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Contents

Workplace engagement as a competence for future engineers

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Abstract

This study examines the work engagement of future engineers. Work engagement used to describe the extent to which employees are involved with, committed to, enthusiastic, and passionate about their work, consequently, the degree of commitment can be a predictor of efficiency and stability of workforce retention for the workplace manager. Employee engagement has become so important in a virtual and global environment. Employee engagement is imperative for the organizations. This emotional commitment is the engagement of employees about their actual interest in their business and their companies. They do not work for money alone or for future promotion, but they work for the foundation's goals. When employees are concerned, when they are committed, they use discretionary efforts.

This research provides a review of the literature on employee engagement from different academic and business sources. Based on the different reviews and why it is an important and a current concept, its different types and varieties.

Keywords

engagement, competence, management of engineering

1. Introduction

The degree of commitment of a highly skilled workforce to the workplace can greatly affect performance. This is no different for engineers, however, we also know that they learn much less about management and managerial practices during their studies. In addition, generation differences must be considered by a leader. In this study, we point out the importance of workplace commitment and its value. In addition to categorizing the extensive literature theories and seed statements, we also show the results of empirical researches. After listing the different approaches (engagement/commitment), we pay special attention to middle (frontline) management responsibility, the role that plays in the direct relationship between boss and employee. Later, we intend to examine the commitment of engineers through an empirical survey.

Employee engagement has become so important in a virtual and global environment. Employee engagement is imperative for the organization because it works in virtual teams around the world: virtual nature is partial due to flexible work practices. While flexible work practices are positive for many employees and reduce utility costs for the organization, this flexibility is accompanied by some negatives such as loneliness, loneliness and increased personal distractions. Isolation, especially if coupled with demands for employment in an increasingly competitive environment, can break the sense of engagement, commitment and enthusiasm to work for the organization. This is a strong challenge for managers of the virtual teams of staff interdependence. (Harter et al., 2002)

When people are engaged in their work and feel a deep connection to it, they deliver passionate performance. In turn, passionate performance creates satisfied customers, and ultimately, value for the organization. You can both feel the enthusiasm and see the results. Engaged employees are more likely to stay with the organization, perform at high levels, influence others to perform well, deliver exceptional customer service, and promote the organization externally.

Disengaged employees may be frustrated, unfocused, and disconnected. Performance and productivity are subpar, customers are dissatisfied, and business results ultimately suffer.

Engagement exists when an employee experiences the following:

- Rational Commitment to the organization – The extent to which employees believe that staying with their organizations is in their best interest.
- Emotional Commitment to the organization – The extent to which employees' value, enjoy and believe in their organizations.
- Discretionary Effort – The extent to which employees are willing to go "above and beyond" the call of duty.
- Intent to Stay – The extent to which employees desire to stay with the organization. (Human Resources Executive Council)

According to the book, *First, Break All the Rules*, fewer than one in every five workers is actively engaged in their work. (Buckingham and Coffman, 1999) This low rate of engagement has continued in the past 10 years and represents a global crisis in productivity and worker well-being.

Indeed, engaging employees is one the top five most important challenges for management according to a survey of 656 chief executive officers from countries around the world (Wah, 1999).

Academic researchers and professional organizations are also becoming increasingly interested in employee engagement, in particular for different countries. (Bakker et. al.,2008)

2. Workplace engagement

Definitions of Corporate f Engagement

What is an employee engagement? Employee engagement can be defined as 'a positive attitude held by the employee towards the organisation and its values.

An engaged employee is aware of business context and works with colleagues to improve performance within the job for the benefit of the organisation. The organisation must work to develop and nurture engagement, which requires a two-way relationship between employer and employee.' (Robinson et al., 2002)

The six factors referred to the engagement: Workload, Control, Prize, Community, Equality and Values. (Maslach et al., 2001)

Employee engagement is a workplace approach that leads to the right conditions for all members of the organization to do their best every day, committed to the goals and values of their organization, and motivated to contribute to organizational success while enhancing their sense of well-being. (Macey and Schneider, 2008)

Employee engagement is positive orientation and behaviours that lead to better business outcomes, by guiding and promoting each other. Our employees feel proud and loyal to our organization, as they are supporters and advocates of our organization to customers, users and customers, and spend more miles to complete part of the work. Employee engagement is to extract ideas and knowledge from our employees to improve products and services, and to create a way to work with them. Employee engagement means drawing deeper commitment from our employees, fewer days off, less sick leave, reduced accident rates, reduced conflicts and complaints, and increased productivity. The engagement of staff on the work of the organization that is consistent with the values of the organization, that is, the fulfilment of promises or an explanation of why they have not been met. (Gruman and Saks, 2011)

Employee engagement in a way of employee satisfaction, many companies conduct a staff satisfaction survey, and executive managers also report employee satisfaction. He pointed to two very low lines, and the satisfaction of the employee when he worked five to nine hours a day without complaint. But the same satisfied employee may not spend the extra effort alone. You may invite the person who identifies and nominates employees to their posts with a pay-out to attract 10% of the wages. The staff member is not enough (Wang and Hsieh, 2013)

According to McLeod, "This is how to create the conditions in which the employee can provide the best capabilities and capabilities" Employee engagement is based on trust, integrity, commitment, and communication between the organization and its members. An approach that increases business success, contributes to organizational and individual performance, productivity and well-being. Employee engagement can be measured. It varies from low to brilliant. It can also be nurtured and greatly increased and can be lost and wasted. Dealing with the success report (the McLeod report) identifies the results of four common features of high correlation and high performance of the organization. (McLeod, 2014)

Unlike recruitment and recruitment, staff engagement activities can be divided into several groups, including; Communication activities, Reward schemes, Activities to build the culture of the organization, Team building activities, Leadership development activities, Communication activities. This helps staff discover what is happening within the organization. It also helps to instil

confidence and openness within the organization where it is possible to speak freely. Where the employee's sense of voice helps him to express his dissatisfaction with some things and drives them to work together to solve these problems without affecting their performance. (Kompaso and Sridevi, 2014)

Happiness, someone may be happy in a coin, but that does not necessarily mean that he is working hard or profitable for the organization. While the pleasure lies in the company's creation of video game rooms, a free massage venue, games on Friday. This can be useful for other reasons. Making employees happy is quite different from making them engaged (MacPherson and Oehler, 2016)

Employee engagement cannot be achieved through an automated approach that tries to extract the estimated effort by manipulating the employee's emotions and obligations. The employee sees through these attempts very quickly and can become malicious and disappointing. Employee engagement strategy helps to create a collective spirit within the work environment and not just among the workforce. When employees are positively and effectively associated with the organization, they are emotionally connected to the company. This emotional attachment affects their behaviour towards both co-workers and corporate clients and enhances customer satisfaction and service levels. Each organization has a set of practices for improving staff engagement levels. Failure is one of the risks of employee engagement programs, whether it is a real or perceived failure to follow the employee's sense of the organization. If your organization wants to succeed, as many approaches should be used as possible. (Saks, 2019)

Importance of Engagement

According to some reports, the lack of employee engagement has intensified in this town. Gallup found in her latest report "Workplaces in the US State" that 70% of workers in the United States are not connected to their work or effectively disengaged from work. While there is controversy over the validity of this claim. We know that job creation leads directly to increased profitability, increased customer rate, and reduced turnover. The question here is not whether we should address staff engagement, but the question is how? (J., 2014)

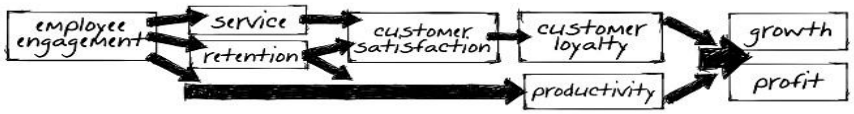

Figure 1. Why is engagement current?

