and information so that the results obtained can be properly accounted for. The data used in the calculation of availability time, takt time, calculation of uptime, change over time, value-added (VA) and non-value-added (NVA), total lead time and PCE. To calculate PCE can use formula (1) and calculate efficiency value use formula (2):

$$PCE = \frac{Value\ Added\ Time}{Total\ Process\ Lead\ Time}\ x\ 100\% \tag{1}$$

$$E = \frac{\sum_{i-1}^{n} Wi}{\mathrm{n.Ws}}\ x\ 100\% \tag{2}$$

Stage 3: Make improvements to the largest waste based on WAM results. After the improvement is done then suppress with the future process flow. The implications of the research are discussed to determine the contribution of research to the industry. Finally, conclusions are obtained based on the results of improvements that have been made to the production line. The stages of this research can be seen in Figure 1.

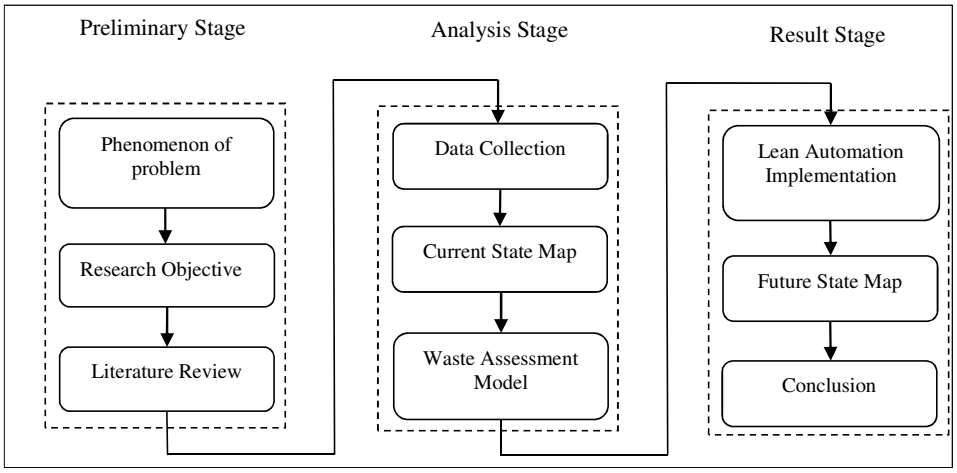


Figure 1 – Study Framework

4 RESULT AND DISCUSSION

4.1 Analysis of WAM

This chapter will discuss problem-solving analysis based on the research steps that have been determined. Then an analysis of the implications of this research is carried out as the value of the research contribution to the industry. The analysis begins by making a VSM based on initial observations in the field. The following VSM current conditions can be seen in Figure 2.

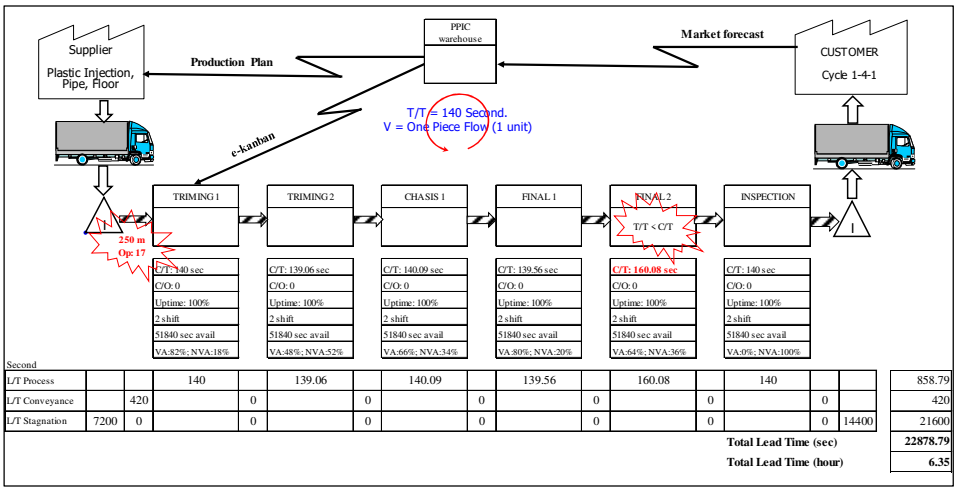


Figure 2 – Current State Map

Based on Figure 2, the Takt Time (T/T) value in the Final 2 process is less than C/T, which means that the final 2 process cannot meet the customer's demand so that improvements need to be made by minimizing activities that do not have added value. This assembly process is a process that has the same work elements, so the classification of work elements is divided into several activities such as the Install, walking, pickup, torque, marking, check, unpack, withdraw process. The following classification of work elements based on VA and NVA can be seen in Table 1.

Table 1 – Classification of NVA and VA Activities

Work Element Classification	Trim 1	Trim 2	Chassis	Final 1	Final 2	Inspection
Install	115	65.64	83.59	112.01	102,08	0
Walking	9	11.28	0	12.85	14	0
Take/put	5	37.06	40.76	14.7	16	0
Torque	0	0	9.16	0	0	0
Marking	0	0	6.58	0	0	0

Work Element Classification	Trim 1	Trim 2	Chassis	Final 1	Final 2	Inspection
Check	11	0	0	0	0	140
Unpack	0	17.45	0	0	28	0
Withdraw	0	7.63	0	0	0	0
Total	140	139.06	140.09	139.56	160.08	140
VA (%)	82.14	47.20	66.20	80.25	63.76	0
NVA (%)	17.85	52.79	33.79	19.74	36.23	100

The amount of production process performance can be determined by calculating PCE, which is using the total value add (VA) divided by the total process lead time. Where the total process lead time consists of the total process lead time from the beginning to the end. To calculate PCE can use formula (1), as $\frac{487.48}{858.79}\ x\ 100\% = 56.76\%$.

WAM is used to identify waste in each process. To get accurate data, respondents consisting of expert judgement must answer the questions in the waste assessment questionnaire that occurs in the production line and about the waste that may occur due to other waste. The results of the questionnaire were then assessed and ranked using WAM. Based on this assessment, it was found that transportation is the largest waste in the four-wheeled vehicle assembly process, which is 20.44%. This waste is the biggest waste that affects the entire production process. The summary of the percentage of waste that appears in the production process can be seen in Table 2.

Table 2 – Recapitulation Result of WAM

Remark	O	I	D	M	T	P	W
Score (Yj)	0.1416	0.1291	0.1274	0.0665	**0.1424**	0.0347	0.0765
Pj Factor	171.19	204.38	222.73	183.42	**215.74**	110.05	321.43
Final Result (Yj final)	24.24	26.39	28.37	12.20	**30.73**	3.82	24.59
Final Result (%)	16.13	17.55	18.87	8.12	**20.44**	2.54	16.35
Rank	5	3	2	6	**1**	7	4

Based on transportation activities from the warehouse to the assembly line, currently supplying materials uses the line stocking concept where materials are supplied to each assembly work station in packaging containers such as poly boxes, carton boxes, or pallets and the layout of materials in storage is arranged based on each supplier. The following process details can be seen in Figure 3.

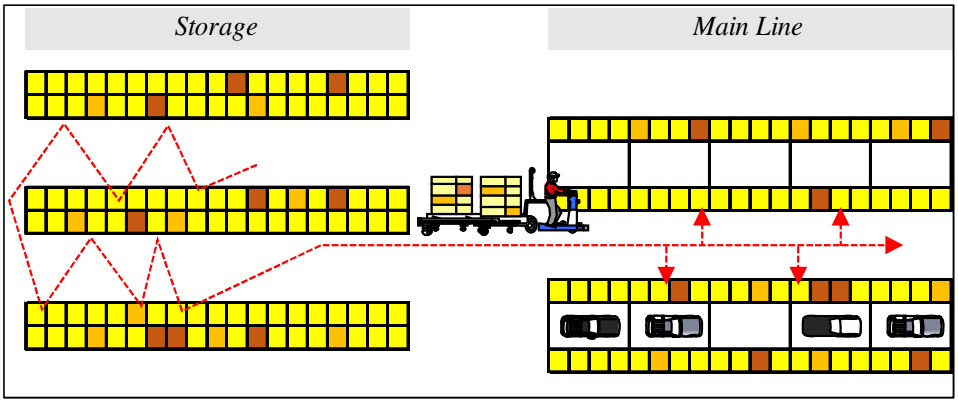


Figure 3 – Line Stocking Concept (Current Condition)

Based on the analysis, the weakness of this system is that sometimes operator errors occur in taking materials due to high material variations. The distance between the 1st, 2nd and so on material collection is very far and the process of finding material takes a lot of time, due to the large variety of vehicle models and stock parts are generated at each work station. The lead time (L/T) of the process of taking materials and supplying materials to the mainline needs to be calculated as the value of the efficiency line in terms of time and the use of labour in this transportation process. Based on the existing data, the average lead time of transportation in supplying materials is shown in Figure 4. (T/T is obtained from 140 seconds multiplied by the minimum material in the box = 3 materials so that 140 x 3 = 420 seconds). The overall efficiency value in the assembly process can be seen in Figure 4.

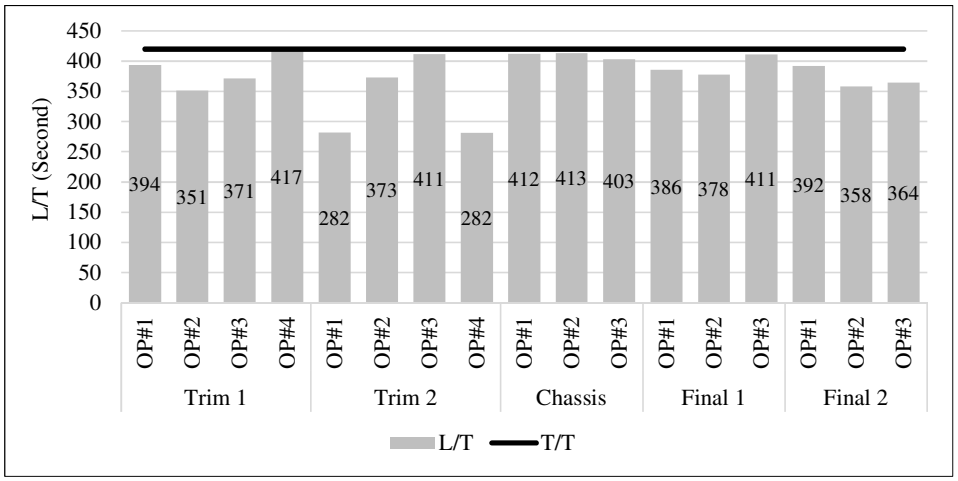


Figure 4 – Job Balancing Transfer Man Power

The efficiency value can be calculated by the formula (2) as $\frac{394+351+371+417+282+373+411+282+412+413+403+\cdots+364}{17\ x\ 417} x\ 100\% = 90.28\%.$

4.2 Improvement with Lean Automation

4.2.1Kitting System

Based on the FGD by expert judgment, the supply system will be changed from line stocking to kitting system, namely the delivery of materials to the mainline in a set and ready to be assembled. In this system, each material is collected, transported, and stored in a specific container which will be sent to the mainline. Where the layout in the material warehouse is arranged according to the order of material requirements on the mainline. The concept of kitting system can be seen in Figure 5.

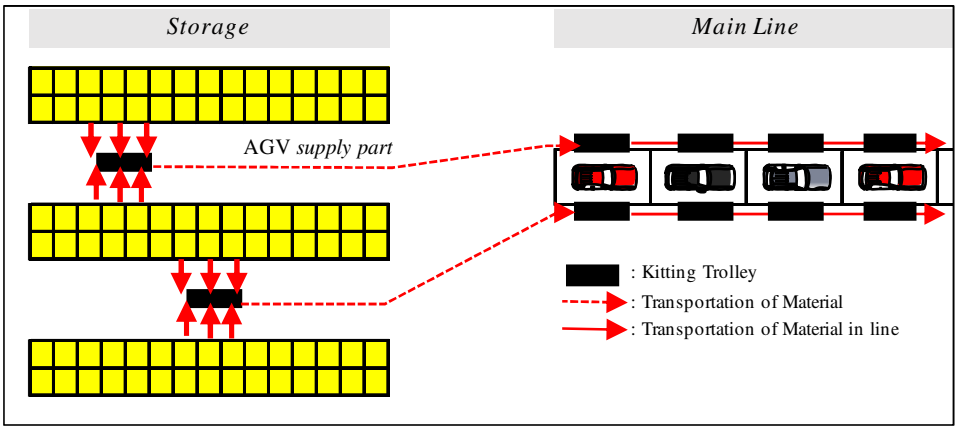


Figure 5 – Kitting System Concept (Future Condition)

The way this kitting system works is that the operator takes the material using a trolley that has been designed according to the shape of the material. This trolley contains materials that are arranged in sets for the needs of operators on the mainline. An example of a trolley kit can be seen in Figure 6.

Figure 6 – Trolley Kit

4.2.2Picking Lamp System

To reduce the time in the process of finding materials in the warehouse, we can combine it with an automation system that is integrated with the e-kanban

system, where the operator will work based on the e-kanban command and the system will give a signal to the material warehouse in the form of a live light. This means that only materials with a live indicator light must be picked up by the operator to be set into the Trolley Kit so that the operator does not have to search for materials to be picked up. How the picking lamp system works can be seen in Figure 7.

Figure 7 – Picking Lamp Working System

4.2.3 Automatic Guided Vehicle (AGV)

Another improvement in transportation waste is implementing AGV. AGV is a vehicle that is guided automatically with computer technology. The way the AGV system works is a vehicle that can be programmed like a multi-purpose robot that is guided by a magnetic track attached to the floor. This fix is aimed at processes that do not add value. Improvement was made to replace human labour when supplying materials from the warehouse to the mainline using AGV. This AGV is part of an automated tool with low-cost automation so that it can reduce direct labour costs in this NVA activity. The way AGV works is bringing the Trolley Kit to the mainline so that it can replace human labour in supplying materials to the mainline as shown in Figure 8.

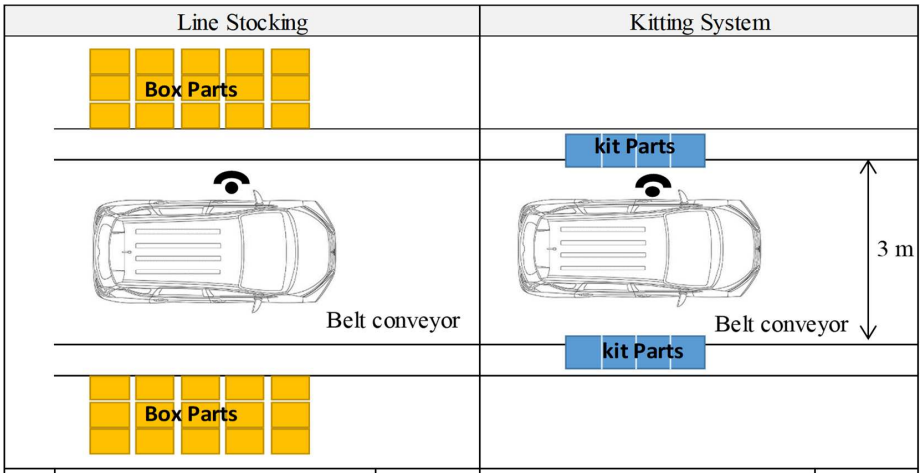
Figure 8 – Transport Parts with AGV System

Based on improvements with Lean Automation, it can eliminate waste such as activities to find materials, supply materials and place materials beside the mainline as in the previous condition (line stocking concept). The results of this improvement can reduce operators for transportation activities as much as 6 people which has an impact on increasing the efficiency value on the transportation line to 98.72%. The following comparison between the number of manpower before and after the repair can be seen in Table 3.

Table 3 – Comparison between the Number of Man Power

Process	Trim 1	Trim 2	Chassis	Final 1	Final 2	Inspection	Total
Before	4	4	3	3	3	0	**17**
After	2	2	3	2	2	0	**11**

Improvements with this Kitting System automatically provide convenience to operators in the mainline process. The operator only needs to take the material and install it. This improvement can eliminate activities that do not have added value such as walking to pick up materials, sorting materials, unpacking materials and moving boxes. Based on the Final-2 process, it is known that T/T: 140 seconds < C/T: 160.08 seconds, meaning that the product completion time is longer than the customer's request or the delivery is late. With this Kitting System, we can eliminate work elements that are NVA, resulting in a decrease in cycle time from 160.08 seconds to 113.08 seconds. Improvements to the Kitting System can be seen in Figure 9.



No	Work Element	Time (s)	Work Element	Time (s)
1	Walk to the shelf	2	Walk to the shelf	1
2	Take a logo	2	Take a logo	2
3	Walk to the unit	2	Walk to the unit	1
4	Open logo in plastic	2	Open logo in plastic	0
5	Install logo	4	Install logo	4
6	Walk to the shelf	2	Walk to the shelf	1
7	Take rear lamp A	1	Take rear lamp A	1
8	Unwrap the rear lamp	18	Unwrap the rear lamp	0
9	Put the pack into the box	4	Put the pack into the box	0
10	Walk to the unit	2	Walk to the unit	1
11	Install rear lamp A	32.06	Install rear lamp A	32.06
12	Walk to the shelf	2	Walk to the shelf	1
13	Take rear lamp B	1	Take rear lamp B	1
14	Unwrap the rear lamp	8	Unwrap the rear lamp	0
15	Put the pack into the box	5	Put the pack into the box	0
16	Walk to the unit	2	Walk to the unit	1
17	Install rear lamp A	32.02	Install rear lamp A	32.02
18	Take the fuel cap and fuel label	2	Take the fuel cap and fuel label	1
20	Move box	3	Move box	0
21	Install cap fuel	14	Install cap fuel	14
22	Install fuel label	14	Install fuel label	14
23	Close the cap fuel and fuel lid	6	Close the cap fuel and fuel lid	6
Total		160.08	Total	113.08

Figure 9 – Comparison of Line Stocking and Kitting System

Based on the system replacement from Line Stocking to Kitting System as a whole, it can eliminate operator time in walking to pick up material on the outside of the assembly line, open boxes and move empty boxes to be returned to the bottom of the rack.