A leader creates points of interaction where a person will choose to go or stay. For example, developing others and providing good performance feedback and coaching is a significant way to recognize someone's importance and engage them. Leaders have a powerful influence to help someone bring all of their talent and energy to the job.

A recent study by the Corporate Leadership Council illustrates the important role that leaders play in employee engagement, moreover, reviewed the performance of over 100 companies worldwide, covering 50,000 employees. In addition to questionnaire application, they conducted in depth interviews with 250 HR and other senior executives to identify what it was that produced high quality performance and high retention of staff.

According to this research, 46 of the top 50 levers necessary to generate high performance through high engagement lie with leaders, not with systems or organizational structure. Every 10% of improvement in the level of employees' engagement produces a 6% improvement in individual effort, which adds 2 percentile points to the level of individual performance. According to research conducted by the CLC in 2004, by increasing employee engagement, organizations can expect to:

- improve performance by 20%
- reduce an employee's probability of departure by
- receive 57% more discretionary effort.

Furthermore, their research showed that engagement results in high performance and high retention. In addition, their findings validated the importance of frontline supervisors to employee engagement. High-performing frontline leaders can improve their direct reports' performance by up to 26%. Frontline leaders' impact is evenly split between direct and indirect performance improvements. Half of frontline leader's impact on employee performance is attributed to direct influences (manager effectiveness) and half is attributed to the leader's ability to change employee attitude and behaviours (change in employee performance).

Emotional factors (such as the extent to which people feel valued and respected) have 5 times more impact than rational factors (such as compensation) on an employee's engagement. Frontline leaders influence hourly employees' attitudes more than behaviours. Frontline leaders can dramatically improve employee attitudes regarding job satisfaction, organizational commitment, intent to stay, and having necessary resources while their impact on employee behaviours is modest (sociability, adaptability, dependability, etc.). Clarity of standards and performance feedback matter most to performance improvement. Of all the development activities on which frontline leaders could focus, those with the highest impact provide employees with clarity around job expectations, modelling expected development and feedback on their performance. (Corporate Leadership Council, 2004)

What to do to have more engagement in the workplace

- **Start from the top** (Walking on foot) is the only effective strategy in any company to enhance employee engagement. Employees should see leadership that indicates the characteristics and behaviours that everyone needs to do. In companies where leaders are a model of behaviour, 55% of employees are more engaged and 53% more focused and more likely to stay in the company.

Be transparent the transparency of management has about 94% of direct f for guidance and assistance rather than locked up in some protected areas. Second,

public recognition of the contributions and achievements of employees. This not only motivates individuals to continue to do great work, but also will motivate their peers. (Sun and Bunchapattanasakda, 2019)

- **Say "Thank you"** It is simple, but often overlooked, especially in large institutions. Thanks, and appreciation by the Foundation and its peers is the fastest way to build trust, restore tense relationships and revitalize the workplace. Employees with a supportive management are 1.3 times more likely to stay in the company, and 67% more committed. (Vance, 2006)
- **Be real and honest** Companies are based on individuals and not on products, machinery, and property. The real relationship between employees, supervisors and management inspires confidence and builds a spirit of friendship. In fact, the Blessing White study found that managers who show their human side were rated at more than 59 points on basic skills among staff.
- **Flexibility** Give employees the freedom to choose their own schedules, or the location that suits their needs. Many employers do not trust the employee's ability to complete the work if he / she does it from home or sets their working hours. Statistically, workers with flexible working hours and more productive locations were happier and more committed. (Rothmann, 2016)
- **Employing personality traits and behaviours** Experience and education do not guarantee performance, even if the most skilled applicants, will fail or fail if they have a weak behaviour and orientation. Moreover, some people simply cannot participate in the work. Emphasize that recruitment and promotion will be on the right behaviour and appropriate personality traits appropriate to your culture. Provide skills training. (Macey and Schneider, 2008)
- **Participation and commitment of the first day** The Mountain Melt Worksheets, and seating during PowerPoint Presentation is a proven way of succeeding to eliminate engagement. New employees begin to work with enthusiasm and curiosity, so this momentum should be harnessed by placing them in the right place for work, helping them to get to know their colleagues or associate them with their teachers. Make them adapt to the culture by making the first impression excellent. They will fall in love with your company and their business. (Gruman and Saks, 2011)
- **Volunteering together** Doing good is good, and companies that support philanthropy by involving employees and management in volunteer projects see a direct increase in participation, engagement and productivity. Working together to help others shows that the company is not only making money but making a difference all over the world.
- **Play and entertain together** Spending good time together does not just break the routine, but it also encourages creativity and cooperation. The company sponsors the baseball tournament or holds a monthly "dress-up day" where employees can wear the worst sweater or make a crazy and weird hair colour. The administration must also get the work that contributes to authenticity, vision and communication. (J., 2014)

Confidentiality in building employee engagement is no secret. Do you want to know what things make your employees more connected to their tasks? Ask them. You might just be surprised by the solution. Often, you reach the golden rule: work people as you would like to be treated, save your money on assigned

advisors, programs, and develop and make other approaches. Mercy, compassion, mutual respect, and flexibility are nothing. Vance R. J. (2006).

Conclusions

This research based on the engagement of the employees in the workplace allowed us to see the different types of engagement, how it is described in theory and the impact of its reality nowadays, its different practices and the future guideline that company can follow in order to enhance employee's engagement.

In a world that is changing both in terms of the global nature of work and the aging of the workforce (Erickson, 2005), having engaged employees may be a key to competitive advantage. This will be especially true if we can show how the engagement construct produces effects at levels of analysis of concern to management. As with all good things, the challenge of establishing the conditions for state and behavioural employee engagement will be great. Once again, there seems to be no silver bullet. The beauty of this conclusion is that companies that get these conditions right will have accomplished something that competitors will find very difficult to imitate. It is easy to change price and product; it is another thing to create a state and behaviourally engaged workforce.

One of the most powerful factors for engaging an employee is his/her direct supervisor. According to CLC (2004) research, 46 of the top 50 factors necessary to generate high performance through high engagement lie with leaders, not with systems or organizational structure.

Again, according to the researches, here are the supervisory behaviours and activities that have the biggest impact on employee engagement:

- Provide timely, fair and accurate informal feedback
- Encourage innovation and risk-taking
- Emphasize strengths rather than weaknesses
- Set clear standards and expectations
- Engage in, encourage and promote communication
- Know what they do
- Put them where they are strong
- Help them solve problems
- Provide adequate resources
- Minimize frequent changes to projects and assignments

Workplace management needs to make sure that future engineers work as quickly and efficiently as possible at their workplace. After all, a dedicated employee can do wonders - something that is still needed in the 21st century

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Assessing achievements and impacts on water quality of hungarian rural development program

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Abstract

The legal framework requires from Member States in 2019 to report on the Rural Development Plan's achievements towards the objectives of the programme and its contributions. The evaluations should assess the programme´s net contributions in the CAP impact indicator values and answer the evaluation questions according to the Common Monitoring and Evaluation System. One of the impact indicators is the water quality. The assessment requires the use of a counterfactual analysis. The programme effect is the difference in value of the specific outcome for the same unit under the programme area and on the unsupported area.

Keywords

evaluation, rural development plan, impact indicator, water quality

1. Introduction

The legal framework requires from Member States in 2019 to report on the Rural Development Plan's (RDP) achievements towards the objectives of the programme and its contributions to the EU's strategy for smart, sustainable and inclusive growth. This is achieved through the Annual Implementation Reports submitted in 2019. The evaluations should assess the programme´s net contribution to changes in the CAP impact indicator values and answer the evaluation questions. The legal framework and the Common Monitoring and Evaluation System provide the foundation for the evaluation of RDPs, which is

part of the CAP Common Monitoring and Evaluation Framework (CMEF) and includes several guidance documents on the use of common evaluation questions and indicators in the monitoring and evaluation of rural development policy. 13 impact indicators shall be used in the assessment of RDP impacts out of 16 common CAP impact indicators. One of them is the change in water quality.

Programme effects can never be directly observed because of other intervening factors and therefore their assessment requires the use of a counterfactual analysis. The programme effect is the difference in value of the specific outcome for the same unit under the programme area and on the unsupported area.

The impact indicator has three sub-indicators: (1) Gross Nutrient (nitrogen and phosphorus) Balance; (2) Groundwater quality and (3) Surface water quality. It has been examined how these sub-indicators changed in the supported areas compared to all agricultural areas. As an additional indicator we also examined how water quality protection measures contributed to improve the status of water quality in critical areas (those surface and groundwater bodies which are not in good status) in accordance with the EU Water Framework Directive.

2. Material and methods

For the 2014-2020 programming period, three groups of common evaluation questions for rural development are designed:(1) Focus area-related evaluation questions; (2) Evaluation questions related to other aspects of the RDP; (3) Evaluation questions related to EU level objectives.

Focus area-related evaluation questions are linked to the objectives of the focus areas of rural development priorities. Focus area-related evaluation questions capture the contribution of the interventions under the respective focus area (set of measures and sub/measures) in terms of programme results. Hence, the assessment is conducted on the basis of common target and complementary result indicators.

Among the six priorities of the RDP, Priority 4 aims to restore, preserve and enhance the condition of agricultural and forestry-related ecosystems. The Rural Development Program, taking into account the water management problems and objectives set out in the River Basin Management Plan (RBMP), addresses the improvement of water quality as a separate focus area ("4B. Improving water management, including fertiliser and pesticide management").

The following table summarizes the evaluation question related to the improvement of water quality and the related result and impact indicators.

Setting out the common CAP impact indicators is a challenging task and raises several questions: how can changes observed in rural areas attributed to the RDP's interventions and which evaluation approaches should be used for this purpose; which data from the existing sources should be used to inform the suggested evaluation approach etc.

Table 1. „Water quality" Evaluation Question for Rural Development

Rd priority	4. Restoring, preserving and enhancing ecosystems related to agriculture and forestry
Focus area	4B. Improving water management, including fertiliser and pesticide management
Focus area-related evaluation question	9. To what extent have RDP interventions supported the improvement of water management, including fertilizer and pesticide management?
Judgement criteria	Water quality has improved (I.11. Water quality). The fiche makes explicit reference to two sub-indicators: I.11-1 Gross Nutrient Balance (GNB) that is measured by: – Gross Nitrogen Balance (GNB-N), or the potential surplus of nitrogen on agricultural land (Gross Nitrogen Surplus); and – Gross Phosphorus Balance (GNB-P), or the potential surplus of phosphorus on agricultural land (Gross Phosphorus Surplus). I.11-2 Nitrates in freshwater measured by: – Groundwater quality as the percentage of monitoring sites in 3 water quality classes; and – Surface water quality as the percentage of monitoring sites in 3 water quality classes.
Common rd indicators	% of agricultural land under management contracts to improve water management (FA 4B – Result indicator)
Additional information	Additional information on water quality of the land under management contracts

The method of counterfactual analysis is to compare concrete results achieved (eg. gross value added or labour productivity) for the same unit with the programme and without the programme. The analysis should be based on comparisons between the control groups of programme beneficiaries and non-beneficiaries, being as similar as possible (in observable and unobservable dimensions). If the two groups are sufficiently statistically similar (they have similar characteristics), then it can be assumed that any difference in outcomes is due to the intervention of the programme. The counterfactual layer is applicable for both micro and macro level assessments and it is up to the programme evaluator to decide at which level (micro/macro) the analysis of programme

effects is carried out. This decision will depend on the available data and precede the choice of the unit of analysis for which the data is collected. The unit of analysis at micro level could be farms, parcels, communities or regions whereas at macro level it could be a catchment, a regional unit or the whole RDP territory.

Evaluation questions (EQs) are important elements of the common monitoring and evaluation system for rural development. Namely, they define the focus of evaluations in relation with policy objectives and help to demonstrate the progress, impact, achievements, effectiveness, efficiency and relevance of rural development policy.

The objectives of water management are supported by the following operations of the Rural Development Program:

- Non-productive water protection investments: development of facilities and development of wetlands
- Habitat development investments
- Investments in forest area development and improvement of the viability of forests: support for afforestation, establishment of agro-forestry systems, investments improving the resilience and environmental value as well as the mitigation potential of forest ecosystems
- Forest-environmental measures
- Support for agri-environmental management
- Converting to organic farming, or maintaining organic farming
- Compensation payments for Natura 2000 agricultural and forest areas
- Compensation payments in areas facing natural and other specific constraints
- Modernization of livestock farms, dissemination of good practices in manure storage and disposal
- Modernization of individual waste water disposal for settlements with populations below 2000.