Based on these improvements, a new PCE was obtained, namely as follows (formula 1): $\frac{487.48}{766.21}\ x\ 100\% = 63.62\%$.

After improvement, the process lead time is reduced due to the elimination of processes that are considered unnecessary. The total lead time of the assembly process decreased from 22,878.79 seconds to 22,666.21 seconds. Based on the improvements that have been made to the assembly process flow, the company

can find out a map of the future production process flow. Processes of the future become Leaner and more efficient. The following mapping of the future production flow can be seen in Figure 10.

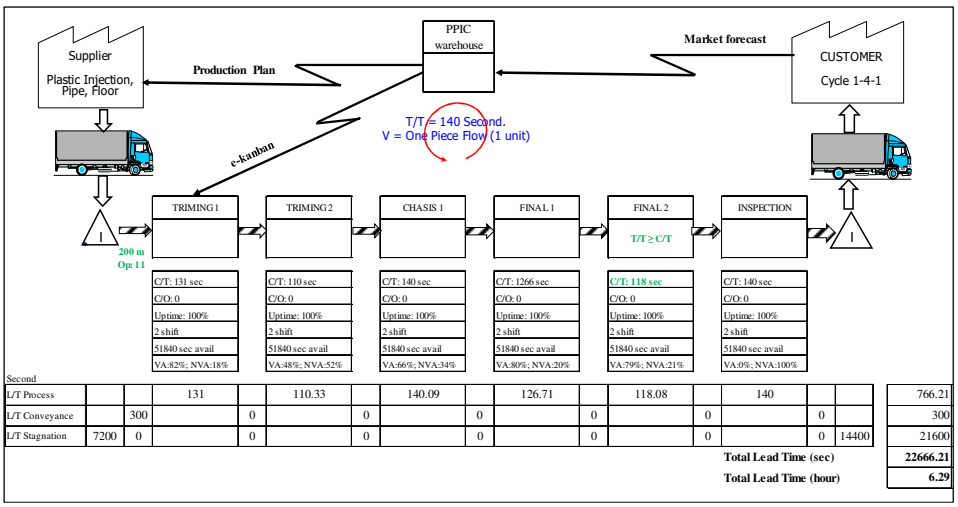


Figure 10 – Future State Map

These results indicate that lean production has a significant effect on the original production process. The comparison before and after the improvement can be seen in Table 4.

Table 4 – Comparison Before and After Improvement

Type of Activity	Before	After
Lead time (second)	22,878.79	22,666.21
Process Cycle Efficiency (%)	56.76	63.62

4.3 Research Contribution

This research provides benefits for companies related to waste reduction. For similar companies, this research can be input for manufacturing practitioners in improving manufacturing performance to compete in the global market. With this Lean production, it can improve manufacturing performance by saving production costs, reducing manpower, increasing productivity and increasing customer satisfaction. The improvements made in this study can be a good example to be applied, developed especially in the four-wheeled vehicle manufacturing process. Finally, improvement can support the company's sustainable business to become a world leader in manufacturing.

4.4 Comparison with Previous Research

Production line improvement using the WAM method can identify the biggest waste that must be repaired immediately to create an effective and efficient production system. This is in line with previous research (Henny and Budiman, 2018) that the WAM method can determine the largest waste. Most of the research with WAM is integrated with the Lean concept. This is in line to create a Lean production system. There are differences in the analysis of improvements in this study, namely making improvements with Lean Automation. The improvements made direct to modern industrial automation. This is a novelty in this study which shows the improvement of industry 4.0.

5 CONCLUSION

The results of identification using the WAM method obtained the largest waste in the four-wheeled vehicle assembly line for the MPV model. The biggest waste occurred is Transportation (20.44%), Defect (18.87%), Inventory (17.55%), Waiting (16.35%), Over Production (16.13%), Motion (8.12%), Process (2.54%).

Improvements in transportation waste are carried out using a Lean automation approach, where transportation activities or material transfer from the warehouse to the assembly line which were originally manual using human labour are replaced with AGV, so as to reduce human labour in the transportation or material handling section from 17 people to 11 people. This study also increased the value of PCE, which before improvement was 56.76% and after improvement increased to 63.62%. Future research can apply Lean concepts to all elements of the production process by integrating all production lines based on industrial automation.

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Conceptualization, S.S. and I.S.; Methodology, S.S.; Validation, S.S and H.H.P.; Formal analysis, S.S.; Data curation, S.S.; Original draft preparation, S.S. and I.S.; Review and editing, I.S.; Visualization, S.S.; Supervision, C.J.; Advisor, H.A.P; Project administration, S.S.; Funding acquisition, S.S.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Modelling Customer Satisfaction with Food

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ABSTRACT

Purpose: The subject of the article is the relationship between customer satisfaction, loyalty and personality characteristics. It aims to analyse factors that influence customer satisfaction and loyalty, including their mutual relationships. For this purpose, a comprehensive model of customer satisfaction was created.

Methodology/Approach: The research was carried out using a questionnaire survey on a sample of 1,530 customers of food producers (and 103 food business products that were non-durable) corresponding to the Czech population in terms of gender, age and region. The questionnaires were statistically evaluated using Structural equation modelling (SEM).

Findings: The results show that a strong link between standard customer satisfaction factors (perceived quality, perceived value, customer expectation) overshadows the influence of weaker factors (personality). However, this effect is fully demonstrated when these strong factors are filtered out.

Research Limitation/Implication: The paper focuses on foods that are sold through retail intermediaries, which also affect customer satisfaction. It may be different for other types of products and services and for products sold otherwise. It can also be limited to CR, resp. transition economics, ie. that in developed countries it could be different.

Originality/Value of paper: The contribution of the paper is the finding that customer satisfaction is influenced by a personality factors, whose effect is at first glance weaker. It also shows that the factor image can be constructed taking into account the competitive ability of the company as a hybrid and the functionality of the customer loyalty factor influences the way of its construction.

Category: Research paper

Keywords: customer satisfaction; personality; customer loyalty; image; competitiveness; modelling

1 INTRODUCTION

Since the 1990s, customer satisfaction models have emerged in the literature (Fornell et al., 1996; Gronholdt, Martensen and Kristensen, 2000), which assume that customer satisfaction is a multidimensional construct that is influenced by certain factors that are themselves one-dimensional or more dimensional (cf. Chang et al., 2016). Factors that have been repeatedly confirmed by researches as influencing customer satisfaction, including perceived quality (Ophuis and Van Trijp, 1995), perceived value (Chou and Kohsuwan, 2019), customer expectation (Chang et al., 2016) and complaint (Landon, 1980). The research carried out differs only in the strength of the relationship found (e.g. the difference between satisfaction and loyalty on profits and growth for products and services or in the specific interconnection of individual factors; for example, whether they affect customer satisfaction directly or indirectly (cf. Eklöf and Selivanova, 2008; Fornell et al., 1996; Gronholdt, Martensen and Kristensen, 2000; Johnson et al., 2001). Extending the model with customer loyalty confirms the impact of customer satisfaction on customer loyalty (Eklöf and Selivanova, 2008; Fornell et al., 1996; Gronholdt, Martensen and Kristensen, 2000; Ajami, Elola and Pastor, 2018), with authors rarely agreeing on the influence of customer satisfaction on customer loyalty (and not vice versa). In this respect our research is based on established and verified standards of the last thirty years.

In recent years, the issue of the competitive ability of a company has also come to the forefront, which also reflects customer satisfaction and competitiveness is usually given in the context of customer satisfaction alone (Chen, Chen and Lee, 2011), rather than under the action of the factors in the above models. Image is another factor that primarily appears in customer satisfaction models for services (Eklöf and Selivanova, 2008; Gronholdt, Martensen and Kristensen, 2000), and in the case of (food) products, González Menorca et al. (2016). The aim of the article is to extend the standard model of customer satisfaction relations (including standard factors that affect it) and its loyalty to include competitive ability and especially personality and find out new mutual relationships between the factors.

If competitiveness is an advantage in today's highly competitive market and customer satisfaction is the key to a company's financial performance, customer knowledge and the ability to influence customer satisfaction is a key ability. It is possible to ask several questions. How to incorporate factor competitiveness into the customer satisfaction model? How to construct this factor? How to incorporate the personality factor into the customer satisfaction model? How to construct this factor? How to construct a loyalty factor? Does the design of this factor affect the functionality of the customer satisfaction model? Our research answers all these questions.

2 THEORETICAL FRAMEWORK

In today's market environment, long-term customer relationships are being built and it plays a vital role in execution of strategy (Budianto, 2019). Customer satisfaction is defined according to Giese and Cote (2000) as a consumer's perception of how well a company has delivered their communicated value proposition.

Researches have shown a relationship between personality and customer behaviour (e.g. Chukwu and Igani, 2017). The relationship between customer behaviour and customer satisfaction has been demonstrated (Söderlund and Vilgon, 1999). The relationship of personality to other types of satisfaction, to financial satisfaction through financial capacity (Xiao, Chen and Chen, 2014) and to life satisfaction (Azizli et al., 2015) has also been shown. The relationship between customer satisfaction and personality was demonstrated (Gountas and Gountas, 2007), but it was only a simple model where the relationship of overall customer satisfaction to one of the four emotional types was determined.

In the context of customer satisfaction and loyalty research, the perception of the customer may be based on his or her personality (personal characteristics). These unique set of attributes represents the factor "personality" and McCrae, Costa and Busch (1986) classified personality traits into five factors (so-called Big Five): 1 extroversion; 2 agreeableness; 3 conscientiousness; 4 neuroticism; and 5 openness. These factors were applied in several studies (e.g. Jani and Han, 2014).

Tan, Foo and Kwek (2004) discovered that the positive emotions of customers related to customer satisfaction. A complex theoretical model was presented by Jani and Han (2014) that related personality, loyalty, satisfaction, ambience and image in a hotel setting. The results showed that satisfaction had a significant impact on hotel image and customer loyalty. With regard to satisfaction it can be measured in other ways (see Methodology).

Currently, several models are known which include the above factors. Swedish Customer Satisfaction Barometer (CSB) by Fornell (1992) was the first complex model. the authors continued with the American Customer Satisfaction Index (ACSI) for measuring the overall customer satisfaction. Eklöf and Selivanova (2008) used an Extended Performance Satisfaction Index (EPSI) for measuring employee and customer satisfaction, which includes the variables: image, customer expectations, customer perceived product quality, customer perceived service quality, customer perceived value, customer satisfaction and customer loyalty.

In conclusion, some factors have a proven influence on customer satisfaction and loyalty. These factors are perceived quality (Ophuis and Van Trijp, 1995), perceived value (Chou and Kohsuwan, 2019), customer expectation (Chang et al., 2016) and complaint (Landon, 1980) are found in the above models. Models are rather expanding, i.e. the number of factors is increasing. The personality

factor is missing there, or so far it was only part of the model parts, whether already within Big Five by Jani and Han (2014), or spread out in several factors, within the scope of exploring other forms of satisfaction.

3 METHODOLOGY

To methodology, two different constructions were used to construct the loyalty factor to verify its functionality. The research was carried out using a questionnaire survey on a sample of 1,530 customers of food producers (and 103 food business products that were non-durable) corresponding to the Czech population in terms of gender, age and region. The questionnaires were statistically evaluated using Structural equation modelling (SEM).

3.1 Setting of Factors Examined

In the design of customer satisfaction (CS) we are based primarily on the model Fornell et al. (1996), Juhl, Kristensen and Østergaard (2002) and Jani and Han (2014). Overall customer satisfaction, which is the focus of our research, is measured by default with three indicators (Juhl, Kristensen and Østergaard, 2002) that focus on general product satisfaction (CS1), expectations about general customer satisfaction (CS2) and general satisfaction with the product compared to the ideal product (CS3).

In the basic models, customer satisfaction is a relationship of general customer satisfaction, perceived quality, perceived value, customer expectation supplemented by complaining or image (cf. Fornell et al., 1996; Juhl, Kristensen and Østergaard, 2002).

Perceived Quality (PQ), in the case of foods, quality means “good nutritional, microbiological and textural quality” (Cardello, 1995). Due to the fact that the research was focused more broadly on customer satisfaction, where perceived quality is only one of the factors, individual variables and questions were created by a combination of focus on general quality evaluation (PQ5) or evaluation of a specific quality requirement (PQ1-4) (compare with Fornell et al. (1996)) and focus on selected dimensions where taste (PQ1) represented experience quality attributes, composition (PQ2), and appearance (PQ3) represented intrinsic quality cues, nutritional value (PQ4) represented extrinsic quality cues and all of the above the parameters were then summarized in the last question (PQ5).

“A customer’s perceived value (PV) represents an overall mental evaluation of a particular good or service” (Beneke et al., 2013). We created this construct in accordance with the perceived quality construct where we measured the price/quality ratio of the product in general (PV1), focusing on product properties (PV2) and product functionality (PV3). Some authors (Samudro et al., 2020) also emphasize the impact of costs, so the construct has been supplemented with a survey of the cost-performance relationship (PV4) and overall quality (PV5).

Customer expectation (CE) in the food industry, expectations are linked to product quality (Cardello, 1995). Thus, the individual variables examined are related to the product quality forward (CE3, CE4) and backward (CE1, CE2) and were inspired by Fornell et al. (1996).

Complaint (C) is an expression of customer dissatisfaction (Landon, 1980). Therefore, the relationship of complaint to customer satisfaction should be negative (Fornell et al., 1996). Because quality is the most common cause of dissatisfaction (Day and Ash, 1979), the complaint factor has focused on it. In accordance with Fornell et al. (1996), the first variable (C1) was focused on whether the respondent ever complained about the product. Research into this factor has been complemented by a measure of feeling at least little dissatisfaction (C3) and propensity to complain (C2) in connection with the unsatisfactory purchase experience (Cho et al., 2003).

The problem of the image (I) factor is its difficult assessment because the evaluation of individual variables is left solely to the subjective evaluation of the respondent (cf. González Menorca et al., 2016). In terms of image, important factors are brand (I1), marketing campaign rankings (I4), which are inspired by González Menorca et al. (2016), as well as price (I3) and quality (I2) inspired by Kandampully and Suhartanto (2000). In terms of competitiveness, price (I3) and quality (I2) (Demeter, 2003), marketing and advertising (I4) (Siudek and Zawojska, 2014) and brand (I1) are the most important variables (Paul and Iuliana, 2018).

Customer loyalty (CL) can be defined as "a deeply held commitment to rebuy or repatronize a preferred product or service consistently in the future, despite situational influences and marketing efforts having the potential to cause switching behaviour" (Oliver, 1997). In our research, we focused on all three dimensions and within them to selected variables, which are answered in the questionnaire. Specifically, the behavioural dimension can be measured by up to three variables: repurchase intentions (CL1a), switching intentions (CL4), and exclusive purchasing. Attitude can be measured by variables: strength of preference (CL1b, CL2), advocacy (CL5), altruism and cognitive dimension. It can be measured by willingness to pay more (CL3), exclusive consideration and identification with the service provider (Jones and Taylor, 2007).

The personality factor (P) was not constructed on the basis of the Big Five Factors model as in Jani and Han (2014), because this approach is purely from a psychological perspective on human personality. In our research, we constructed the factor of personality on the basis of variables that have a demonstrable relationship to a certain form of satisfaction. Because of that, personality characteristics are divided into four areas (dimensions): financial capacity, personality disposition, future planning rate and attitude to marketing (advertising). To measure financial capacity, we use sufficiency of monthly income (Personality 1), access to the purchase of cheap products (Personality 2),

reserve for unexpected expenses (Personality 3), which were formulated on the basis of questions used in Taylor's research (Taylor, 2011).

Personality dispositions (optimism or pessimism) could influence product satisfaction (cf. Westbrook, 1980). Optimism (or its degree - Personality 4) can be classified as personality traits, and research has shown a link between optimism and life satisfaction (Ho, Cheung and Cheung, 2010). For planning future, respectively to measure future planning, the quantities Personality 5 (filling of the refrigerator) and Personality 6 (frequency of shopping) are focused.

Several kinds of research also examine customer attitudes to advertising or marketing (e.g. Chan and Cui, 2004) and their impact on customer satisfaction. The attitude of customers (their criticality) to marketing (specifically advertising) is focused on Personality 7.

3.2 Model and Hypothesis

The construction of hypotheses and the model constructed from them (see Figure 1) is based on research and especially modelling of customer satisfaction in the last thirty years. The model is based on The American customer satisfaction index designed by Fornell et al. (1996), which is built on nine hypotheses:

H1: Customer expectation positively influences perceived quality.

H2: Customer expectation positively influences perceived value.

H3: Perceived quality positively influences perceived value.

H4: Perceived quality positively influences customer satisfaction.

H5: Customer expectation positively influences customer satisfaction.

H6: Perceived value positively influences customer satisfaction.

H7: Customer satisfaction positively influences customer loyalty.

H8: Customer satisfaction negatively influences complaint.

H9: Complaint influences customer loyalty.

The basic model has been expanded to include a factor image and three other links (in the form of hypotheses), which is part of the ECSI model (Ciavolino and Dahlgaard, 2007):

H10: Image positively influences customer satisfaction.

H11: Image positively influences perceived value.

H12: Image positively influences customer loyalty.

Based on the research by Jani and Han (2014), the model was extended by a factor of personality and last link (hypothesis):

H13: Personality positively influences customer satisfaction.

Hypotheses H1 to H12 are based on verified findings and models, which were not tested in this complex form, resp. in the form of such a complex model. Hypothesis H13 is completely new in this respect, as the personality factor has not yet been part of any comprehensive model of satisfaction.