Examination of the effectiveness of VP water quality improvement measures (evaluation of result indicators)

With the help of GIS analysis we investigated the following two questions:

- To what extent are water protection measures found in areas critical in terms of water quality (based on surface water and groundwater bodies that are not in good water quality status in the National River Basin Management Plan)? - the appropriateness of the territorial distribution of supported areas
- On how large part of the areas critical in terms of water quality protection have water quality protection measures been applied? - an examination of the quantitative relevance of the supported areas

Method for analysing nutrient balances

Nutrient balances were calculated from data of the farm field register book of the supported areas for the years 2016-2018, at the agricultural field level, with the coefficients used by the Hungarian Central Statistical Office (HCSO), based on the methodology recommended by the OECD. The N and P nutrient balances of the supported areas were compared with the 2016-

2018 data of the unsupported control group. This group consists of farms that did not receive AES support, their data came from the official data collection of the HCSO. For the purpose of comparability with farm field register book's data, nutrient balances were calculated using the same soil-budget method and the data were extended to the same area. After filtering and correcting a total of 565,765 records of farm field register books received in 2016-2018, crop area-weighted ΔN (kgN /ha) and ΔP (kgP/ha) nutrient balances were calculated for each supported areas based on data of farm field register books. The nutrient balance data were compared with the previous years (2010-2014) to show the changes over the time.

Methodology for assessing changes in groundwater quality

The water quality monitoring network alone is not suitable to detect the impact on groundwater quality due to delayed effects and lack of territorial representativeness. Therefore, the impact of the measures was assessed by comparing the nitrate contamination of generally representative groundwater and springs with data can be estimated in the supported areas. The control value was the contamination rate determined for each agricultural body on the basis of the water quality monitoring network (2010-2017 period). For the supported areas we can determine the proportion of contamination expected in the long run. We estimate the expected nitrate concentration of groundwater infiltration for each supported field from a nitrogen balance calculated on the bases of farm field register books. We used a simple empirical model by estimating the expected nitrate concentration of groundwater infiltration for each supported agricultural field with data of nitrogen balance (calculated from the farm field register books). Subsequently, the proportions of agricultural fields above 25 and 50 mg/l concentrations were also determined for each water body. Assuming similar management in the future, the estimation approximates the contamination rates expected in the long run.

For the assessment of the indicator of the nitrate contamination in groundwater, the proportion of wells above 50 mg/l concentration determined for shallow and karstic water bodies (112 water bodies) was available in the second national River Basin Management Plan (RBMP2). (The proportion of wells above 25 mg/l concentration is not reported in RBMP2, therefore, it could not be reliably determined on the basis of the available data. There were a total of 400,000 annual balances available for the calculations for 3 years (2016, 2017, 2018). Significant N-surpluses relevant to groundwater contamination were checked and we have filtered out those data resulting from incorrect completion of the farm field register books. We also excluded from the analysis those data that could not be identified in the MEPAR (IIER) GIS system. Data for the same agricultural fields were combined. As a result of processing / filtering, we were able to evaluate the expected impact on groundwater quality in case of 117,000 fields. Concentrations in excess of 25 and 50 mg / l were also estimated for the supported areas.

Methodology for the assessment of changes in surface water quality
Because of the different rates of supported areas in a river basin, for the first step of the analysis representative river basins had to be selected. In Hungary, a total of 1078 surface water bodies have been designated on the basis of the Water Framework Directive's (WFD) requirements, of which 889 are watercourse water bodies, which can be characterized by the associated catchment area. For these areas, we have determined the size of all areas (SAPS) and of the supported land areas by Agri-Environment Scheme (AES) and their geographical proportions using GIS. The water bodies with a transboundary catchment area were excluded from the assessment. Only the water bodies whose entire catchment area is geographically within our borders have been considered. The AES/SAPS ratio on average is 12% and ranges from 0 to 99%. A representative territorial share was defined as a minimum territorial share of 25% (11% of water bodies). A further selection during the evaluation was the exclusion of water bodies with significant pressurized municipal or industrial sewerage, hiding the water quality differences. Finally, the processing of the Water Quality Database provided further narrowing, as the lack of perceptual data sets led to a reduction in the number of statistically evaluable water bodies and river basins. Data processing was carried out for the period 2016-2019. From the analyzed parameters the basic statistics were calculated for the sum of the 3 inorganic nitrogen forms (total mineral nitrogen) and total phosphorus, because the WFD river water quality definition defines water quality limit values for these substances.

3. Results and assessment

Based on the analysis, the answers to the evaluation questions can be summarized as follows:

Contribution of water quality protection measures to the improvement of critical areas in terms of water quality
About 51% of the agricultural (SAPS) area of 1078 surface water bodies catchment area is considered to be a source of significant diffuse pressures. The total area of operations supported by area-based measures with a positive impact on water protection (AES, Organic farming, Natura 2000, areas with natural constraints) covers 38.5% of these areas. However, it can also be said that about 40.8% of these measures are located in the source area causing significant diffuse loads.

In the case of groundwater, surface water bodies that are in contact with the surface (shallow porous, shallow mountainous and karstic and mountain water bodies) have a poor status or are at risk of developing poor status in about 57% of the country's territory. In 2018, 10.9% of these areas had some type of area-based measure having a positive impact on water protection (AES, Organic Farming, Natura 2000, areas with natural handicaps) and 58.3% of the supported

operations under these measures were located in groundwater bodies identified as being at risk.

Changes in N and P nutrient balances

By law, farmers in supported areas are required to follow Good Farming Practice, setting the maximum amount of N ingredient to be released per hectare. It is expected that the amount of high nitrogen nutrient surpluses (ΔN> 50 kgN / ha), which is a significant N contamination risk, should be reduced in supported areas. The crop area-weighted average values of ΔN (kgN / ha) calculated on the basis of farm field register books for the supported areas show a decrease compared to the average of 2010-2014.

Table 2. Changes in N and P nutrient balances in the supported and control area

Period	Supported area		Control area	
	ΔN	ΔP	ΔN	ΔP
2016-2018	+10,5 kgN/ha	-5,3 kgP/ha	+4,0 kgN/ha	= -1,0 kgP/ha
2010-2014	+20,9 kgN/ha	-5,1 kgP/ha		

This is due to the reduction in the proportion of agricultural fields with N-nutrient balance more than 50 kgN/ha from 16.4% to the current 11.5% in the total supported agricultural area. The decrease is even more pronounced in cropland: from 25.5% to 17.2%, which supports the hypothesis of a decrease in high N surplus areas. The ratio of very negative N nutrient balance fields threatened by soil degradation is very high (47.4%), showing no significant change compared to the average value in 2010-2014 (42.3%). Thus, almost half of the supported areas remove more nitrogen from the cropland than they replace.

The nutrient balance of phosphorus does not change compared to the average value of 2010-2014. Persistently low P nutrient balances indicate a potential risk of soil degradation. However, the risk of P contamination of groundwater would not be high even with positive ΔP, as most phosphorus is bound in the soil, which is indicated by the virtually zero P content of the groundwater, at water quality monitoring points.

The differences of the average values for the control group from the farm field register book-based average balance is not significant due to uncertainty caused by the high standard deviation.

The impact of the measures on groundwater quality

In supported areas, the proportion of contamination above 25 mg/l nationwide is 11.2%, of which 9.7% is the proportion of fields exceeding the 50 mg/l threshold. The national value for RBMP2 at 50 mg/l is 14%, so the difference is -4%. The difference is small.

According to the RBMP criterion, water bodies with more than 20% contamination do not meet the "good status" criterion. This applies to all areas and all sources of contamination, but it is worth looking at how this critical value develops in terms of agricultural areas. According to RBMP2 data, 22 such bodies of water were found (20%, although 9 were identified on the basis of limited data). These areas are mostly found in the Great Plain and especially in Transdanubia, where the contamination rate in many water bodies is more than 30% (and sometimes 50%). The number of water bodies exceeding 20% however is only 10 (9%), the difference is -11%. In the long run such an improvement would be expected in the status of groundwater bodies.

For grasslands, RBMP2 had a national contamination rate of 7.7% (which is not significant), while the nitrogen surplus that would result contamination in groundwater has been negligible in the case of the approximately 40.000 supported grassland and pasture fields.

The impact of measures on surface water quality

Data analysis yielded the following numerical results: average of N concentrations were 2.39 mg/l and median 1.65 mg/l (N = 51 pcs.) on representative water basins based on the application of AES programs. In the water basins of representing the control area the average was 3.11 mg/l and the median of 2.18 mg/l (N = 368 pcs.). The average of total P in AES water basin plots was 0.36 mg/l, median 0.21 mg / l (N = 42 pcs), in the control areas the total P was 0.35 mg/l, median 0.25 mg / l (N = 262 pcs). In both groups, the standard deviation is high, ie. significantly different concentrations (significantly polluted waters) were also found. The status of waters can be characterized by belonging to the categories used in the WFD classification. According to the nitrogen content, 71% of the water bodies in AES water basin plots reach the WFD target (excellent or good status), 19% moderate and 10% poor and bad status. In the control areas, these ratios are 68%, 14% and 18%. The result of classification for the phosphorus concentration rating in AES water basin plots is 53% excellent-good, 33% moderate and 14% poor-bad. In the control areas, these ratios were in this order: 42%, 36%, and 22%.

Based on the analysis it can be stated that the nitrate, nitrite and ammonium content of the water of the catchment areas representing AES support areas is slightly lower, but there is no significant difference between the phosphorus concentrations in the two groups. According to the nutrient criterion of the WFD, the status of watercourses is proportionally better than in the control areas. However, the difference cannot be considered significant due to the high standard deviation of the data and the statistical uncertainty resulting from the different number of data (in the control areas, extreme, highly contaminated water bodies occur at higher rates, where local sources of contamination are likely to cause extremely high concentrations of nutrients, which values distort statistical parameters).

Conclusions

It is an important result that several rural development proposals in the RBMP have been integrated into the Rural Development Plan, but further efforts are needed to promote positive impacts on water quality. The shortcomings are mainly due to the fact that the aspects of water quality protection are not always properly emphasized in the evaluation criteria of tenders, but mainly the poor status of the water bodies as a priority is missing in the calls for proposals which could further increase the positive effect of the RBMP. In addition to enforce the objectives and priorities of water protection in area-based tenders, it is important to apply the water management aspects in training and advisory services in order to increase the efficiency of implementation. For invitations to tender where appropriate, ex post harmonization should be carried out.

The assessment of the distribution of nutrient balances has shown that there are relatively many outstanding negative values of ΔN and ΔP, where the amount of removed nutrients are higher than that of the replaced ones. It would be necessary to increase the spread of organic manure and fertilizers on these fields in order to prevent further soil degradation. At the same time, there is still a large proportion of fields potentially causing groundwater contamination with potential nutrient surplus of ΔN> 50 kgN / ha. These fields should reduce N nutrient application. The supports should be focused on promoting the good practice of optimal nutritional supplementation. With the involvement of the stakeholders (National Food Chain Safety Office, CSO etc.) the standardization of data collection, the extension of data collection with new data (including pesticide use) and the creation of a mega-database will be necessary in the future.

The comparative assessment between the control (reference) river basins and the spot of the water basins representative of the supported areas confirms that the measures have a small positive impact on the quality of surface waters. The difference between the supported and the control areas is more pronounced for the inorganic nitrogen forms (ammonium, nitrite and nitrate) than for the differences in the phosphorus concentrations. Experience has shown that prescriptions that focus primarily on nutrient application do not adequately help to reduce phosphorus load (especially considering negative ΔP balances). Measures affecting the sources of phosphorus and, more particularly, the spread of pollution should be given greater emphasis and priority in subsidies. Measures to mitigate erosion and to establish plant protection zones (field border and river buffer zones) should be significantly increased.

The analysis of groundwater nitrate pollution shows that nutrient management in supported areas contributes to the improvement of water quality. Currently, only about 50-60% of the measures fall on water bodies with poor water quality status, but as this roughly corresponds with the area proportion of bodies of poor status, the relationship may be random. For approximately only 10% of the areas affected by the measures belongs to water body on poor status. During the practical implementation of the RDP, territorial specificities need to be more

effectively enforced. Nitrate contamination of groundwater under different management conditions can only be investigated with very thorough monitoring system or modelling extended to unsupported control areas. Instead of large-scaled (unrealistic) monitoring development and taking into account the slow progress of the effect, the targeted, regularly repeated, "expeditionary" surveys based on model area principle may be the solution.

Acknowledgements

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Design and experimental investigation of parabolic trough solar collector

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Abstract

The parabolic trough solar collector (PTSC) is mainly used for power generation. In this case, the system is used to produce hot water. The most important data (solar radiation, mass flow rate, temperature of the inlet and outlet of the collector) were measured, and energetic values (thermal power, efficiency) were determined. Copper and stainless-steel tube and glass cover tube was used with different diameter. The performance of PTSC system with glass covered copper receiver tube applied four ranges of mass flow rate. The best results obtained when glass covered copper tube was used as absorber and mass flow rate was (0.0036)kg/s.

Keywords

parabolic though solar collector, development, solar energy, control measurements

1. Introduction

The sun emits the Solar radiation in all the space that appear in the electromagnetic waves and the energy is carried at the light's speed. The solar radiation is reflected, diffused or absorbed by solid particles and especially by the earth surface which depends on many factors such as climate, weather and agriculture as well as the earth geometry. Depending on the geometry of the earth, its distance from the sun, the location of geographical features in any point at the earth, the astronomical coordinates, the atmosphere composition. In addition the solar radiation is absorbed by the atmosphere and it is partly reflected back to space (J. A. Duffie and W. A. Beckman, 2013).