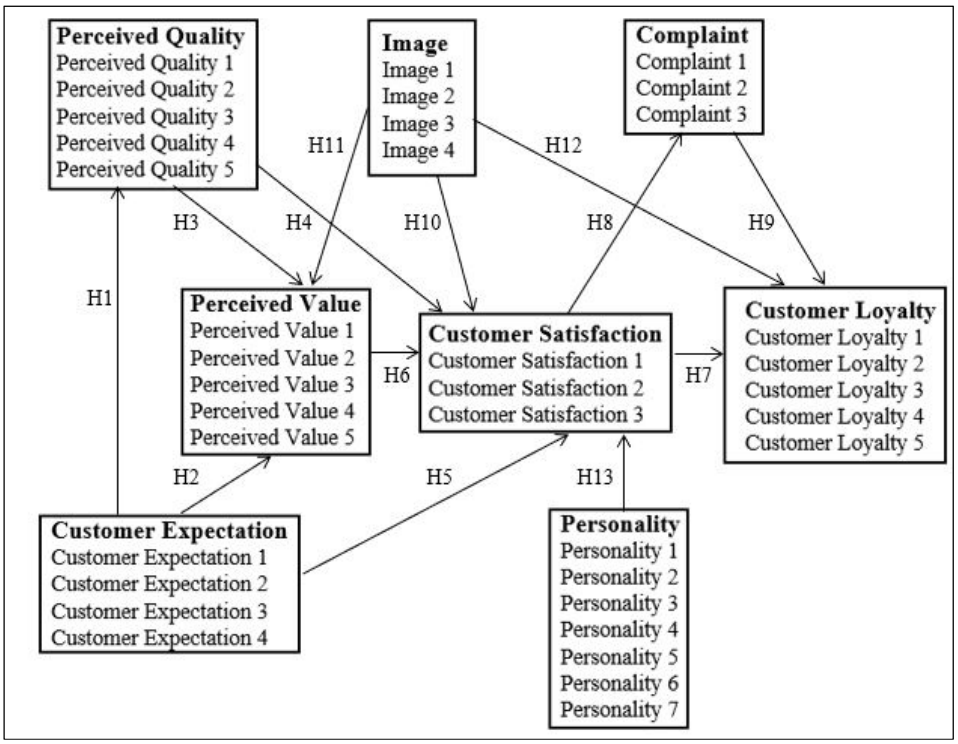

Figure 1 – Customer Satisfaction Model

Concerning the results achieved, one more (partial) model was created in order to clarify better the relationships of the personality factor within the customer satisfaction model. The model is shown in Figure 2 and is based on four hypotheses (Jani and Han, 2014):

H14: Personality positively influences customer satisfaction.

H15: Customer satisfaction positively influences customer loyalty.

H16: Customer satisfaction positively influences the image.

H17: Image positively influences customer loyalty.

Hypotheses H14 and H17 are based on a validated model, which was, however, designed for the area of services (specifically for the hotel). The benefit of our

research is therefore its testing on products, resp. in the processing industry (specifically in the area of food production and sales).

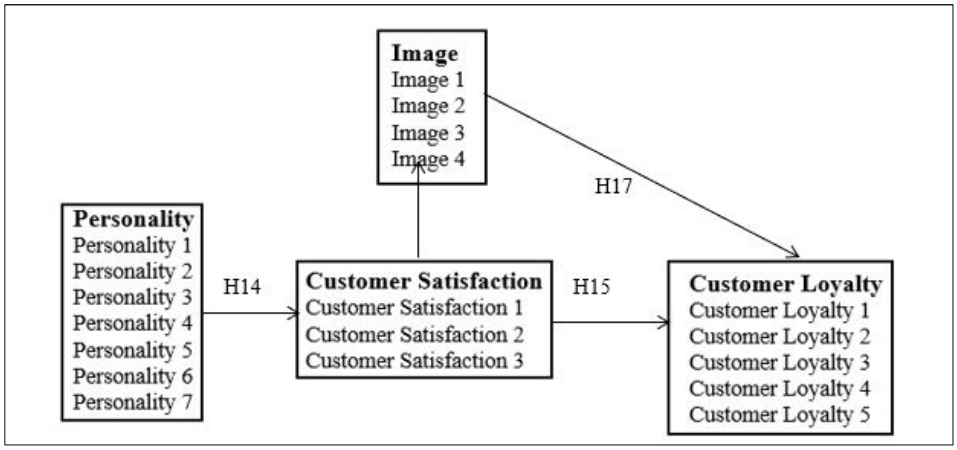

Figure 2 – Sub-Model of Customer Satisfaction and Personality

3.3 Statistical Methods

For data processing, we used the methods of SEM. The aim is to describe the investigated situation by a model of dependencies of variables that are directly measurable or constructed from measurable, observable variables. Such variables are called latent. The predicted structure of dependencies is then tested using the SEM technique. Variables can be either direct or also mediating, all such types of bonds being tested simultaneously. Therefore, it is a versatile method (Nachtigall et al., 2003). The SEM method uses confirmatory factor analysis (CFA) techniques to verify the structure of latent variables and path analysis (PA) to test relationships between latent variables. It improves and generalizes these techniques, because, unlike the path analysis alone, it allows testing of latent variables measured with some reliability, which should not be 100%. Therefore, taking into account the error due to measurement inaccuracy, the relationships between latent variables can be more accurately estimated (Hair, Anderson and Babin, 2010).

Assessing the suitability of the model is done, for example, by checking the plausibility of the estimated parameters, if the signs of the selected parameters match the expected signs (Hair, Anderson and Babin, 2010). Therefore, good match indices, such as the RMSEA coefficient and others listed below, are used. In general, results may vary with different indexes, and one model cannot be divided into acceptable and unacceptable models. Often several statistically equivalent models with different interpretations can be interleaved with one data, which is one of the problems of this method (Hancock and Mueller, 2006). The suitability of the model is then assessed according to the theory and knowledge of the area. One-way causality in the model must also be justified in this way since this causality cannot be directly proven by the SEM method.

Conformity indexes were used to express the model's compliance with data:

- NFI (Bentler-Bonet Standardized Compliance Index),
- NNFI (Bentler-Bonet non-standard match index),
- CFI (Comparative Compliance Index),
- RMSEA coefficient.

NFI, CFI, NNFI compliance index values greater than 0.9 (Bentler, 1992), RMSEA values below 0.1 can be considered as good fit of the model with the data. However, in some cases, a lower RMSEA coefficient may not always mean a better match. For statistical processing, we used statistical software EQS, which is used to model situations using structural equations.

3.4 Questionnaire and Research Sample

The research was performed quantitatively using a questionnaire (cf. Fornell et al., 1996; Gronholdt, Martensen and Kristensen, 2000). The questionnaire contained 37 closed questions and each question represented a partial variable of the relevant factor (see above). The questions were evaluated in a scale of 1-10 in accordance with the researches of Oliver (1997) and Söderlund (2006), with 1 being the worst rating and 10 being the respondent's best rating. The 10-point scale was chosen because of the expected weaker links between some factors, as Frennea and Mittal (2017) found a relationship between the scale width and the correlation found, where a larger scale width meant a greater correlation.

The research sample consisted of 1,530 customers. The respondents were randomly selected so that the sample was representative of the Czech Republic population over 18 years of age in terms of gender, age and region.

Customers rated 103 food business products that are commonly available on the Czech food market. Products were randomly assigned to respondents. The products included beverages (alcoholic and non-alcoholic) and foodstuffs (dry and wet). The assortment examined can be characterized as non-durables goods.

4 RESULTS AND DISCUSSION

The results of testing the individual hypotheses and the final model construction are shown in Figure 3, related tests in Table 1, specific values of factors, respectively the forces of their relationships than in the respective equations and Table 2.

The results indicate that relationships were found between the factors that anticipated all of the above hypotheses except for H4. It was therefore not possible to prove the influence (positive or negative) of the image factor (in relation to the competition) on customer satisfaction. The relationship of the (positive) image factor to perceived value and customer loyalty without the

relationship to customer satisfaction thus corresponds to the involvement of this factor, which was assumed and verified by Gronholdt, Martensen and Kristensen (2000) in the basic ECSI model.

Table 1 – Fit Indices

NFI	0.886
NNFI	0.882
CFI	0.894
RMSEA	0.087

Because the hypotheses tested in addition to relations of individual factors, whether the relationship is positive or negative, it seems that it is necessary to reject the hypothesis H8. However, the complaint factor has a negative character, i.e. the more complaint, the worse. In accordance with the above methodology, however, a value of 1 meant the strongest complaint and a value of 10 the weakest complaint. Thus, the positive relationship between customer satisfaction and complaint means that the more satisfied the customer, the fewer product complaints, the hypothesis is confirmed and the factual relationship between the factors is negative. Thus all hypotheses H1-H3 and H5-H13 can be confirmed.

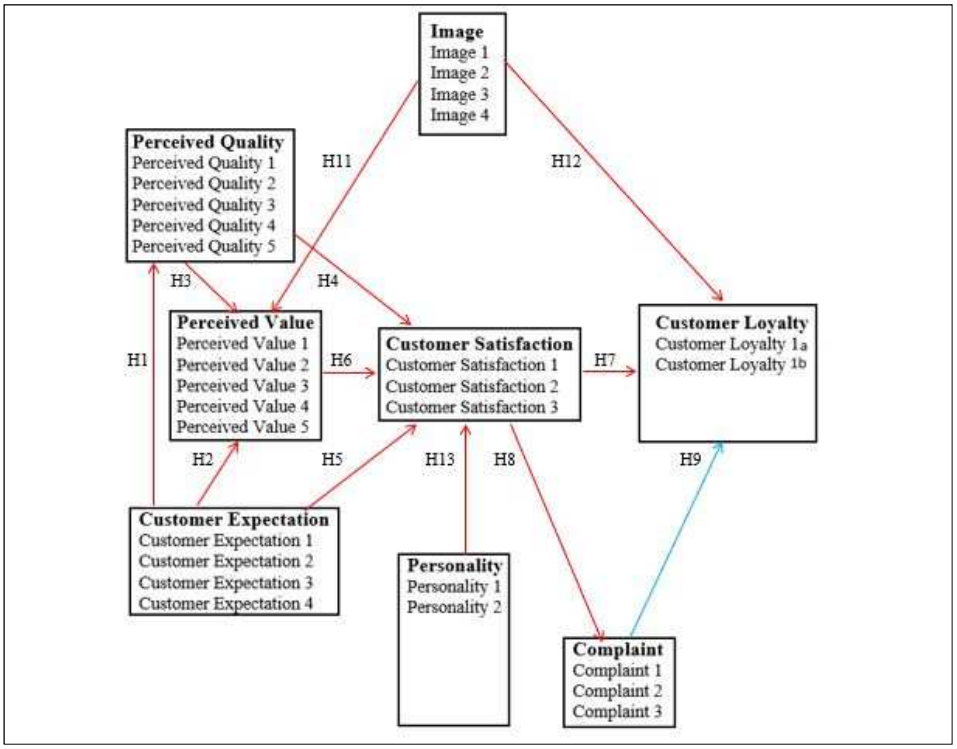

Figure 3 – Customer Satisfaction Model

The finding of the positive impact of the customer satisfaction on customer loyalty (H7) has been confirmed in many previous studies (cf. Ajami, Elola and Pastor, 2018; Ciavolino and Dahlgaard, 2007; Fornell et al., 1996; Gronholdt, Martensen and Kristensen, 2000), so it is not a surprise in this direction. Research shows that factor loyalty in the model (see Figure 2) was constructed from only two variables, namely the repurchase intentions that are part of the behavioural dimension and the strength of preference that is part of the attitude dimension. Thus, the method of measuring loyalty seems to affect the relationships and functionality of the entire model, with fewer dimensions (and quantities) leading to better results. Concerning the nature of goods, which are foodstuffs, the question arises whether the absence of a cognitive dimension of loyalty is not related to the form of sale (self-service) and the way of sale; how much customers think about purchasing and how much they buy mechanically and thoughtlessly based on learned customs (cf. Grunert, 2005).

Also, the finding of a positive relationship between image and customer loyalty (H12) is not surprising, as a number of studies have also confirmed this relationship (cf. Ajami, Elola and Pastor, 2018; Ciavolino and Dahlgaard, 2007). It seems that the design of the image factor (in combination with the competitive ability of a business and a product) can affect this link.

The hypothesis H9 (complaint and customer loyalty) is confirmed, but this effect is not clear (Fornell et al., 1996). Our research suggests that "the firm's complaint handling has been managed to make a bad situation even worse - it has contributed further to customer defection" (Fornell et al., 1996). Research suggests that complaint handling is passive in the retail sector, where we investigate the foods, leading to dissatisfied customers and leaving customers uncomfortable (cf. Hansen, Wilke and Zaichkowsky, 2010).

Another interesting outcome is the demonstration of the impact of personality on customer satisfaction (H13), as the effect of personality is very weak (almost zero), and at the same time, it has proved the effect of only one dimension (financial capacity) and two quantities of this factor. Given that the impact of personality on customer satisfaction is weaker in the conducted research (cf. Jani and Han, 2014), this finding is not surprising. It seems that the influence of the (weak) personality factor is outweighed and overshadowed by other (stronger) factors.

Construct Equations (1 – 5) are following:

Standardized Solution		R2	
PQ	= 0.945*CE + 0.326	= 0.894	(1)
PV	= 0.507*PQ + 0.183*I + 0.282*CE + 0.600	= 0.640	(2)
CS	= 0.549*PQ + 0.270*PV + 0.182*CE + 0.000*P + 0.318	= 0.899	(3)
CL	= 0.634*CS - 0.110*C + 0.285*I + 0.725	= 0.474	(4)
C	= 0.275*CS + 0.961	= 0.076	(5)

Conformity indices are close to 0.9, which is considered to be the threshold for good model quality. The RMSEA is less than 0.1, which also indicates good model quality. For structural equations, there are relatively high coefficients of determination (R squared), which means good predicative value of partial regression models. Almost all sub-dependencies have a predicted direction and are statistically significant (p-value less than 0.05). Only the dependence between the constructs Complaint and the Customer loyalty has the opposite direction, but the effect of the Complaint construct in the model is generally rather weak. The Personality construct has an extremely small effect in the model, but this effect is statistically significant. The effects on the Loyalty construct are negative, which is fine, because the sub-variables of this used construct have a reverse range compared to all other variables.

Table 2 – Values of Relationships of Factors Examined

Outcome	Predictor	St. estimate	St. error	Test statistic	p-value
PQ	CE	0.945	0.021	42.1	<0.05
PV	PQ	0.507	0.069	6.08	<0.05
PV	I	0.183	0.015	9.607	<0.05
PV	CE	0.6	0.064	3.362	<0.05
CS	PQ	0.549	0.057	10.093	<0.05
CS	PV	0.27	0.026	13.253	<0.05
CS	CE	0.182	0.052	3.381	<0.05
CS	P	<0.01	<0.01	>100	<0.05
CL	CS	0.634	0.01	20.402	<0.05
CL	C	-0.11	0.1	-3.978	<0.05
CL	I	0.285	0.008	10.816	<0.05
C	CS	0.275	0.003	8.897	<0.05

In the case of the sub-model (see Figure 4 and Table 3), all hypotheses (H14-H17) were confirmed. It is interesting to note that in this sub-model, the influence of all three dimensions and all personalities was demonstrated. This fact confirms that the sub-model is able to detect any relationships that would otherwise remain hidden in a complex model. However, the informative ability of the bond is again very weak. At the same time, in comparison with the comprehensive model, it appears that the financial capacity dimension is the strongest in terms of the personality factor.

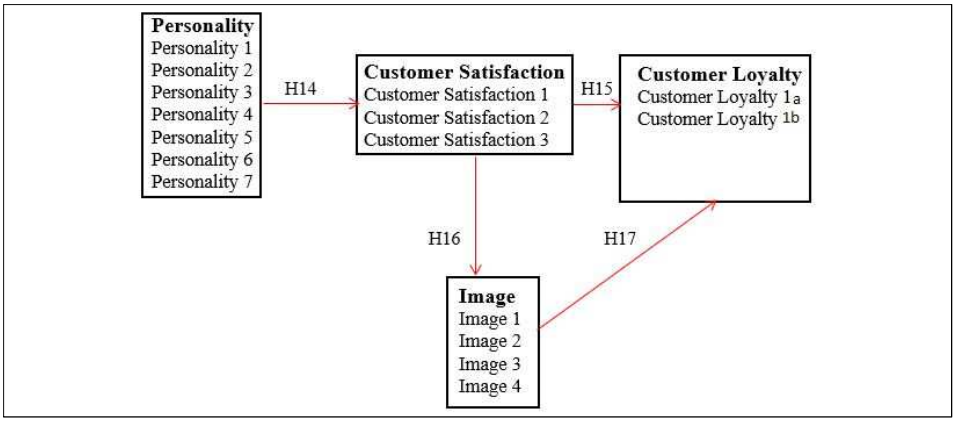

Figure 4 – A Partial Model of Customer Satisfaction and Personality

Table 3 – Fit Indices

NFI	0.742
NNFI	0.733
CFI	0.751
RMSEA	0.112

Construct Equations (6 – 8) are following:

Standardized Solution R2

I = 0.805*CS + 0.594 = 0.647 (6)

CS = 0.212*P + 0.977 = 0.045 (7)

CL = 0.269*I + 0.530*CS + 0.645 = 0.583 (8)

All assumed dependencies were proved in the model. There was also a weak but statistically significant influence of the Personality construct, even when using all its sub-variables. In the previous overall model, the effect of this construct was masked by the very strong influence of other predictors. In this model, the indexes of conformity are slightly worse. The model has a weaker informative ability (see Table 4).

Table 4 – Values of Relationships of Factors Examined

Outcome	Predictor	St. estimate	St. error	Test statistic	p-value
I	CS	0.805	0.022	34.175	<0.05
CS	Personality	0.212	0.038	5.854	<0.05
CL	I	0.269	0.015	6.311	<0.05
CL	CS	0.53	0.014	12.304	<0.05

During the construction of a partial model of customer satisfaction and personality, it turned out that it did not matter how customer loyalty was measured. If more characteristics (four in total, different from those used in the above model) from all three dimensions (including cognitive) were involved in the factor, the modelling results achieved were almost identical (see Table 5). Figure 4. A partial model of customer satisfaction a personality.