The diameter of the sun is $R = 1.39 \times 10^6$ km. The sun is generates energy and emits it to the space. It is estimated that 90% of the energy is generated in the region between 0 and 0.23R, which contains 40% of the sun's mass. The core

temperature varies between 8×10^6 K and 40×10^6 K and the density is estimated at about 100 times that of water. At a distance 0.7R from the center the temperature drops to about 130,000K where the density is about 70 kg/m^3 (E. B. Babatunde, 2012).

The Electromagnetic (EM) Spectrum

The sun's radiation is the sum of the electromagnetic waves. The electromagnetic waves (so the solar radiation) carries energy according to the wavelength, if it's longer that mean the energy is lower and vice versa, Because of the energy content of the photons, enormous amount of energy arrives to the Earth every seconds. The average solar potential (yearly) at the different parts of Hungary can be seen in figure 1. (M .Suri. T, 2008).

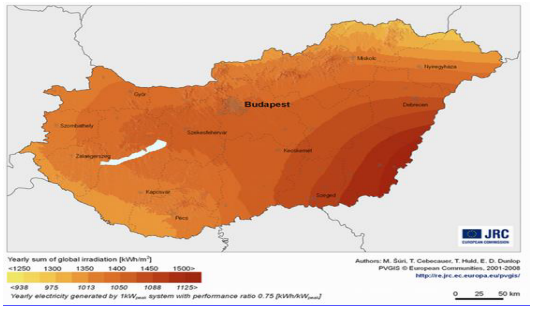

Figure 1. The solar potential distribution in Hungary.

Parabolic trough solar collector

The concentrating of solar thermal systems are classified by their focus as either point- concentrators (parabolic dishes and central receiver systems) or concentrators of line-focus (parabolic trough collectors (PTCs)). PTCs are concentrated solar radiation on focal line for the axis's collector. The collector receives the direct solar radiation from the sun over a big surface and focus.

A fluid flowing inside the tube that absorb the heat energy that is generated from focus solar radiation raises its enthalpy and causes an increase in the temperature of the tube wall. This process does not emit carbon because it does not burn fuel to get the heat PTCs use only in direct solar radiation in the collectors which not deviated by the dust , fumes or clouds (R. Vasquez Padilla, 2011).

2. Xperimental setup-design

A - Design Parameters

The design of parabolic tough collector involves concentrating solar collector. The reflecting surface is formed in a parabolic shape depending on the focus

point. The reflecting surface consists of polished aluminum sheets or polished mirrors. Solar radiations are reflected on the absorber tube held at the line of focus point. Generally, the trough is aligned on the east-west axis or north-south axis, also the sun tracks the required sunlight directly on the surface collector. The fluid passed through the absorber tube and received the thermal energy from the solar radiations , which focused on the receiver tube. The design should be more accurate for better efficiency to increase the thermal efficiency of parabolic collector. The various parameters that have effect on the efficiency of parabolic solar collector such as the material used in the reflector and the material of the receiver tube. Also, mass flow rate , heat removal factor, coefficient of heat transfer and efficiency. The design parameters of parabolic trough solar collector are classified into two parameters. They include the following:

- Geometric Parameters.
- Functional Parameters.

Geometric parameters are width and length of aperture, focal length, rim angle, receiver diameter, glass diameter and the ratio of concentration.

Functional parameters are instantaneous thermal efficiency, overall thermal efficiency, optical efficiency and thermal loss of receiver.

This system has effect on these parameters especially on the absorber tube as well as surface of the reflector material. The receiver location must be exact on the focal point and rotated to track the sun as it moves across the sky each day. Figure 2. shows the parameters.

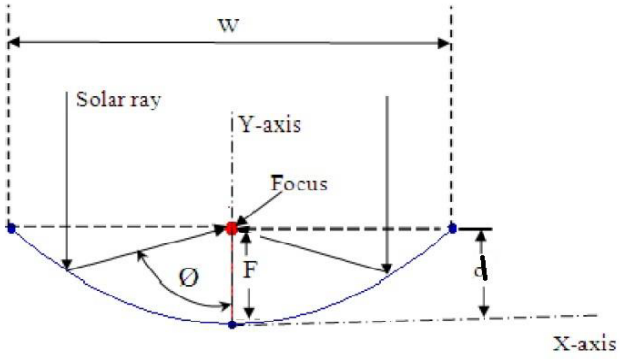

Figure 2. Drawing of Parabolic Trough Solar Collector

B- Design of PTSC system

Software called (PARABOLIC CALCULATOR-2) can be used to design the prototype of parabolic trough solar collector. Moreover, the information is checked by the equation of parabola are shown in Figure 3.

$$X^2=4.a.Y \quad (1)$$

Where ,
X : Distance along horizontal axis .
a : Focal length.
Y : Distance along vertical axis .

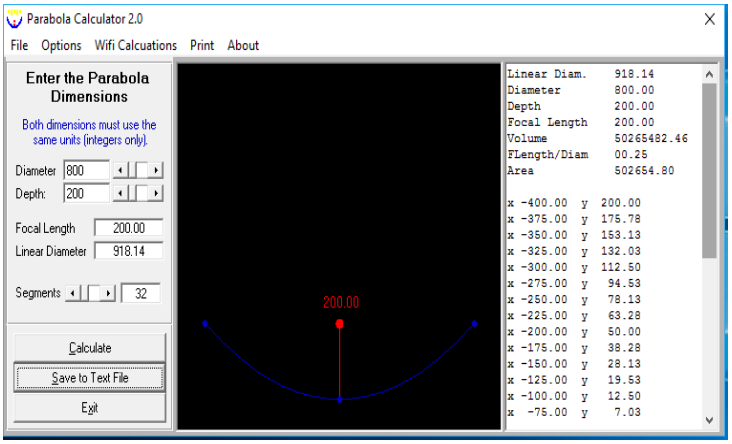

Figure 3. Parabolic Calculator-2 Software

3. Manufacturing of protoype ptsc system

After the completion of the design of parabolic trough solar collector, all the required information data are taken into consideration for best design. The different materials used in the model and important alternatives with quality and less cost. The model must be strong to withstand wind energy, stress that are generated from weight on the structure of model. Moreover, the parabolic trough solar collector must be accurate in dimension to avoid the losses which have effect on the efficiency of the system. The part of the PTSC system are shown in Figure 4.

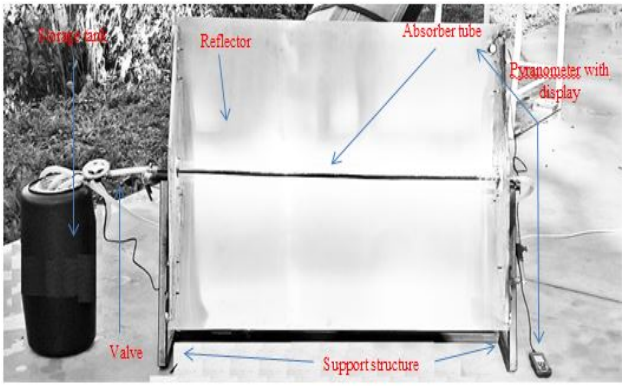

Figure 4. Components of PTSC System.