Table 5 – Fit Indices

NFI	0.740
NNFI	0.733
CFI	0.751
RMSEA	0.107

Construct Equations (9 – 11) are following:

Standardized Solution R2

I = 0.805*F4 + 0.594 = 0.648 (9)

CS = 0.216*P + 0.976 = 0.046 (10)

CL = 0.295*I + 0.649*CS + 0.428 = 0.817 (11)

The findings from the partial models regarding the construction of the loyalty factor in the complex model do not apply, as a statistically significant complex model was not created with all dimensions. It confirms the idea mentioned above that loyalty measurement affects the linkages and statistical significance of the model in which this factor is present, with fewer dimensions (and quantities) leading to better results in larger (more complex) multi-factor models.

5 CONCLUSION

The resulting complex model in Figure 2 is basically a combination of ACSI and ECSI models, complemented by factor personality. Given the time of both models and the development of customer satisfaction modelling over time, it is evident that a number of factors affect customer satisfaction and loyalty, and it can be assumed that even this extended model is not final. On the other hand, it is clear that the customer satisfaction model, taking into account customer loyalty, image, perceived quality, perceived value, customer expectations and complaint, is the most powerful factor, which is complementary to other factors (such as personality in this case). However, the considerable strength of these factors can weaken the weaker factors to the point that they will not be reflected in the customer satisfaction model, even if they have some influence on it. It, therefore, makes sense to shield the effects of these influential factors and to create not only complex but also partial models (see Figure 3 and 4).

At a time of ever-increasing competition, which may not be and is not the case with the food market, it is important to know all the factors that influence customer satisfaction. Changing the factor with a weak link can give the company a significant competitive advantage. Knowledge of the influence of specific personality factors on customer satisfaction can be used by the company in marketing activities (especially promotion) and with regard to the customer's critical approach to marketing (advertising) can choose the appropriate form. Of course, this knowledge can also be used in the sale itself, especially if there is an interaction between the customer and the store staff.

The results also show that it does not matter how the investigated factor is constructed and understood. Obviously, the different design of a factor and taking into account different dimensions (for multidimensional factors such as loyalty in particular), especially in terms of quantity, affect the functionality of the resulting model. It is true that the larger the model in terms of the number of factors involved, the smaller the number of multidimensional factors (in this case customer loyalty).

To limitations, the paper focuses on foods that are sold through retail intermediaries, which also affect customer satisfaction. It may be different for other types of products and services and for products sold otherwise. It can also be limited to CR, resp. transition economics, ie. that in developed countries it could be different.

Furthermore, it would be appropriate to continue research into the synergy of customer satisfaction with the manufacturer's product and at the same time customer satisfaction with the service of trade as an entity selling the manufactured product. It would be interesting to examine the relationship and influence of the intermediary (seller or shop) on customer satisfaction with the product. All this in the context of the personality factor, as it is a question of how the product of the manufacturer and the service of the business affect the customer. Synergy would be ideal, but the action can also go against each other or well-received, and the product acting on the customer can compensate for the poorly received trade service and vice versa.

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Customers' Intention to Recommend Takeaway Food during COVID-19 Pandemic

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ABSTRACT

Purpose: The aim of this study is to predict perceived risk and consumer willingness in recommending takeaway food from restaurant served in buffet style.

Methodology/Approach: This study used an online survey of 170 consumers who were selected based on purposive sampling method. The research questionnaire was adapted from previous research. The data were analysed using Structural Equation Modelling (SEM), with Smart PLS.

Findings: The research findings show that health risk and psychological risk have a positive effect on intention to recommend takeaway food. Meanwhile, quality risk and trust have no effect on intention to recommend takeaway food. In addition, psychological risk and quality risk have no effect on trust. This study also shows that trust does not function as a mediator of the relationship between health risk, psychological risk, quality risk, trust, and intention to recommend.

Research Limitation/Implication: This study only uses a self-report questionnaire by customers. For further research, to enrich the discussion, it is recommended to use interviews or FGD. In addition, this study only uses three risk variables. For the future, it is advisable to add other risk variables.

Originality/Value of paper: In other countries such as China, Korea and the United States, related research has been carried out, however for the context of RM Padang which is unique with all the menus served (Buffet) on the visiting customers' table has not been found in literature.

Category: Research paper

Keywords: health risk; psychological risk; quality risk; trust; intention to recommend

1 INTRODUCTION

The Indonesian government has set up various efforts to break the chain of COVID-19 that has hit the world since March 2020, such as stay at home, work and study from home, Large-Scale Social Restrictions, Rapid Tests, SWAB Tests, Antigen Tests, and Vaccinations. In order to adapt with the new habits, The Decree of the Minister of Health No. HK.01.07/MENKES/382/2020 has been launched to respond to the pandemic disaster. A longitudinal study in the United States found that more than 50% of restaurant consumers did not want to dine in (Gursoy and Chi, 2020). Restaurants have to set up their activity to respond by adapting to new habits. Consumers feel uncomfortable eating and spend a longer time in restaurants.

In general, research conducted during the COVID-19 Pandemic confirms that restaurants are the worst affected sectors by social distancing regulations implemented by governments worldwide (Gössling, Scott and Hall, 2020). The business has adjusted its processes and strategies to keep up with changes in consumer behaviour. Nowadays, people must implement health protocols such as wearing masks, washing hands with soap and running water, maintaining distance, staying away from crowds and limiting mobilization and interaction. During the current crisis, consumers are generally more careful in their activities outside the house, especially in public places and facilities. Changing consumer behaviour is in line with the Indonesian government's appeal through the Decree of the Minister of Health No. HK.01.07/MENKES/382/2020 concerning Protocols for Public Health in Public Places and Facilities on June 19, 2020. According to this decree, public places and facilities include markets and the like; Malls/shops and the like; Hotels/inns/homestays/dormitory and the like, restaurants and the like, sports facilities and activities, modes of transportation, stations/terminals/ports/airports, tourist sites, beauty/hair care services and the like, creative economy services, religious services activities in houses of worship, and services for organizing events/meetings. In addition, Kurniawan (2020), in his article published in the online Economic Balance Sheet, explained Restaurant is one of the scary places for COVID-19 transmission.

In relation to previous explanation, the Indonesian Hotel and Restaurant Association made a "New Normal Guide for Hotels and Restaurants" for the members. The guide explains that the presentation of all types of condiments cannot be directly served at the table but must be served according to the requests of visiting consumers (Agmasari, 2020). Thus the presentation of buffet food (dishes) on dining table such as in the typical Padang Restaurants (or more well known as RM Padang) is not recommended. In order to survive in these difficult situation, therefore, the RM Padang owners need to rearrange marketing strategies in accordance with the conditions of the COVID-19 pandemic so that consumers continue to shop while paying attention to the health aspect.

This research is motivated by the findings of previous study in the United States reported by Gursoy and Chi (2020) and the New Normal Guide for Hotels and Restaurants compiled by PHRI (Indonesian Hotel and Restaurant Association) aimed to develop marketing strategies at RM Padang through the application of Prospect theory. The theory developed by Kahneman and Tversky (1979) is widely used to observe consumer behaviour by considering uncertainty and risk in shopping decisions. Therefore, this theory is very suitable for the COVID-19 Pandemic conditions, especially during adaptation of new habits.

According to the research on consumer behaviour in restaurants in the United States, about 35% of restaurant consumers are willing to pay more for increased safety against possible health risks (Gursoy, Chi and Chi, 2020). To confirm this finding, it is deemed necessary to conduct a similar study in Indonesia. The problem to be investigated is related to consumer behaviour at RM Padang. So, the problem to be studied is: how are the effects of health risk, psychological risk, quality risk and trust toward intention to recommend takeaway food from RM Padang?

2 LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

This research focuses on the implementation of Prospect Theory developed by Kahneman and Tversky (1979). Trust is added as a determinant of intention to recommend and also as a mediating variable.

2.1 Prospect Theory

Many studies used Prospect Theory to predict consumer behaviour based on real-life choices (Al-Ansi, Olya and Han, 2019; Olya and Al-Ansi, 2018; Radic et al., 2021). This theory reveals that consumers make decisions based on the value of potential loss and gain outcomes and evaluate these losses and gains using specific heuristics (Olya and Al-Ansi, 2018). During Pandemic COVID-19 most consumers consider uncertain situation with relatively high health risk, so their final decision to buy or consume the product is based on the perceived advantage (Radic et al., 2021). Therefore, Prospect Theory is recommended and suitable to utilize in times of crisis with full of risk and uncertainty by using Health Risk, Psychological Risk, Quality Risk as the consumer consideration (Al-Ansi and Han, 2019; Day et al., 2020). Most previous studies have used this prospect theory for the hospitality industry. However, there is a limited number of studies focusing on takeaway food. There has been no published research using this theory to formulate marketing strategies for full service restaurants such as RM Padang. In general, previous studies have used this prospect theory for the hospitality industry.

2.2 Hypotheses Development

Consumer behaviour theory explains that a person's desires and actions start from looking for goods or services needed, buying, using and deciding to continue using or discontinuing or recommending to others in the future. Such future behaviour is referred to as behavioural intention (Han and Hyun, 2017). It can be seen that intention to recommend is a part of behavioural intention (Jani and Han, 2011).

Risk is one of the factors that influence consumer decision making in choosing and buying a product. Several studies have found risk and trust have positive effects on purchase intention (Day et al., 2020; Hoque and Alam, 2018). This study confirmed the findings of Al-Ansi, Olya and Han (2019) which explained that health risk, psychological risk, quality risk, which are part of general risk, have a positive and significant impact on trust and intention to recommend halal food. Related to the findings of previous research, this study also examines the role of trust as a mediating variable in the relationship between risk and intention to recommend. Therefore, this study proposes ten hypotheses as follows:

H1: Health risk has a positive effect on the intention to recommend takeaway food from RM Padang.

H2: Psychological risk has a positive effect on the intention to recommend takeaway food from RM Padang.

H3: Quality risk has a positive effect on the intention to recommend takeaway food from RM Padang.

H4: Trust has a positive effect on the intention to recommend takeaway food from RM Padang.

H5: Health risk has a positive effect on the intention to recommend takeaway food from RM Padang.

H6: Psychological risk has a positive effect on the intention to recommend takeaway food from RM Padang.

H7: Quality risk has a positive effect on the intention to recommend takeaway food from RM Padang.

H8: Health risk has a positive effect on the intention to recommend takeaway food from RM Padang through trust.

H9: Psychological risk has a positive effect on the intention to recommend takeaway food from RM Padang through trust.

H10: Quality risk has a positive effect on the intention to recommend takeaway food from RM Padang through trust.

3 METHODOLOGY

Data was collected online through an administered questionnaire by consumers with the criteria of having made a purchase takeaway food from RM Padang. Respondents were selected with a non-probability sampling approach, specifically purposive sampling. Based on the G power sample size calculator (Kang, 2021), with statistical power: 0.95 and α error 0.05, the calculation suggests the minimum sample that must be collected to answer research questions is 129. This is also consider 4 predictors from 5 constructs consisting of health risk, psychological risk, and quality risk, as an independent variable, trust has a dual role as the independent variable and mediating variable and the intention to recommend.

To obtain consumer perceptions on the 5 constructs, a research instrument was developed using a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly disagree). This instrument was adopted and adapted from previous research, such as Indicators of Health Risk, Psychological Risk and Quality Risk (Al-Ansi and Han, 2019; Al-Ansi, Olya and Han, 2019; Hwang and Choe, 2020), Trust and Intention to Recommend (Al-Ansi, Olya and Han, 2019).

The distribution of Google Forms through WhatsApp groups managed to collect 170 data that were suitable for further processing. The following Table 1 shows the characteristics of the respondents.

Table 1 – The Characteristics of the Respondents

Characteristics		**Frequency**	**Percent**
Sex	Male	58	34.10%
	Female	112	65.90%
Age	< 26 years	50	29.40%
	26-40 years	81	47.60%
	41-55 years	30	17.60%
	56-70 years	9	5.30%
Education	Below high school	4	2.40%
	High school	10	5.90%
	Junior college	14	8.20%
	Undergraduate	89	52.40%
	Master	44	25.90%
	Doctor	9	5.30%

Characteristics		Frequency	Percent
Occupation	Student	33	19.40%
	Private company employee	41	24.10%
	Government employee	40	23.50%
	Entrepreneur	23	13.50%
	Housewife	8	4.70%
	Retired	1	0.60%
	Others	24	14.10%
Total		170	100%

4 DATA ANALYSIS AND DISCUSSION

The data, collected from respondents who meet the specified criteria, is processed using structural equation modelling (SEM) using SmartPLS 3.2.9 software. There are 2 stages of testing that must be carried out on PLS, namely testing the outer model and testing the inner model. First, outer model test is the assessment of the validity and reliability of the measurement. A measurement model testing using a research instrument is said to be reliable if the value of Cronbach alpha or composite reliability is 0.7. Second, Structural model or inner model test the hypothesis by looking at the results of the t-statistics (table between constructs). This table consists of the original sample estimate value, the mean of subsamples and the standard deviation. Provisions on the results of hypotheses testing for 1 tail if the t-statistic value is higher than 1.645 (t-table) then the hypothesis statement is supported. However, if the t-statistic value is lower than 1.645 then the hypothesis statement is not supported (Sekaran and Bougie, 2016).

Before the data was analysed with SEM, then a descriptive analysis and normality test were carried out. Table 2 below shows the results of the analysis.

Table 2 – Descriptive Statistics and Normality Assessment

Construct	Indicator	Min	Max	Mean	Standard Deviation	Excess Kurtosis	Skewness
HR	HR1	2.000	7.000	6.100	1.083	1.960	-1.407
	HR2	1.000	7.000	6.106	1.143	2.618	-1.545
	HR3	1.000	7.000	5.735	1.374	0.894	-1.159
	HR4	1.000	7.000	6.035	1.132	2.353	-1.396
PR	PR1	1.000	7.000	5.782	1.200	1.252	-1.055
	PR2	1.000	7.000	5.718	1.204	0.841	-0.909
	PR3	1.000	7.000	5.665	1.297	1.143	-1.119

Construct	Indicator	Min	Max	Mean	Standard Deviation	Excess Kurtosis	Skewness
QR	QR1	1.000	7.000	4.312	1.527	-0.410	-0.188
	QR2	3.000	7.000	6.088	0.893	0.730	-0.924
	QR3	2.000	7.000	5.494	1.261	-0.012	-0.696
	QR4	1.000	7.000	5.541	1.307	0.769	-0.953
TR	TR1	2.000	7.000	5.982	0.942	0.987	-0.901
	TR2	2.000	7.000	5.794	1.011	0.193	-0.644
	TR3	2.000	7.000	5.718	0.959	0.731	-0.697
IN	IN1	1.000	7.000	5.882	1.192	1.912	-1.220
	IN2	1.000	7.000	5.988	1.117	3.642	-1.588
	IN3	1.000	7.000	5.876	1.247	1.895	-1.306

Based on Table 2, the data is normally distributed because the skewness of all indicators is not greater than 2 and less than -2. The normality of this data can also be seen from the kurtosis of all indicators which are between -7 and +7. Thus, further analysis can be carried out.

4.1 Measurement Model Assessment

The assessments commonly carried out on the measurement model (outer model) with reflective constructs used in this research are convergent validity and discriminant validity. The results of the calculation of the outer model can be seen as follow.

Convergent Validity testing uses the following indicators: Outer Loading, Average Variance Extracted (AVE), and Internal Consistency Reliability. Based on the rule of thumb, Outer Loading all indicators must be statistically significant as indicated by a value >0.708. Table 3 indicates that the indicators of Quality Risk 2 (QR2) has outer loading value of 0.503<0.708. Therefore, QR2 is deleted or not included in the next analysis.

Table 3 – Outer Loading

Construct	Indicators Code	Indicators Description	Outer Loading
Health Risk (HR)	HR1	I worry about the implementation of health protocols in restaurants if consuming food dine in.	0.912
	HR2	I worry about COVID-19 if I eat in a crowd	0.926
	HR3	I worry about the quality of food that doesn't meet health standards	0.726
	HR4	During this COVID-19 pandemic, I'm worry about consuming unhealthy food, if I eat in crowded places	0.834
Psychological Risk (PR)	PR1	I feel anxious during this COVID-19 pandemic if I eat at a restaurant	0.948
	PR2	During this COVID-19 pandemic, I am not psychologically comfortable eating at restaurants	0.962
	PR3	During this COVID-19 Pandemic, based on my experience, eating in a restaurant makes me unnecessarily tensed.	0.947
Quality Risk (QR)	QR1	I am concerned about the integrity of the restaurant owners and employees regarding the quality of the food offered	0.710
	QR2	I care about the suitability of the quality of the food ordered with what I expect.	**0.503**
	QR3	I worry about the quality of the product that doesn't match with the information in the ad.	0.728
	QR4	I worry about the availability of food that meets health standards during the COVID-19 pandemic	0.842
Trust (TR)	TR1	RM Padang provides trustworthy food	0.935
	TR2	RM Padang guarantees the quality of the food offered	0.957
	TR3	I believe in the accuracy of the information that RM Padang provides to consumers	0.887
Intention to Recommend (IN)	IN1	I would recommend purchasing takeaway food from RM Padang	0.912
	IN2	I will say positive things about buying takeaway food from RM Padang	0.829
	IN3	I will encourage friends and relatives to buy takeaway food from RM Padang	0.908

After QR 2 is deleted, the Outer Model analysis is carried out again by modifying the Model. The results of the analysis show that the remaining 16 indicators of the 17 indicators in the initial model have an outer loading of 0.705 to 0.962. It is exhibited in Figure 1.

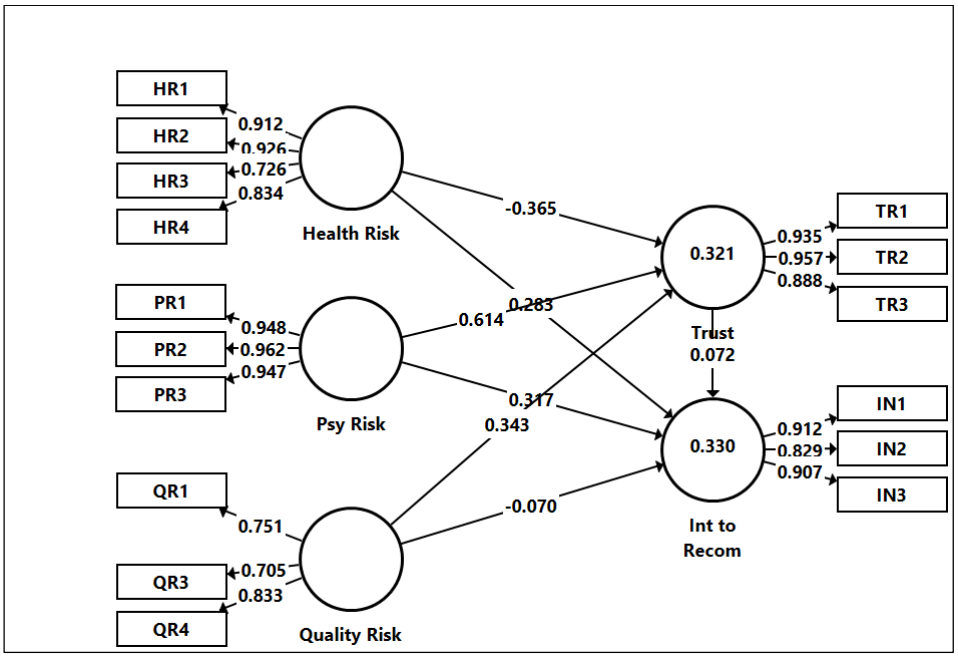

Figure 1 – Modified Model

Furthermore, the validity test is carried out by assessing the Average Variance Extracted (AVE). This AVE indicates how much variation in some items is explained by the latent variable. This AVE value is between 0 and 1. According to Bagozzi and Yi (1988) and Fornell and Larcker (1981), the recommended AVE value is >0.5. Then table 4 represents the reliability test was carried out using Cronbach alpha and composite reliability.

Table 4 – Construct Reliability and AVE

	Cronbach Alpha	rho_A	Composite Reliability	AVE
HR	0.877	0.928	0.914	0.728
IN	0.866	0.930	0.914	0.781
PR	0.949	0.949	0.967	0.907
QR	0.657	0.672	0.808	0.585
TR	0.918	0.921	0.948	0.859

Table 4 shows that all constructs are reliable, as seen in the Cronbach Alpha value of 0.657 to 0.949. Although generally accepted Cronbach Alpha is 0.7 but 0.657 of Quality Risk is acceptable in exploratory research for Takeaway food at RM Padang (Nunnally and Bernstein, 1994). The reliability of the variable construct used in this study is also indicated by the composite reliability value >0.7 with a range from 0.808 to 0.967.

Discriminant validity assessment aimed to see the correlation between constructs and other constructs. If the square root of the average AVE value of each construct (indicated by a number on the diagonal higher than the correlation value between constructs in the model), it can be said that the construct has a good valid level. The value of discriminant validity can be seen in Table 5.

Table 5 – Discriminant Validity

	HR	IN	PR	QR	TR
HR	**0.853**				
IN	0.528	**0.884**			
PR	0.800	0.551	**0.952**		
QR	0.386	0.181	0.353	**0.765**	
TR	0.258	0.256	0.443	0.419	**0.927**

4.2 Structural Model Assessment

This study applies the PLS–SEM algorithm to estimate the structural model. This test begins by looking at the R-square value which is a goodness of fit test. The dependent variable R-square can be used to see the effect of the independent variable on the dependent variable. Assessment with PLS begins by looking at the R-square value for each dependent variable. Changes in the value of R-square can be used to see the effect of the independent variable on the dependent variable, whether it has a substantive effect. Analysis found R-square value is 0.33 for the intention to recommend and 0.321 for the Trust. Based on the index for predictive relevance of the recommended structural model higher than 0.10, the predictive ability of individual paths and structural models in this study has been satisfactory.

To test the hypothesis, it can be done by bootstrapping and looking at the probability value and t-statistics. The hypothesis will be accepted if the t-statistic > t-table (1.645) for the two tails test. Table 6 shows assessment of the effect between the independent variable and the dependent variable concluded as follows:

- Health risk has a positive and significant effect on intent to recommend because the t-value of 2.139 is greater than 1.645. The Path Coefficient value of 0.257 indicates the direction of the positive effect.
- Psychological risk has a positive and significant effect on intention to recommend because the t-values are 2.942>1.645. The Path Coefficient value of 0.361 indicates the direction of the positive effect.
- Quality risk has a negative and insignificant effect on intention to recommend because the t-values are 0.534< from 1.645. The Path Coefficient value of -0.041 indicates the direction of the negative effect

- Trust has a positive and insignificant effect on intention to recommend because the t-values are 1.256<1.645. The Path Coefficient value of 0.072 indicates the direction of the positive effect.
- Health risk has a positive and significant effect on trust because the t-value of 3.902 is greater than 1.645. The Path Coefficient value of -0.365 indicates the direction of the negative effect.
- Psychological risk has a positive and significant effect on intention to recommend because the t-values are 6.410>1.645. The Path Coefficient value of 0.614 indicates the direction of the positive effect.
- Quality risk has a negative and insignificant effect on intention to recommend because the t-values are 5.164>1.645. The Path Coefficient value of 0.343 indicates the direction of the positive effect.
- Health risk has a negative and insignificant effect on intent to recommend mediated by trust because the t-value of 1.233 is less than 1.645. The Path Coefficient value of -0.026 indicates the direction of negative effect
- Psychological risk has a positive and insignificant effect on intention to recommend mediated by Trust because the t-values are 1.248<1.645. The Path Coefficient value of 0.044 indicates the direction of the positive effect.
- Quality risk has a positive and insignificant effect on intention to recommend because the t-values are 1.168<1.645. The Path Coefficient value of 0.025 indicates the direction of the positive effect.

Table 6 – Hypotheses Test

Hypotheses	Path	Path Coefficient	Std Beta	Std Error	t-value	Decision
Direct effect						
H1	HR → IN	0.257	0.268	0.120	2.139	Supported
H2	PR → IN	0.361	0.352	0.123	2.942	Supported
H3	QR → IN	-0.046	-0.041	0.086	0.534	Not Supported
H4	TR → IN	0.072	0.071	0.057	1.250	Not Supported
H5	HR →TR	-0.365	-0.355	0.094	3.902	Supported
H6	PR → TR	0.614	0.602	0.096	6.410	Supported
H7	QR → TR	0.343	0.348	0.066	5.164	Supported
Indirect Effect						
H8	HR→ TR → IN	-0.026	-0.025	0.021	1.233	Not Supported
H9	PR → TR → IN	0.044	0.042	0.035	1.248	Not Supported
H10	QR → TR → IN	0.025	0.025	0.021	1.168	Not Supported

4.3 Discussion

Assessment of H1 and H2 indicates that health and psychological risk has a positive and significant effect on the intention to recommend take away food from RM Padang. With the t-values of 2.139 and 2.942>1.645, hence H1 and H2 are supported. Path Coefficient of 0.257 and 0.361 indicate the direction of effect is positive. It means there are association customer perception about health and psychological risk with intention to recommend take away food during COVID-19. In other words, if the health and psychological risk perception of customers increases, their intention to recommend takeaway food is also growing. Results of this study are in line with prior research which states that the perceived health and psychological risk affects customers' intention to recommend halal food (Olya and Al-Ansi, 2018). This finding also support similar study that suggests risk affects customer attitudes and behaviour (DeFranco and Morosan, 2017).

The result of this study also confirms the study of Olya and Al-Ansi (2018) found quality risk does not affect the intention to recommend halal food. Testing of H3 shows the quality of the food from the RM Padang restaurant will decrease if it is not consumed directly at the restaurant, so customers will have less intention to recommend buying takeaway food.

Based on the results of hypothesis testing, it is known that perceived risk, specifically psychological risk and quality risk, have a positive and significant effect on consumer trust in RM Padang. This is indicated by the psychological risk t-statistic value of 6.410 and quality risk of 5.164 which is greater than the t-table or 1.645. The results of this study are in line with research which states that risk has an important role to create trust and customer satisfaction (Olya and Altinay, 2016). In General, loyal customers will communicate positive recommendation. This result also supports prior relevant research which states that general risk has a significant and positive impact on trust of halal food (Al-Ansi, Olya and Han, 2019). However, previous study of Hoque and Alam (2018) in Bangladesh found that perceived risk has a significant and negative effect on trust in liquid milk. The suggestion of that study is relevant with the finding about health risk has a significant negative effect on trust. It means increasing of perceived health risk (on pandemic situation for example) will erode trust on food of RM Padang.

Hypothesis testing of H4 conducted reveals that trust has a positive and significant effect on the customers' intention to recommend RM Padang. Since the t-statistic value of 1.250<1.645, it is concluded that refusing or not supported which means that trust does not affect the intention to recommend takeaway Padang cuisine at RM Padang during COVID-19. The results of this study are not consistent with previous studies (Al-Ansi, Olya and Han, 2019; Shin et al., 2017). Differences in research findings between this research with previous research because of the different objects being studied and the different situations.

The indirect effect of the health, psychological and quality risk on the intention to recommend mediated by trust is not significant, since the t-statistic value of the three risk variables < t-table 1.645. Therefore, the results of this research is not confirm the finding of previous research by Ling et al. (2011), Hong and Cha, (2013), Leeraphong and Mardjo (2013), and Artigas et al. (2017).

5 CONCLUSION

Based on the questionnaire distributed to the consumers of RM Padang and data analysed by using PLS SEM, it can be concluded that among the formulated hypotheses, 5 hypotheses are supported and another 5 hypotheses are not supported. The accepted hypothesis proves that risk has a significant positive effect on trust and intention to recommend. Health risk has a positive and significant effect on intention to recommend. Similarly, Psychological risk also has a positive and significant effect on intention to recommend. The research findings for these two risks indicate that the higher the consumers' concern about the risk of eating food served at RM Padang, both from their perception of health risks and from the psychological risk, the higher the consumers' intention to recommend buying takeaway food. Due to the uniqueness of the food and its presentation, it is understandable that quality risk has a negative effect on purchase intent. This shows that the higher the consumer's anxiety about the quality of takeaway food, the lower the consumer's intention to recommend it. With the same description, it can be explained that trust has also a positive effect on intention to recommend.

In general, respondents of this study are consumers who have visited and bought the food of RM Padang. Therefore, they already have an emotional bond with RM Padang in other words they believe that RM Padang really cares about the implementation of health protocols.

Based on the discussion above, it appears that there is diversity of research results related to the effects of 5 variables, namely health risk, psychological risk, quality risk, trust, and intention to recommend. Therefore, the findings of this study cannot be generalized. Future research is needed to confirm the results of this study by using qualitative research.

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Identification of Environmentally Friendly Alternative for Laundry Detergent Packaging

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ABSTRACT

Purpose: The objective of the study was to analyse and evaluate two alternative liquid detergent packaging systems from the point of view of their overall environmental impact. Using the LCA method, we have come to the conclusion that cardboard packaging is an alternative with a lower negative impact on the environment than an HDPE bottle.

Methodology/Approach: The study is based on the LCA method implemented through the software openLCA, including available databases.

Findings: The environmentally friendlier alternative of the detergent packaging is identified. The decisions about individual stages during LCA must be made with caution and well documented to ensure credibility of the results.

Research Limitation/Implication: The findings of the presented study are limited by the available data used for the environmental impact assessment. The inventory analysis was performed for the conditions of the central European region.

Originality/Value of paper: This study applies LCA methodology to present the details of a decision process involved in selecting better environmental alternative of the product. The information generated by the study is directly applicable in the industry.

Category: Case study

Keywords: packaging material; environmental aspect; environmental impact; life cycle assessment

1 INTRODUCTION

Over the last hundred years, there has been a sharp increase in the types and amounts of pollutants, some of which are synthetic substances, which long-term consequences for our planet we do not know, yet (Hill, 2017). Along with the development of science and technology after the Industrial Revolution, the population grew, resulting in increased demands on natural resources, an increase in produced waste triggering a series of subsequent serious problems such as climate change, soil and water contamination.

In order for humanity to be able to meet all the requirements of the sustainability and thus create a way of functioning of a society with a high emphasis on environmental responsibility, it is necessary to create a suitable economic environment. The level of sustainability may be assessed according to criteria like: level of process management, the quality and quantity as an optimum, acceptance by customers (Slimák and Zgodavova, 2011).

At present, the Slovak economy, as well as that of many other countries, is based on a linear model. The linear economy works on the principle "extract – produce – throw away". This means that we extract the raw materials needed for production, turn them into a specific products and, after using these products, throw them in a landfill and do not deal with its recyclability, renewability or recovery (Lacy, Longen and Spindler, 2020). In the circular/circulatory model, the fundamental idea is product reuse, while the objective is to minimize or eliminate waste. In this type of economy, two types of materials are used – biological (renewable) and technical (non-renewable but recyclable materials, which constantly move between production and consumption with minimal loss of quality or value). The circular economy sees waste materials as a resource (Lacy and Rutqvist, 2015).

At present, the trend towards the circular economy becomes ever more notable. This change requires the cooperation of all parts of society, from consumers, through developers to politicians. Regulations within member states or the European Union are also important – if there are no economic incentives for eco-business, the transition will not be easy (Sillanpää and Ncibi, 2019).

Directive 94/62/EC of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste lays down European Union rules on the management of packaging and packaging waste. The Directive aims to harmonize national measures concerning the management of packaging and the waste from packaging and increase the quality of the environment prevention and elimination of the impact of packaging and waste from them. The scope of the directive covers all packaging that is placed on the European market, as well as all packaging waste, whether used at industrial level, in shops, households, regardless of the material used. The directive requires EU countries to take measures and use economic instruments to prevent the generation of packaging waste and to minimize the environmental impact of packaging.

The directive sets a limit for at least 60% of waste to be recovered (including incineration), 55% to 80% of packaging waste recycled, where the minimum values for individual materials are set as follows: 60% for glass, paper and cardboard, 50% for metal, 22.5% for plastics, 15% for wood. This goal was best met by Finland in 2018 with a recovery of up to 114.6% (a rate of more than 100% can be explained by the storage and subsequent recovery of waste generated in previous years). Slovakia has reached the set limits – the share of recovered packaging waste was 69.1% and that of recycled packaging waste 66.6% (Smernica Európskeho Parlamentu A Rady 94/62/ES z 20. decembr... - EUR-Lex, 2020). EU countries are required to increase the share of reusable packaging and systems in a way that is environmentally acceptable without compromising food safety or consumer safety, including repayable advance schemes or even economic incentives. Member States are also obligated to take the necessary measures to meet the recycling targets: at least 65% of all packaging waste must be recycled by 31 December 2025 and 70% by 31 December 2030, at the latest.

According to the Statistical Office of the European Communities, published on 10 December 2020, the packaging waste generated in 2018 averaged around 174 kg per capita in the European Union. The published data represented data made available by individual EU Member States between 2008 and 2018. The total amount of packaging materials produced has increased by 6.7 million tonnes since 2008, or about 9.4%. Packaging waste produced in 2018 alone accounted for 77.7 million tonnes, of which 40.9% was paper and board, 19% plastic, 18.7% glass, 16.1% wood and 5% metal – these materials are the most widespread packaging materials in the EU. Other materials accounted for less than 0.3% (Packaging waste statistics, 2021). In Slovakia, according to the latest available data from the years 2017/2018, the amount of waste produced was 13 million tonnes, of which about 350,000 tonnes accounted for packaging and waste from packaging (Lieskovská, and Lényiová, 2019).

The packaging is defined as a means or set of means that protect the product from damage or loss, caused by adverse events that could occur during handling, transport, storage, sale or use (Pernica, 1994). At present, the most widespread packaging material for laundry detergents is a plastic bottle. This study presents a cradle-to-grave quantitative assessment of two different packaging for liquid laundry detergent. The proposed alternative is to pack and sell the liquid detergent in a paper container. Life cycle assessment (LCA) is a quantitative method that focuses on the entire product life cycle. LCA is one of the most frequently employed approaches for an environmental evaluation of products and processes. The purpose of this work is to present an alternative packaging system and characterize its environmental aspects and their impacts using the LCA method. The main goal of this study is the environmental evaluation of plastic bottle and paper packaging, to decide which option has lower negative impact on the environment.

The packaging system represents the goods, packaging and packaging process. It is necessary to approach the packaging system comprehensively in order to achieve a functional and economic optimum with the given means. The choice of packaging method must help to integrate packaging technology with production technology into a continuous material flow with a link to a continuous flow outside the production organization (Sixta and Macat, 2005).

Each part of the packaging life cycle, from raw material recovery to disposal, has its own specific requirements. These individual requirements may be compatible with each other, e.g. the packaging should be solid and watertight, or they may be in conflict with each other, e.g. the cover should be strong but at the same time light.

1.1 Product Life Cycle Assessment

A product life cycle is defined as all stages of a product's life from the extraction of the raw materials needed for its production, through the production of the product itself, its use and finally, disposal (Jolliet et al., 2015). Product LCA is the process of collecting and evaluating the inputs, outputs and potential environmental impacts of a product throughout its life cycle (Hauschild, Olsen and Rosenbaum, 2018). The International Organization for Standardization (ISO) has issued a series of standards and technical regulations for LCA – ISO 14040 listed in Table 1, which constitute a very important tool for environmental assessment.

Table 1 – Overview of the ISO Standards for LCA

Designation	**Title**
ISO 14040:2006	Life cycle assessment — Principles and framework
ISO 14044:2006	Life cycle assessment — Requirements and guidelines
ISO 14045:2012	Eco-efficiency assessment of product systems — Principles, requirements and guidelines
ISO 14046:2014	Water footprint — Principles, requirements and guidelines
ISO/TR 14047:2012	Life cycle assessment — Illustrative examples on how to apply ISO 14044 to impact assessment situations
ISO/TS 14048:2002	Life cycle assessment — Data documentation format
ISO/TR 14049:2012	Life cycle assessment — Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis
ISO/TS 14071:2014	Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006

LCA covers a wide range of environmental issues, not just single specific one. The main reason for considering several environmental aspects is to avoid the so-called "Burden shifting", which means that if we focus on reducing only one

impact, we may inadvertently ultimately increase other types of environmental impacts (Hauschild and Huijbregts, 2015).