5. The parabolic trough solar collector after manufacturing

Table 1. shows the overall specifications and dimension of the prototype of the PTCS system .

Table 1. The Overall Specifications of the PTSC System.

Parameters	Specifications	Parameters	Specifications
Collector aperture	1.2 m	Diameter	12 mm , 10 mm
Collector Length	1.2	Absorber Material	Copper and Stainless steel
Aperture area	0.96 m²	Glass tube diameter	58 mm
Rim angle	90º	Working Fluid	Water
Arc Length	0.93 m	flow rate	Four mass flow rate were taken between the range (0.009kg/s to 0.003 kg/s)
Depth	0.2 m	Storage Tank	15 litter
Focal distance	0.2 m	Pump(for water)	10 W
Material of Reflector	Aluminum	Pyranometer	To measure radiation Intensity
Sun Tracker	Single axis	Flow meter	To measure flow rate
Thermocouple sensor	To measure temperature		

The manufacturing of PTSC has various component such as structure, tracking system, reflector absorber tube etc. In this experimental, copper and stainless steel tube. Glass cover tube is used (58mm diameter). The components are as follows:

a) Copper tube .
b) Stainless steel tube .
c) Copper tube with glass cover tube (58 mm) diameter .
d) Stainless steel tube with glass cover tube (58 mm)diameter .

The Thermal Efficiency of The Collector

The thermal efficiency (η) of collector, which is the ratio of the Useful heat gain to the Total input solar energy under steady-state condition can be obtain mathematically. The thermal efficiency of parabolic trough solar collector of hot water is calculated by the equation :

$$\eta_{overall} = \frac{Q_u}{A_a \cdot I} = \frac{\dot{m}cpT_0 - T_i}{A_a \cdot I} \qquad (2)$$

Where :
Q_u - Useful heat gain, [W].
$\dot{m}$ - Mass flow rate of water through the collector, [kgs^{-1}]
cp - Specific heat capacity of water, [$Jkg^{-1}K^{-1}$]
T_0 - Collector water outlet temperature, [K]
T_i - Collector water inlet temperature, [K]
A_a- Collector aperture area, [m^2]
I - Intensity (Beam or direct radiation), [W. m^{-2}].

6. Discussion

The results were compared with different cases of parabolic trough solar collector which used two materials of absorber tube, copper and stainless steel tube Copper material has high thermal conductivity which is considerably better than the thermal conductivity of stainless steel material. Therefore, the temperature difference was higher using copper tube. It can be observed that the performance of collector will increase with glass cover tube. Glass cover tube reduced the heat losses and enhanced the performance of parabolic trough solar collector system by improving the greenhouse effect between the glass and tube.

Conclusion

The parabolic trough solar collector is mainly used for power generation such as steam temperature is gotten from high temperature. The PTSC System can be applied in many applications such as air heating, process steam generation and hot water. in this case, the system is used to produce hot water. The aluminum is used for the reflector surface because of its very high reflectivity. The different absorber tube materials are copper and stainless steel materials. In this present study, various parameters were measured, the absorber tube with and without glass tube, also solar radiation, system efficiency and the temperature was measured at inlet and outlet of receiver tube. The east-west alignment and the system rotating by with the required angle every 1 hour by manual tracking. In addition, the results obtained are, intensity of solar radiation, useful heat gain and thermal efficiency in each case. Execution of the PTSC System was measured on the basis of the recorded parameters.

The best results obtained when glass covered copper tube was used as absorber and mass flow rate was (0.0036 kg/s). So it is the best situation to get the best thermal performance as mentioned

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Degradation and performance evaluation of PV modules in the tropical climate

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Abstract

This paper assesses the rate of degradation of a twelve-year ground mount monocrystalline silicon solar PV module exposed to the tropical climate of the sub Saharan. Visual inspection, current-voltage (I-V) curve characterization and thermal imaging were employed for the assessment. The process of partial shading was applied to determine the state of the bypass diodes. Results show a decrease in short circuit current (I_{sc}) ranging from 7% to 16.4% whiles decrease in open circuit voltage (V_{oc}) was between 11.4% to 17.1%. Decrease in Fill Factor (FF) and maximum power were respectively between 11.3% to 24.2% and 34.5% to 41.4%.

Keywords

photovoltaic modules**,** reliability, translation, visual inspection, degradation rate

1. Introduction

The number of years given as warranty by most manufacturers is 25 years for 80% peak power output of PV modules. These warranties provide for 90% - 95% of peak power output in the first 10 years then after 80% - 87% peak power output until the 25 years. Energy-Sage, (2015) outlines two types of warranties given by manufacturers for PV modules. Performance warranty which guarantees the performance output and equipment warranty for non-failure over the given years.

The lifespan and the reliability of solar modules however, depend on the degradation and failure modes which are controlled by several factors such as, risks incurred during PV module production and transportation, installation and the various issues that arise from climate specific conditions such as solar irradiation and ambient temperature, humidity, wind, water ingress and ultraviolet (UV) intensity (Rahman et al., 2015).

To ensure that PV modules perform reliably over their lifetime, they are taken through rigorous quality qualification test procedures as per the IEC standards.

These tests reveal any design and manufacturing shortfalls which can cause early failure than expected. Accelerated ageing test has also been incorporated and this has led to the improvement in technology and reliability in the last decade. These aforementioned tests however, are incapable of revealing all degradation modes and reliability issues that may exist whiles in real operation with varying climatic influences. Testing for the degradation whiles in operation is meant to ascertain the issues that show forth whiles in real operating conditions (Sharma and Chandel, 2013).

The main mechanisms that lead to performance loss in solar PV cells are observed to be mainly due to corrosion, light induced degradation, decrease in stability of contacts and cracked cells. At the module level the loss in power mechanisms are found to be as a result of losses from individual cells and compounded, also from breakage of glass, delamination, failure of the busbar, front surface discolouration, diode failure, hotspots, loss in inter layer adhesion and broken interconnects (Chamberlin et al., 2011).

A study conducted by NREL shows module degradation rates to reach as high as 4% per year while the average degradation rate is estimated to be a 0.8% per year reduction in power output (Jordan and Kurtz, 2013). Insignificant data is available for tropical climates which has been proven to have the worst impact on PV modules (Jordan et al., 2017). This study assesses the reliability and degradation of performance output of a twelve (12) year ground mount monocrystalline solar PV modules exposed to the tropical climate of the sub Saharan of Ghana.