LCA is a quantitative method. It answers the question: "How much can a product system affect the environment?" Being quantitative means that this method can be used to compare the environmental impacts of different processes and products, for example to assess, which products or systems are more suitable for environment, or to point out the processes that contribute most to the overall impact and should therefore be given more attention. We obtain the result by mapping all used sources and emissions (if possible, taking into account the geographical location of the factors) and using mathematical models to calculate the potential impacts of all factors (Jolliet et al., 2015).

1.2 Advantages and Disadvantages of LCA

The main advantage of this method is its comprehensiveness, as it deals with the whole life cycle and all kinds of environmental aspects. This makes it possible to compare the environmental impacts of product systems, which consist of hundreds of processes representing thousands of used sources and emissions. This complexity is also a disadvantage of this method, as it requires simplification and generalization when modelling the product system and its impacts, which hampers the calculation of real and accurate environmental impacts. More precisely, therefore, the LCA calculates their potential impact (Hauschild, Olsen and Rosenbaum, 2018).

Strength of the comparative LCA method is that it follows the principle of best estimate. This generally allows for an objective comparison, as the same level of caution is applied throughout the impact assessment. The disadvantage of the method being guided by the principle of best estimate is that LCA models are created on the basis of average process performance, without taking into account the probability of the occurrence of an adverse event. For example, according to the LCA, nuclear energy is considered to be environmentally friendly because it does not take into account the small chance of an accident that would have a catastrophic impact on the environment. The disadvantage of this method is that while it can tell us which system has a lower environmental impact, it cannot tell us whether the system is sufficiently environmentally friendly (Hauschild and Huijbregts, 2015).

2 METHODOLOGY

The LCA method consists of 4 main phases: definition of objectives and scope, inventory analysis, impact assessment, and life cycle interpretation (Curran, 1996).

Definition of objectives and scope

The first step is to clearly and unambiguously define the goals of the method. This step serves to define how much of the life cycle will be included in the evaluation and what the evaluation will be used for. It describes the criteria for comparing systems and the timeframe in which the evaluation will take place.

Inventory analysis

This phase is also called LCI – Life Cycle Inventory. At this stage, the inputs and outputs of the product are summarized throughout its life cycle. Quantitative data and calculations are a key element of this step. The first step is to write down all the material and energy flows that enter the processes. The data must be consistent and in relation to the functional unit. The result is a system that provides information on all inputs and outputs in the form of an elementary environmental flow from a functional unit of a given process, with each input/output quantified (Hauschild, Olsen and Rosenbaum, 2018).

Life cycle impact assessment

This phase is also called LCIA – Life Cycle Impact Assessment. It is focused on assessing the significance of potential environmental impacts. ISO has defined mandatory steps that must be followed:

- Selection of impact categories, indicators and model characteristics;
- Classification – to assign the results obtained from the inventory analysis to specific categories;
- Characterization – in this step the emissions are recalculated in units of mass or volume, i.e. the potential environmental impacts in a specific category are quantified (for all categories it is necessary to select a unit that will express the degree of possible damage – category indicator) (Curran, 2012);
- Interpretation – in the final stage there is a summarization and evaluation of the results of the inventory and evaluation phases with respect to a predefined purpose. It is a process in which the main environmental aspects are identified and ways are sought to reduce the environmental impacts of the system. This phase should provide the clear and practically applicable information needed to make the right decision (Jolliet et al., 2015).

2.1 LCA of Detergent Packaging Systems

The objective of this work is to quantify and compare the environmental performance of two types of product packaging that are used as primary containers for liquid detergent. At present, the most widely used packaging material is plastic bottle. The body and neck of the plastic bottle are made of high-density polyethylene (HDPE), the lid is made of polypropylene (PP). The proposed alternative to a plastic bottle is a cardboard package. The body of the package consists of one layer of cardboard paper and three layers of polyethylene (PE). The neck and lid are made of bio HDPE, which was obtained by processing sugar cane.

2.2 The Scope of the Study

The life cycle of both products is divided into 4 phases: raw material extraction, production, transport and waste disposal.

The performed analysis includes:

- extraction/sourcing of raw materials for the production of primary packaging materials (body and lids) and sourcing of raw materials for the production of secondary packaging materials (low-density polyethylene (LDPE) foil, cardboard boxes), which will be used during transport,
- production of primary and secondary packaging,
- transport of packaging materials to the place where they will be filled with liquid detergent,
- recycling, landfilling and incineration of primary and secondary packaging materials.

The performed analysis does not include:

- production, filling process, environmental aspects and effects of liquid detergent, as the aim of the study is to analyse the packaging system,
- transport of already filled packaging materials to the point of sale and to the consumer due to lack of data,
- environmental impacts caused by accidents or incidents during the manufacture or transport of detergent,
- tertiary packaging – pallets used in transport, we assume that they are used repeatedly,
- production, disposal and maintenance of infrastructure in the life cycle of products such as machinery, trucks, roads, etc.,
- loss of detergent during its production, use and transport. It is difficult to identify these losses and data to calculate their impact are not available,

- production and printing of packaging materials labels,
- life cycle of secondary products in the production of individual components.

2.3 Functional Unit

We define a functional unit as the quantitative performance of the product system that will be used as a reference unit for the LCA study. The selected functional unit for presented LCA is packaging for 10,000 liters of product, as described in Table 2.

Table 2 – Quantitative Definition of the Functional Unit

	Weight per 1 pc [kg]	**Weight per 10 000 pcs [kg]**	**Total [kg]**
HDPE bottle body	0.07	700	820
lid + neck HDPE bottle	0.012	120	
paper packaging	0.0292	292	320
lid + neck for paper packaging	0.0028	28	

2.4 Data

The data used to assess the life cycle of packaging products were obtained through OpenLCA software. The data is in line with European emission limits. From the geographical point of view, we focus on the production, transport and disposal of packaging systems in the EU-28 + EFTA. We worked with average data that were obtained over a period of 8 years (2012-2020).

2.5 Primary Packaging Materials

2.5.1 HDPE bottle

A plastic bottle is made of two types of plastic: the body of the bottle is made of polyethylene of high density and the cap is made of polypropylene. The basic raw materials for the production of plastics are mainly oil and natural gas. The selected product is made 100% of oil. After the oil is extracted, it needs to be cleaned and desalted – this is done by distilling the oil at the refinery. By refining the oil, we obtain oil, which we then treat by steam cracking. Cracking is the process by which high molecular weight substances are converted into low molecular weight substances. By cracking we obtain ethylene, propylene and higher alkenes. The individual components have different boiling points, so it is possible to separate them from each other by distillation. After obtaining ethylene and propylene, polymerization takes place and thus we obtain plastic granulate (Polypropylene (PP), no date; Spracovanie ropy na primárne produkty | petroleum.sk, no date).

The individual methods of converting granulate into a specific product differ depending on the intended the use of the product. A plastic bottle is formed from the HDPE granulate by the blow moulding, and a lid is produced from the PP granulate by the injection moulding. The finished product is transported to a place where it will be filled with detergent. From there, it is transported to the point of sale and to consumers. In a process of making a plastic bottle and a lid 1.61 kg of oil must be used to produce 1 kg of plastic. The bottle analysed in this work has a volume of 1 l and dimensions 214x84x84 mm.

2.5.2 Cardboard packaging

The cardboard packaging consists of a body and a lid. The body consists of four layers. One layer is unbleached kraft paper and three layers are polyethylene. Unlike cardboard packaging for food and beverages, the alternative we choose does not contain an aluminum layer, which protects food from direct sunlight, oxygen and bacteria. This type of carton is called non-aseptic. The neck and lid of the package are made of bio HDPE, which is obtained by processing sugar cane.

Cardboard makes up about 70-80% of the entire packaging, polyethylene 20-25%. The analysed cardboard package has a volume of 1 l and dimensions 230x70x70 mm. Non-recycled paper was assumed for production the paper part of the packaging. After harvesting the wood, and before its processing, it is necessary to debark, clean, cut and mechanically split the wood. In order to make paper out of wood, we need to convert it into pulp. The pulping method differs according to required paper properties. We generally recognize three types of pulping: Kraft pulping, acid sulfite, and neutral sulfite semichemical pulping. Sulfide pulping is used to produce kraft paper. This type of pulping uses a solution of NaOH and Na_2S. The result is a solid pulp with long fibers. The pulp is then cleaned and travels to a mill and a paper machine. The result is kraft paper (Twede, 2014). The production of the polyethylene layer is similar to the production of HDPE bottles – polymerization of ethylene. The connection of the paper and plastic layer takes place by extrusion lamination.

Bio HDPE for the lid and neck are obtained from sugar cane. The first step in the production of organic HDPE, after growing sugar cane is its cleaning, slicing, grinding, which releases glucose in the form of fibers and juice. Anaerobic fermentation of glucose decomposes it to give a mixture of ethanol and dregs. After distillation, bio-ethanol is dehydrated to obtain bio-ethylene. Polymerization of ethylene produces a bio-polymer that is identical in chemical, physical, and mechanical properties to the petroleum-derived polymer. The final step is injection moulding, which results in a lid and a neck (Siracusa and Blanco, 2020).

2.6 Secondary Packaging Materials

2.6.1 Cardboard box

The cardboard box serves as a secondary packaging for the primary packaging materials stored therein for transport to the place of filling. The box consists of two types of paper – two layers of plain paper and corrugated three-ply cardboard. Non-recycled wood was assumed to make the cardboard box (Twede, 2014).

2.6.2 LDPE foil

Classic LDPE foil is used for product transport. The production of foil is similar to the production of all plastic products. The foil is made in 100% of oil. The LDPE granulate is extruded into a foil. LDPE foil covers the cardboard boxes, in which the primary packaging materials are placed.

2.7 Environmental Impacts of Products

A detailed examination of all environmental impacts is not possible, whereas it depends on several factors, such as the quality of the data obtained or the availability of the data. At present, one of the biggest problems is air pollution, therefore in this study focused on the three main indicators, namely global warming, acidification and photochemical smog (these impact data exist for almost every product). The fourth selected impact is eutrophication, which is caused by water pollution. Another most common aspect is energy consumption, which is included in all data throughout the product life cycle.

2.8 Characteristics of Selected Impacts

2.8.1 Eutrophication

Eutrophication is caused by the excessive presence of inorganic nutrients, especially nitrogen and phosphorus, in the water. This results in increased growth of cyanobacteria and algae. Due to the increased production of biomass and its subsequent decomposition, there is a lack of oxygen in the aquatic environment. Lack of oxygen causes the death of organisms that live in or near water – a reduction in biodiversity. The main causes of eutrophication are wastewater, intensification of livestock farming, energy and fossil fuel consumption, increased fertilizer consumption, land use (Ansari and Gill, 2014).

The indicator for this category is kg PO_4 equivalent. PO_4-eq. is a value expressing the degree of eutrophication potential of substances.

2.8.2 Acidification

Acidification is the process by which the components of the environment are acidified. The result of acidification leads to forest degradation, deterioration of buildings, climate change, the loss of nutrients from the soil, extinction of animal and plant species (acidifikácia, 1999).

The indicator for this category is kg SO_2 equivalent. SO_2-eq. is a value expressing the degree of acidification potential of the substances.

2.8.3 Global arming

The result of global warming is the gradual increase in temperature of the Earth surface, oceans and atmosphere (Bradford and Pappas, 2017).

The indicator for this category is kg CO_2 equivalent. CO_2-eq. is a value expressing the rate of global warming potential of substances.

2.8.4 Photochemical smog

Air pollution by photochemical smog, is the result of the interaction of photo-sensitive substances in the atmosphere with UV part of the solar radiation – especially ozone (smog | Causes, Effects, & Types | Britannica, 2019).

The indicator of this category is kg ethylene equivalent. Ethylene-eq. is a value expressing the degree of photochemical potential of the substances.

2.9 Interpretation of Results

2.9.1 Obtaining raw materials

In the phase of raw materials sourcing, we focus on oil extraction, logging and sugar cane cultivation. The data also include the transport of individual raw materials to the place where they will be further processed, including energy.

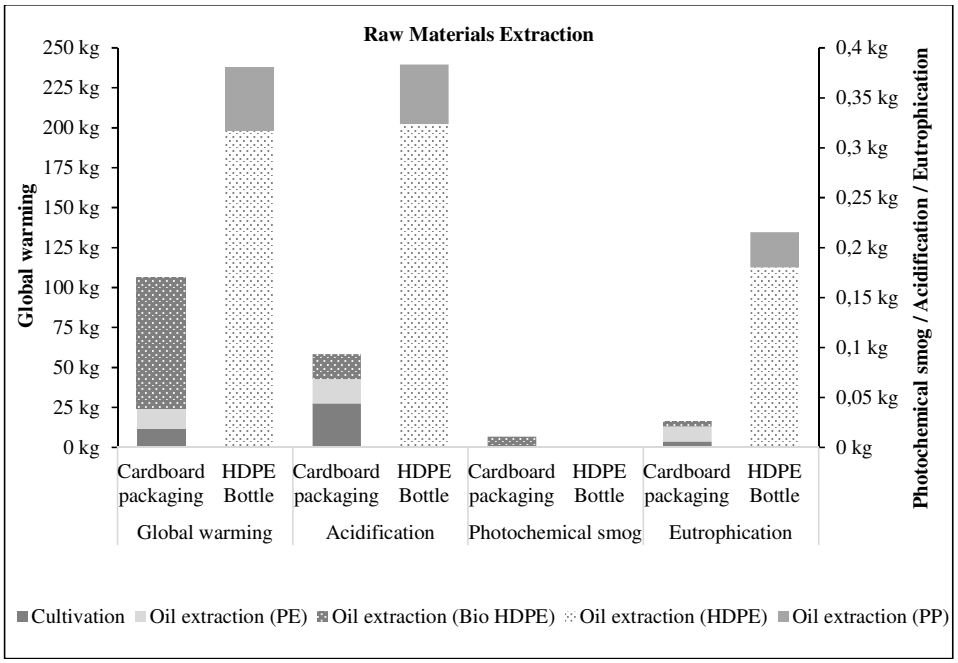

Figure 1 – Impacts of Raw Materials Extraction

The graph in Figure 1 shows that in the raw material recovery phase, paper packaging has a less negative impact on the environment in three categories – global warming, acidification and eutrophication. The biggest burden on the environment is the extraction of oil, which is needed to produce the entire plastic bottle.

2.9.2 Production

The production phase includes the complete process of converting the basic raw material into the final product. The data also include the transport of products between individual production companies, including energy. As shown in Figure 2, the biggest burden on the environment is the production of HDPE bottles. Compared to the paper packaging, the HDPE bottle entails significantly higher emissions, for example in the category of global warming it is up to about 1,640 kg CO_2-eq. more. On the contrary, in the photochemical smog category, the production of HDPE bottles represents a lower environmental burden than the production of paper packaging by about 0.8 kg ethylene-eq. less. As far as paper packaging is concerned, the production of kraft paper has the highest emissions of all three packaging components.

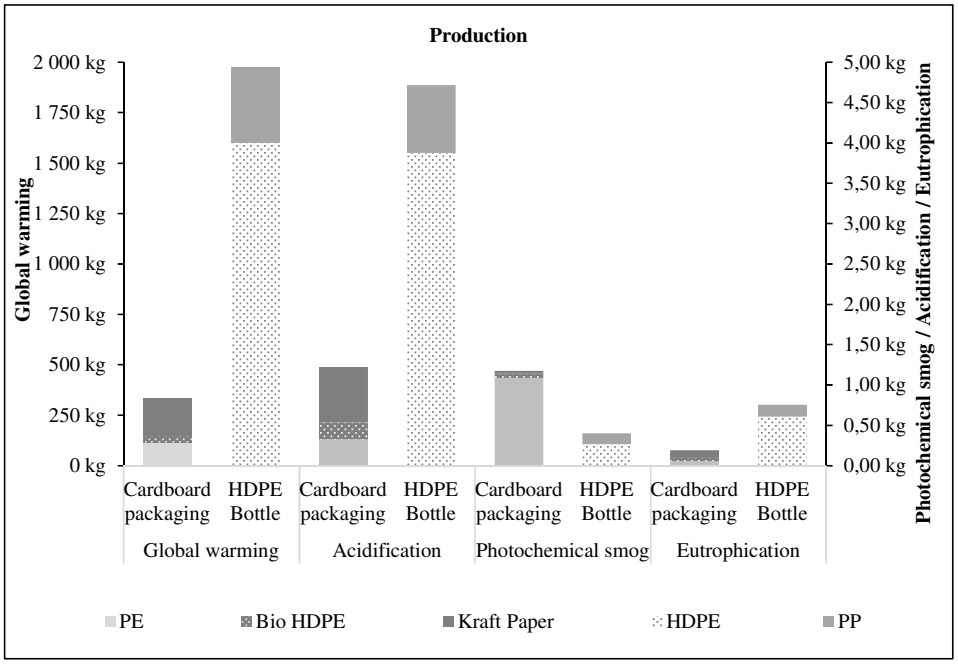

Figure 2 – Impacts of Production

2.9.3 Transport

The data used represent the regional mix of EU-28 + EFTA countries. We assume that a truck with a payload capacity of 5 tonnes will be used for the transport. We assume that 59% of the total route will be on the highway, 28% in the country and 13% in the city. The data also includes fuel – diesel. The data do

not include the production and disposal of the truck. We use cardboard boxes and LDPE foil as secondary packaging for transport. Emissions of secondary packaging materials are included in the data. The comparison of impacts in transport phase is shown in Figure 3.

For the purposes of this work, the city of Košice was chosen as the place of filling, the place of production of cardboard packaging is Gornji Milanovac, Serbia and the place of production of HDPE bottles is Kralovice, Czech Republic. The distance between Gornji Milanovac and Košice is 730 km and the distance between Kralovice and Košice is 760 km. When transporting materials from the place of production to the place of filling, the HDPE bottle again represents a significantly higher burden on the environment than cardboard packaging in all 4 categories. This might be explained by the fact that the HDPE bottle is bulkier than the cardboard packaging. In terms of secondary packaging, the life cycle of LDPE film has a greater impact on the environment (especially in terms of air emissions) than a cardboard box.

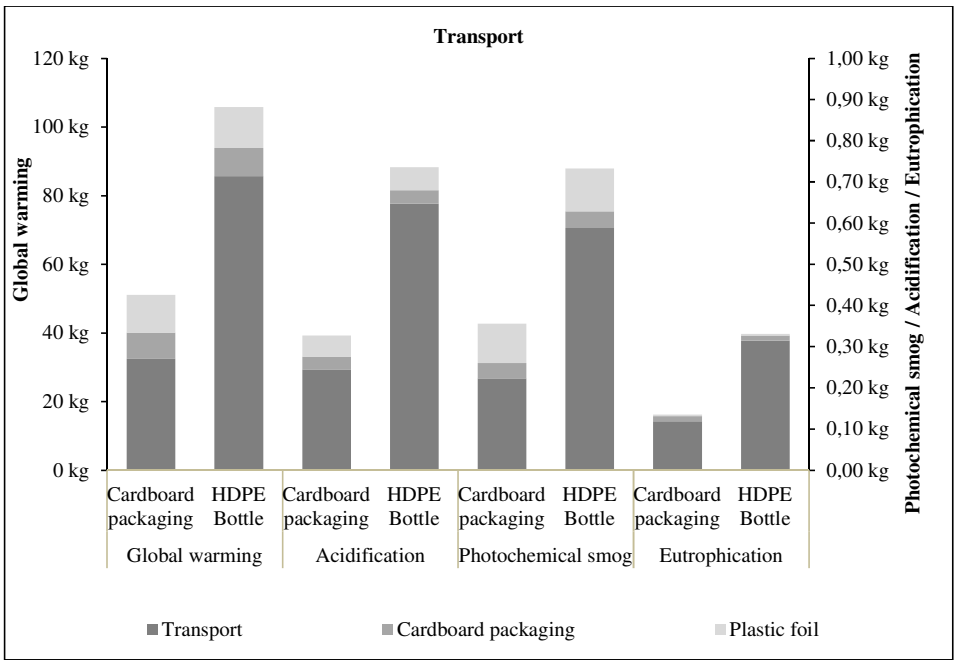

Figure 3 – Impacts of Transport

2.9.4 Waste Disposal

In the phase of packaging materials disposal, we have focused on three basic types of waste disposal, namely recycling, incineration and landfilling.

Recycling

Recycling means repeated recovery of materials. It is the most preferred method of waste treatment. The data used include the transport of waste to the recycling site, cleaning, sorting, separation, granulation and palletisation of waste. The method of recycling differs from material to material. The sources of energy in recycling are coal, oil, natural gas, uranium. All energy recovery data are also included.

Assessing the environmental impacts of recycling in the waste disposal phase is relatively complicated. In general, there are several approaches that can be applied in the evaluation, for example we will consider that the input to the production process is made from already recycled material or we estimate how many times the material can be recycled and so we will count specific values as 1/N-th of functional units. The second approach was chosen in the work. We assume that the paper can be recycled 7x, bio HDPE and HDPE 2x, LDPE 4x, PP 5x, so we assume that the paper has 8 life cycles, bio HDPE and HDPE 3, LDPE 5 and PP 6. Negative values are actually positive – they represent the amount of emissions not released into the environment. For example, if we recycled an HDPE bottle twice, we would save up to 300 kg CO2 eq. than, if we burned the bottle or landfilled it. However, if we look at the photochemical smog category, it is more environmentally friendly to burn an HDPE bottle than to recycle it twice.

Incineration

Incineration takes place in waste-to-energy plants – in the heat treatment of municipal waste, dry flue gas cleaning takes place and NOX is removed by selective catalytic reduction or selective non-catalytic reduction. The incineration plant consists of a combustion chamber equipped with a steam generator. The recovered energy is either returned to the combustion process, used for energy production or exported as heat to industry or households. The resulting bottom ash is extinguished, ferrous scrap and non-ferrous metals are selected from the ash, followed by three-month ash aging process. Part of the ash thus obtained is used as a building material. The rest is deposited in the ground. The used data include waste transport and pre-treatment.

Landfilling

Landfilling as waste disposal is used when no other method of disposal is possible. However, it is the least preferred method of waste disposal. The used data represent a typical municipal waste landfill with a basic surface sealing that meets European emission limits. The data do not include pre-treatment of waste, as we assume that the waste is pre-treated before it is landfilled. The data include the cleaning and treatment of landfill gases and leachates. The data also include the individual life cycles of the materials used to seal the landfill. The materials used to seal the landfill are gravel, sand, clay, PE film. Gravel and sand are used as filter layers. PE film is used as a waterproof seal, clay as a base seal and a mineral layer. Gravel, sand and clay are mined from the dry quarry. PE is made

from oil. All production processes of sealing materials are included. The sealing efficiency is 70%. The height of the landfill is 30 m, the landfill area is 40,000 m^2.

The graph in Figure 4 shows that incineration is the biggest burden on the environment. The best option is recycling. At this stage, an HDPE bottle is a better alternative due to the amount of emissions in 3 categories – acidification, photochemical smog and eutrophication. For the global warming category, cardboard packaging is a more appropriate option if the waste is disposed of by incineration. However, if the waste was recycled, a more suitable alternative is an HDPE bottle again.

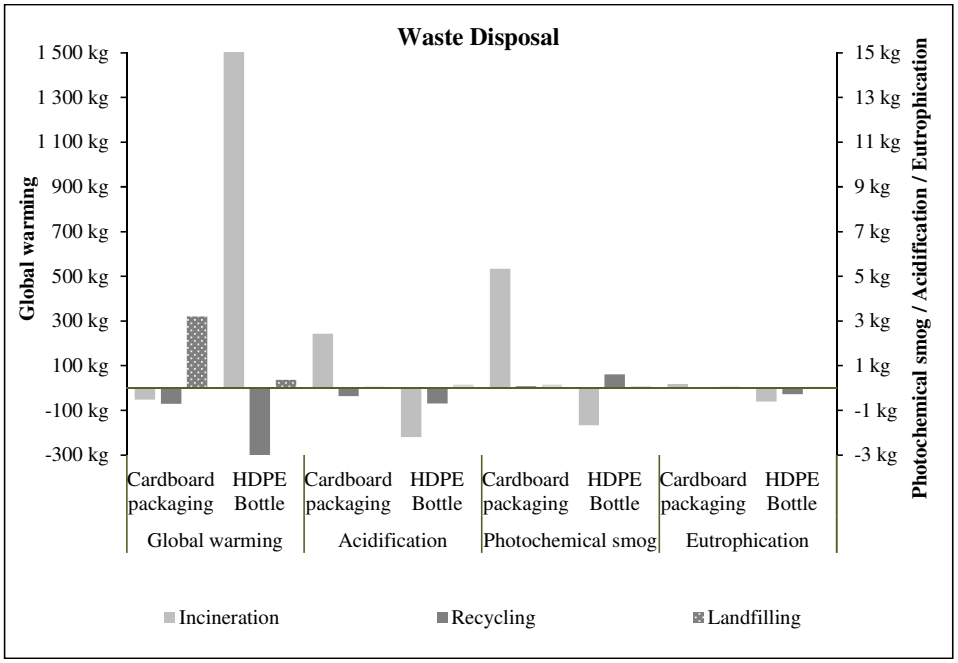

Figure 4 – Impacts of Waste Disposal

3 DISCUSSION

Using LCA method we have found that paper packaging is a more suitable alternative for the environment. The summary results are shown in Figure 5. In the raw materials extraction phase, cardboard packaging had a smaller negative impact on the environment in three of the four categories – global warming, acidification and eutrophication.

The biggest burden on the environment in the raw material extraction phase is the extraction of oil, which is needed for both products. The life-cycle stage that produces the most emissions is the materials production phase.

Production is a complicated process that consists of a large number of technological operations, which a large amount of materials enters and a large amount of emissions and secondary products leaves. Even at this stage, the paper packaging represented a lower environmental burden. However, the photochemical smog values in both phases of the paper were higher than those of the HDPE bottle.

In the transport phase, we focused on the transport of containers from the place of production to the place where they will be filled with detergent. Both products cover approximately the same distance of 750 km. The results of this phase also include the values of the effects of secondary packaging materials – LDPE foil and cardboard box during their entire life cycle.

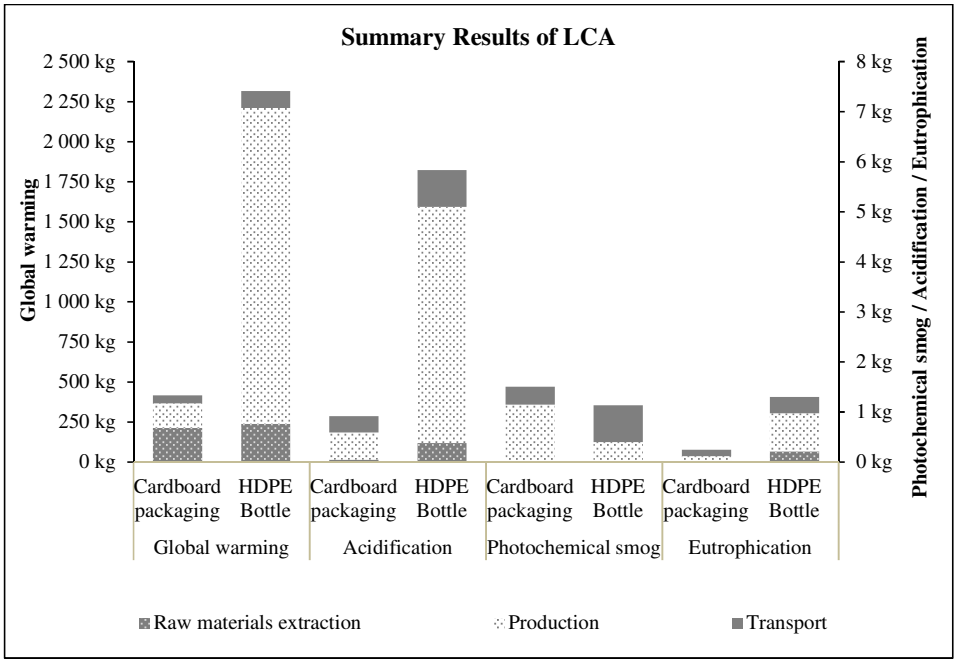

Figure 5 – Overall Environmental Impacts

At this stage, the cardboard packaging also had a more favourable impact on the environment. This can be explained by the fact that the HDPE bottle is heavier and we need more secondary packaging materials to transport it. The HDPE bottle had a significantly lower environmental impact when disposing of packaging waste, except for incineration in the global warming category, than paper packaging. However, this does not change the fact that paper packaging is a more suitable alternative for the environment, because despite subtracting the individual values of the effects of disposal from the summary results, the HDPE bottle has much higher emissions in the previous three phases.

4 CONCLUSION

The LCA method was chosen mainly because of its complexity, as it allows us to evaluate and compare all processes, inputs and outputs related to the production of packaging from the acquisition of raw materials to their disposal. This makes it possible to focus on a wide range of environmental issues, not just single specific one.

The problem seems to be that the LCA provides an answer, which of the analysed systems has a potentially lower impact on the environment, but does not provide an answer as to whether a particular system is really environmentally friendly enough. However, it helps us identify, which phase of product's life cycle poses the greatest environmental burden; where we need to focus in order to be able to produce environmentally friendly product.

This method is very costly and time consuming. In order to be able to perform a truly detailed analysis that will cover all environmental issues, a large amount of finance, capable software, availability and high data quality are needed.

Using the LCA method, we have come to the conclusion that cardboard packaging is an alternative that has a more favourable impact on the environment than an HDPE bottle. The presented work provides a reason for the decision on a more detailed examination of the issue of packaging for liquid detergent and the consideration of cardboard packaging as an alternative to HDPE bottles.

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Conceptualization, P.P.; Methodology, P.P. and B.M.; Formal analysis, B.M.; Investigation, B.M.; Data curation, B.M.; Original draft preparation, B.M.; Review and editing, P.P.; Supervision, P.P.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

The Impact of Quality Management on Business Performance of Manufacturing Firms: The Moderated Effect of Industry 4.0

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ABSTRACT

Purpose: The research aims to investigate the individual quality management (QM) factors impact on business performance in manufacturing firms. We then assess their influence and look at how industry 4.0 affects business performance directly. Furthermore, the study will demonstrate the moderate effect of industry 4.0 on the interaction between QM and business performance.

Methodology/Approach: The authors used two methodologies. The first is qualitative methods, by interviewing experts to develop a realistically appropriate model. The second is quantitative methods, by carrying out the survey and getting 84 observations. This research used the multivariate data analysis technique PLS-SEM to evaluate three measurement models: formative measurement model, reflective measurement model, and structural model.

Findings: The QM was operationalised as a multi–dimensional construct. According to the findings, these individual QM factors significantly affect the organisation's performance, including customer satisfaction, employee satisfaction and quality performance. Besides, QM and Industry 4.0 have directly impact on performance. The study also shows that industry 4.0 has a positive moderating role in the relationship between QM and business performance.

Research Limitation/Implication: The survey was only done in emerging countries and the sample size is limited. There are other QM and business performance measurement parameters that have not yet to be discussed.

Originality/Value of paper: The study contributes to the QM literature by building a business quality model, in which the role of Industry 4.0 was explored.

Category: Research paper

Keywords: quality management; performance; manufacturing; Industry 4.0

1 INTRODUCTION

With the increasingly outstanding development of the current globalised economy, it is required that the production and business process be accurate and cost–effective. In that context, the application of quality management (QM) to ensure the above requirements is extremely necessary. Quality experts have proposed several approaches through a set of QM practices. Several researchers have attempted to clarify that implementing quality management through QM practices impacts business performance (Ahire and Dreyfus, 2000; Madu, Kuei and Jacob, 1995; Magd, Negi and Ansari, 2021). It is widely applied in developed countries and has been proven to be a vital factor in determining business performance (Jaafreh and Al-abedallat, 2013) and enhancing the competitiveness of enterprises (Douglas and Judge, 2017). Many studies have investigated the relationship between the factors of quality management based on QM and business performance. Most of which have demonstrated that QM has a positive effect on business performance, referring to Benavides-Velasco, Quintana-García and Marchante-Lara (2014), Choi and Eboch (1998), Xu et al. (2020), Talib, Rahman and Qureshi (2013). There are many studies by authors in developed countries that have studied QM affecting performance, but in emerging countries (Vietnam, for example), this issue has not been properly paid attention. By applying the PLS-SEM analysis method, this study has theoretically contributed to re-affirming the relationship between QM and business performance and analysing individual QM factors to business performance.

In this study, the authors used industry 4.0 as a moderator variable for the model and the QM-based approach to conducting the research. Industry 4.0 is a new phase in the Industrial Revolution that primarily focuses on connectivity, automation, machine learning, and real-time data. Over a decade, industry 4.0 has been widely applied globally and started to be applied in Vietnam manufacturing enterprises in recent years. However, the role of technology 4.0 for manufacturing enterprises in emerging countries has been unexplored. Therefore, this study will focus on three questions: Will the adoption of industry 4.0 tools lead to more effective QM implementation; If the enterprise implements QM under the support of industry 4.0, will it achieve better business results? In other words, does industry 4.0 moderate the relationship between QM and business performance?; And finally, analysing how do individual QM factors affect business performance?

2 LITERATURE REVIEW AND HYPOTHESES

2.1 Quality Management Factors

Quality management is a long-standing concept, and many researchers analyse it (Talib, Rahman and Qureshi, 2013). QM is represented by many different factors. In this study, QM was operationalised as a multi-dimensional construct,

including leadership, strategic planning, processes and products QM, people management, customer focus, information and analysis systems, and supplier QM.

Leadership: Kotter (1988) believed that leadership is not just an individual quality, but a process. According to the above definition, this process must be voluntary and obeyed by colleagues. Zaleznik (2004) argued that leadership requires the use of power to influence the thoughts and actions of other individuals. These discussions have helped to develop a new definition of leadership from the authors' perspective that, in different contexts, individuals appear to be capable of guiding the collective to achieve goals in different ways is considered leadership. Leadership is positively related to the operational and overall performance of the organisation through a variety of approaches, such as reward level, leadership commitment, cross cooperation between parts (Xu et al., 2020). Leadership creates motivation for open communication and continuous improvement among employees, thereby creating potential to improve organisational performance (Nair, 2006). Hypothesis H1 is proposed:

H1: Leadership has a positive effect on performance.

Strategic planning: The definitions of strategic planning are numerous, but they all have one thing in common: a defined and identifiable set of activities (Nickols, 2016). According to Nickols (2016), strategy is the determination of the short or long-term goals of an enterprise and the sequence of actions to allocate resources to realise those goals. According to Kerzner (2001), strategic planning is the process of forming decisions about the future direction of an enterprise and options to support its implementation in the right direction and it is closely related to the success of the project and the company. Jaafreh and Al- abedallat (2013) indicate that strategic planning have a significant impact on organisational performance. Indeed, many studies have found a significant relationship between strategic planning and quality performance (Prajogo, 2005), organisational effectiveness (Sila, 2003). Hypothesis H2 is proposed:

H2: Strategic planning has a positive effect on performance.

Processes and products QM: According to Palmberg (2009), a process is a sequence of activities that turn inputs (needs) into outputs (standards) to satisfy the needs of customers. Based on the different nature of products and related processes, the QM system changes dynamically (Nilsson, Johnson and Gustafsson, 2001). Product quality is a fundamental factor that has an impact on motivating customers' buying behaviour in a variety of choices, which is the main factor affecting business results (Filip and Marascu-Klein, 2013). Yang (2006) found that process management has positive effects on customer satisfaction, by which companies can gain competitive advantage. Fotopoulos and Psomas (2010) insisted that processes and product quality are significant effects on market benefits and financial performance improvement.

Hypothesis H3 is proposed:

H3: Process and product quality management have a positive effect on performance.

People management: In general, the element of human resource management refers to employee training, empowerment management, relationships and teamwork, people involvement, collectively referred to as the extent to which employees participate in the QM system (Xu et al., 2020). All people in the enterprise must engage in continuous improvement and fulfil their own role to achieve customer satisfaction, which is a measure of business performance (Gatchalian, 1997). The human factor has been proved to have a positive effect on the overall performance of an enterprise. This has been shown in previous studies by Gatchalian (1997), Xu et al. (2020). Hypothesis H4 is proposed:

H4: People management have a positive effect on performance.

Customer focus: Customers are considered an essential asset for every business. Therefore, to be successful, firms must design products according to customer requirements. Research by Cai (2009) suggests that customer-centric organisations will create an impact on customer relationships, then affect customer satisfaction and production performance. Focusing on the customer is not only an essential component of TQM practices but also a core issue of a business (Deming, 2018). Similarly, the study of Brah, Tee and Rao (2002) also confirmed that a business that wants to achieve profitable growth must build long-term value for customers. Hypothesis H5 is proposed:

H5: Customer focus has a positive effect on performance.

Information and analysis systems: TQM philosophy emphasises fact-based decision making and information analysis such as customer needs, production problems, achievement of improvement projects (Brah, Tee and Rao, 2002). Information and analytics help businesses ensure the availability and high quality of data, timely delivery to users such as employees, customers and suppliers (Kim et al., 2012). Prajogo (2005) also demonstrates the importance of information and analysis for business performance, specifically quality performance. Hypothesis H6 is proposed:

H6: Information and analysis systems have a positive effect on performance.

Supplier QM: Developing long-term relationships with suppliers is a factor that helps businesses improve organisational efficiency, including production process development, product development, and nonconformity elimination. These activities reduce costs for enterprises such as production costs, product research, and development time costs (Calvo-Mora et al., 2014; Zakuan et al., 2010). Supplier quality can improve overall performance and effective financial results through cost reduction and focus on core competencies (Xu et al., 2020). According to Zineldin and Jonsson (2000), supplier relationships can improve firm performance by increasing competitiveness.

Hypothesis H7 and H8 are proposed:

H7: Supplier quality management has a positive impact on performance.

H8: Quality management has a positive impact on performance.

2.2 Business Performance Factors

Business performance: Cyert and March (1992) said that business performance is the level of meeting the objectives set forth by the enterprise initially, expressed through indicators such as net profit, market share growth, revenue and effectiveness of strategic goals, et cetera. Developing long-term relationships with suppliers is a factor that helps improve organisational performance, including process development, product development and nonconformity elimination. These activities reduce costs for enterprises such as production costs, research and development time costs (Calvo-Mora et al., 2014). Zakuan et al. (2010) also agree with the above point of view that effective supplier QM can be achieved through long-term cooperation with suppliers.

Quality performance: For manufacturing enterprises, improving product quality will help to reduce waste and improve production efficiency, thereby helping to increase return on assets (Handfield, Ghosh and Fawcett, 1998). In addition, improvements in quality will attract more customers because of higher satisfaction and loyalty, increasing sales (Ahire and Dreyfus, 2000; Handfield, Ghosh and Fawcett, 1998), enhancing competitive position (Choi and Eboch, 1998).

Customer satisfaction: Customer satisfaction is seen as a business goal (Liu and Jang, 2009). The purchase decision of customers is a measure of business performance. Contributions from customers help improve the company's innovation performance (Moilanen, Østbye and Woll, 2014). Customers are the end users of the products and are closely linked to the market, so understanding customer-relevant metrics will increase insight into current market needs (Nilsson, Johnson and Gustafsson, 2001).

Employee satisfaction: Research by Lashbrook (1997) has demonstrated that job satisfaction, job completion and employee empowerment greatly influence business performance. Matzler and Renzl (2007) pointed out that the intangible assets of the organisation are all in the skills of the employees, the future of the organisation will depend a lot on the employees as well as the customer's perception. Research by Koys (2003) also confirms these views. Long-term employees will help reduce recruitment and training costs, which is a prerequisite for increasing financial efficiency for businesses (Chi and Gursoy, 2009).

2.3 Industry 4.0 Technology

Industry 4.0 technology: In "The Fourth Industrial Revolution" by Klaus Schwab (2016), technology 4.0 includes business processes and production network organisation on the basis of information, communication and internet technology.

Industry 4.0 can change the existing technology, open up possibilities for a new global industry and be the development standard of the global economic system (Popkova, Ragulina and Bogoviz, 2019). Slusarczyk et al. (2020) also suggested that businesses need to plan for digital transformation. Industry 4.0 practice barriers are significantly different across contrasting economies, which makes business performance is also affected to varying degrees (Haseeb et al., 2019). Elements of the 4.0 technology revolution such as Big data and IoT actively promote information technology, contributing to sustainable business performance. Although there have been many studies about the importance of 4.0 technology to business results, the moderating role of the relationship between QM and business performance has not been mentioned. Technology 4.0 in Jayashree, Reza and Mohiuddin (2021) have shown that it is effective and meaningful for research. Therefore, in this study, the authors chose 4.0 technology as a moderating effect to clarify the relationship between QM and business performance. Hypothesis H9 is proposed:

H9: Industry 4.0 has positive impact on business performance.

And hypothesis H9a is also proposed:

H9a: Industry 4.0 moderates positively the relationship between quality management and business performance.

2.4 Conceptual Model

Studies related to the influence of QM on business performance in the world have been analysed from many different points of view, fields or research methods (Benavides-Velasco, Quintana-García and Marchante-Lara, 2014; Fotopoulos and Psomas, 2009; Xu et al., 2020). After literature review, we propose the following model below.

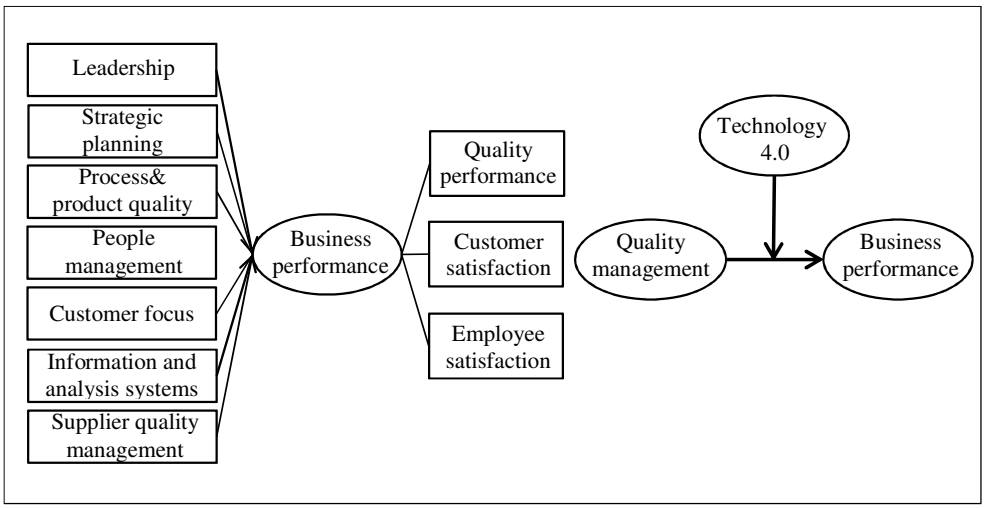

Figure 1 – The Proposed Model

3 METHODOLOGY

3.1 Qualitative Method

The authors interview three quality and production experts and one senior executives who have worked in a manufacturing environment to review draft questionnaire. They'll be the ones to determine whether the scale being utilised is appropriate and offer comments or advice. After process, we have final questionnaire to collect data for quantitative method.

3.2 Quantitative Method

According to Handi et al. (2018), to measure opinions, attitudes, and perceptions of a person about an opinion, a Likert scale is suitable to be used. Therefore, we design a questionnaire with Likert scale consists of a range from 1 to 5 levels: totally disagree, disagree, normal, agree, and totally agree.

According to Cochran (1977), there are two sampling methods: probability sampling and non-probability sampling. In this research, the authors chose non-probability sampling. The research is to survey the subjects who are employees of the QM department and production department of manufacturing firms.

According to Handi et al. (2018), the validity test is used to measure whether or not a questionnaire is valid. A questionnaire is valid if the questions or statements can be used to measure something that is relevant to the questionnaire. This research used the multivariate data analysis technique PLS-SEM using SmartPLS software. Through the evaluation of three measurement models: formative measurement model, reflective measurement model, and structural model, by using measurement indicators.

According to Hair et al. (2016), an indicator is valid if it has an outer load index ≥ 0.7. By testing reliability based on Average Variance Extracted index ($AVE \geq 0.5$), Composite Reliability index ($0.7 \leq CR \leq 0.9$), multicollinearity based on Variance Inflation Factor index ($VIF \leq 5$), individual accuracy based on Heterotrait-Monotrait Ratio ($HTMT \leq 0.85$). Furthermore, the bootstrapping analysis technique is appropriate for testing the observed variables in the research model. In particular, the p-value regression weights are used to test whether the hypotheses are accepted or not. From there, check which direction the variables impact by using the Original Sample index.

Finally, based on the Moderating Effect technique, the authors test the impact of the moderator on the relationship of QM to business performance by hypothesising H9a.

4 RESULT

The survey was conducted from June 28, 2021 to August 3, 2021 with 84 respondents who are considered to have appropriately completed the survey. Based on manufacturing, there were 67.86% of respondents working at enterprises that manufacture equipment, machines and components; 32.14% were working at an agrochemical company. Based on position, 83.33% were employees; 8.33% were managers; 3.57% were department heads and 3.57% were deputy department heads. The department can be divided into two parts: 55.95% of the production department and a 44.05% quality department. Based on experience, there are 40.48% under 3 years, between 3 to under 5 years and over 5 years are equal with 29.76%.

Table 1 – Measurement Value Test

No	Variable	Indicator	Variance Inflation Factor (VIF)	p-value	Variable
1	Quality performance	QP	4.013	0.045	Valid
2	Customer satisfaction	CS	2.139	0.035	Valid
3	Employee satisfaction	ES	3.261	0.690	Invalid

Based on Table 1, both quality performance (QP) and customer satisfaction (CS) have valid results, because they meet the statistical significance criteria (p-value ≤ 0.05) and are not multicollinearity (VIF ≤ 5). This demonstrates that, despite the fact that they are non–financial measures, they all contribute to improved financial performance and are measuring business performance. Employee satisfaction (ES), on the other hand, has a p-value of $0.690 > 0.05$, indicating that it is ineligible for use in measuring business performance and is thus removed from the model.

Table 2 – Validity and Reliability Test

No	Variable	Indicator	Validity	AVE	CR	Reliability
1	Leadership	LD	Valid	0.615	0.827	Reliable
2	Strategic planning	SP	Valid	0.724	0.887	Reliable
3	Processes and products QM	PQ	Valid	0.750	0.899	Reliable
4	People management	PM	Valid	0.673	0.891	Reliable
5	Customer focus	CF	Valid	0.710	0.879	Reliable
6	Information and analysis systems	IS	Valid	0.745	0.836	Reliable
7	Supplier QM	SQ	Valid	0.773	0.872	Reliable

Based on Table 2, all variables are shown to be valid and reliable because they meet the CR and AVE indexes are fit or good. All factors are consistent in terms of internal consistency reliability ($0.7 \leq CR \leq 0.9$), convergence accuracy ($AVE \geq 0.5$).

Table 3 – Model Fit Test

Goodness of Fit Index	Cut-off Value	Result	Evaluation
VIF	≤ 5	From 1 to 1.038	Fit
R square adjusted	Expected big	0.677 (67.7%)	Fit
Heterotrait – Monotrait Ratio (HTMT)	≤ 0.85	max 0.842	Fit
Bootstrap	≤ 1	From 0.033 to 0.988	Fit

Table 3 shows that all of the indexes in the Model fit Test are fit or good. The Variance Inflation Factor (VIF) result ranges from 1 to 1.038, which is less than 5. It can be concluded that there is no multicollinearity between the variables in the model. Other criteria such as R square adjusted, individual accuracy (HTMT) and Bootstrap are also implemented and passed prior to hypothesis testing.

The next analytic step is looking at p-value on the output of regression weights based on the level of significance set to 0.05 (5%) to test the statistical significance of the factors for business performance. If the p-value ≤ 0.05, then the hypothesis is accepted and significant. The Original Sample coefficient will indicate the direction of the effect of this relationship if it is greater than 0.

Table 4 – Hypothesis Test

Hypothesis	Effect	Original Sample	p-values	Result
H1	LD → BP	0.729	0.000	Accepted
H2	SP → BP	0.686	0.083	Not accepted
H3	PQ → BP	0.461	0.461	Not accepted
H4	PM → BP	0.761	0.000	Accepted
H5	CF → BP	0.674	0.000	Accepted
H6	IS →BP	0.674	0.000	Accepted
H7	SQ → BP	0.674	0.058	Not accepted
H9a	I4.0 moderator → BP	0.167	0.042	Accepted
H9	I4.0 → BP	0.286	0.022	Accepted
H8	QM → BP	0.461	0.000	Accepted

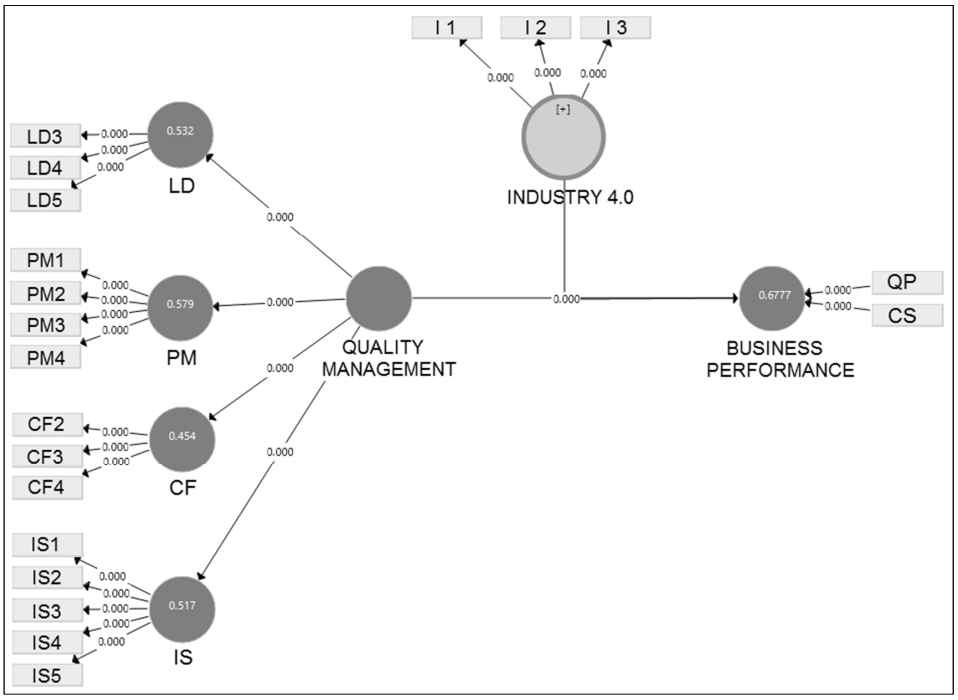

Figure 2 – The Proposed Model

The suty show that leadership has a positive effect on performance. The majority of respondents' positions were employees, who are the creators of work productivity and they often had to work directly with leaders. Therefore, their job is directly affected by leadership decisions or actions. Business performance will almost certainly improve if leaders concentrate on the importance of quality in the execution of work.

The research also proves that people management has a positive effect on performance. The human element is present in all organisational activities. Given that the majority of respondents have less than three years of work experience, there is a significant need for training and willingness to participate in projects and hone teamwork skills. So, people management is responsible for maximising human potential and thus improving business performance.

Customer focus, according to the findings, has a positive effect on performance. The survey is for those who work in the manufacturing and quality control departments. These are departments that work with regular customers. Therefore, they understand that the company's profitability is determined by its customers. The more satisfied customers are with products or services, the more productive the company becomes.

The result also indicates that information and analysis systems have a positive effect on performance. People who participate in the survey work in manufacturing firms; therefore, they must be ready to adapt rapidly to changing

client demands at all times. Information and analysis systems can help with product design, processes, and data for production. Rapidly deploying information and analysis systems will aid in increasing labour productivity and business performance.

The result of moderator effect show that p-value < 0.05, relationships have an effect on each other, so the hypothesis H9a is accepted, the relationship between QM and business performance is affected by industry 4.0. The Original Sample > 0 shows that industry 4.0 has the function of moderating the relationship between QM and business performance in a positive direction. So, incorporating industry 4.0 into a business's operations is a wise decision.

The p-value of the relationship between industry 4.0 and business performance is positive, indicating that industry 4.0 influences business performance. Industry 4.0 has a beneficial impact on business success, according to the Original Sample regression coefficient. Businesses will be able to improve their efficiency by incorporating Technology 4.0 into their manufacturing and commercial activities.

Quality management has a significant impact on business performance based on the p-value and Original Sample index. It is clear that the better QM is implemented, the better the business performance will be. As a result, QM is critical in the enterprise's production activities.

5 CONCLUSION AND LIMITATIONS

The analysis results of the structural model show that there are four independent variables affecting business performance: leadership, people management, customer focus, information and analysis systems. Therefore, businesses need to focus more on these four factors if they want to increase business efficiency. These variables affect the right direction. If the manufacturing enterprise does not have a clear action direction, improve employee engagement, effectively use analysis, and focus on customer's demand, it will negatively impact the company's business performance. Research also shows that industry 4.0 has a moderating effect on the relationship between QM and business performance. Effective application of industry 4.0 in enterprises not only helps in strict and accurate QM, but also improves business results in many aspects.

Although the study has some contributions, however, it has some limitations. Firstly, only a small number of respondents from developing countries took part in the survey. As a result, the sample size might not be representative of the entire globe. Secondly, the study did not take into account other TQM variables that impact business performance, such as devices, quality procedures and tools, data quality, etc., nor did it examine all of the criteria that measure business performance, such as social performance, green performance.

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CONFLICTS OF INTEREST

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