2. Materials and methods

Description of the site of installation, the system, methods and materials employed for the study is presented in this section. The location of the installation, Koforidua, has a tropical climate. According to Köppen-Geiger climate classification, this climate is classified as 'Aw' which is savanna with dry winter (Peel et al., 2007). The average temperature of the site is 25.9 °C and about 1407 mm of precipitation annually as shown in Fig. 2. The average maximum temperature of the location is 30.58 °C and the average minimum temperature is 24 °C (Climate-data, 2019). The annual average horizontal irradiation for the site is 1,733.75 $kWhm^{-2}$.day with an average value of 4.75 $kWhm^{-2}d$. Monthly irradiation figures of the site ranges from 4.19-5.37 $kWhm^{-2}d$ horizontal global radiation, minimum and maximum wind speed being 2.40 and 4.19 ms^{-1} respectively. Average monthly humidity ranges from 76.5-88.3%.

System description

The off-grid PV system is located at the Energy House of the Renewable Energy Department of the Koforidua Technical University in Ghana. It is installed for demonstration purposes to aid students' practical work and hands-on training. It is situated on the 6.062545 *N*, -0.266001 *W* at an elevation of 173 *m* above sea

level. The ground mounted system was installed in 2007 with the modules fixed on a structure made of aluminium angle bars and bolted onto metal bars as shown in Fig. 1.

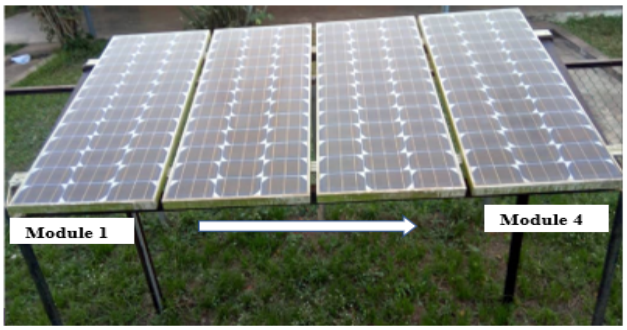


Figure 1. General view of installation

The array consists of four monocrystalline modules with specifications outlined in Table 1. They are certified by CE Europe, TÜV and ESTI. The limited power output guarantee given by the manufacturer is 25 years for 80%.

Table 1. Specification of PV module at STC given by manufacturer

Parameters	Value
Maximum power (P_{max})	50Wp
Short circuit current (I_{sc})	3.16A
Open circuit voltage (Voc)	21.6V
Voltage at Pmax (V_{mp})	17.60V
Current at Pmax (I_{mp})	2.9A
NOCT	43±2°
Power tolerance	±10%

The EKO MP–170 I-V curve plotter was used to obtain the module parameters under the experimental conditions. Current (I_{dc}) accuracy of ± 1% for 0.1-10 *A*, Voltage (V_{dc}) accuracy of ± 1% for 10-1000 V. Solar radiation was measured with a Kimo solarimeter LSL 200 at the level and inclination of the PV modules (resolution *1* Wm^{-2}, accuracy *5%)*. The Voltcraft infrared thermometer *(IR260 – 8S)* with a measuring range of *-30 to 260 ℃ (± 2 ℃)*, resolution and emissivity of *0.1 ℃* and *0.95* respectively was employed in measuring the temperature of the modules. Quantitative analysis of the captured IR images was performed with the aid of the Report Generator Lite software. IR images were obtained using the (NEC Avio H2640) camera having

specifications as follows: temperature range, *−40 to 500 °C,* Spectral range, *8-13 μm*, Emissivity, *0.1-1.00* with accuracy of ± *2% or* ± *2* °C.

Translation of experimental data to STC values

A uniform translation procedure which was developed at the Joint Research Centre (JRC) of the European Commission in Ispra is adopted. This is easily applicable and could be used even when module specific parameters are not known and input parameters are deduced from experimental measurements. Applying this procedure, a translation accuracy of 4% is achieved for one array measurement (IEA-PVPS, 2014). The default values applied which are valid for crystalline silicon modules are: Dimensionless temperature coefficient of I_{sc} (α)= 0.0045, Dimensionless temperature coefficient of V_{oc} (b) =0.06 and Dimensionless irradiance correction factor (a)= 0.06.

These equations (Eqns. 1 to 4) provide a less complex but practicable and accurate procedure of translating the parameters of a PV module in operation without having to determine several constants at certain specific ambient conditions which are not achievable with modules in operation (Quansah et al., 2017).

$$I_{sc,2} = I_{sc,1}\left[1+\beta\left(T_2 - T_1\right)\right]\frac{G_2}{G_1}\ , \tag{1}$$

$$V_{oc,2} = V_{oc,1}\left[1 + aIn\frac{G_2}{G_1} + b\left(T_2 - T_1\right)\right], \tag{2}$$

$$I_2 = I_1\left(\frac{I_{sc,2}}{I_{sc,1}}\right), \tag{3}$$

$$V_2 = V_1 + \left(V_{oc,2} - V_{oc,1}\right) + R_s\left(I_1 - I_2\right)\ . \tag{4}$$

where I_1 *(A)* and V_1 *(V)* are the measured current and voltage, I_2 and V_2 are the pair of the corrected module current and voltage characteristics. G_1 and G_2 *(W/m^2)* are the measured and reference irradiance respectively. $I_{sc,1}$ *(A)* and $V_{oc,1}$ *(V)* are the measured short circuit current and open circuit voltage whilst $I_{sc,2}$ and $V_{oc,2}$ are the corrected short circuit current and open circuit voltage. α is the dimensionless temperature coefficient of short circuit current, b is the dimensionless temperature coefficient of open circuit voltage, a is the dimensionless correction factor for irradiance, with a default value of *0.06*. R_S is the series resistance. The default values are valid for crystalline silicon.

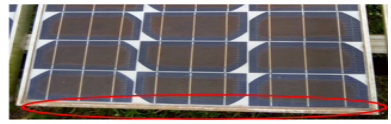
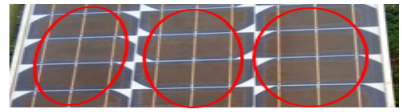
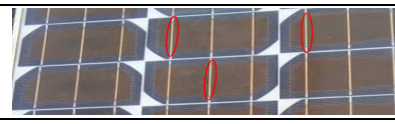
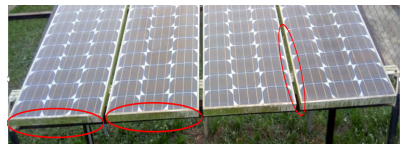
3. Results and discussions

In this section, the results of the various observations and measurements made on the modules are presented, discussed and compared with results in other climatic conditions.

Visual Inspection

The fastest but most effective method for finding defects and failures in solar modules is by visual inspection (Oliveira et al., 2017). The *IEC 61215* and *61646* standards require an illumination of more than *1000 lux* during the visual inspection and are applicable to defects detectable with the bare eye. These standards were adhered to in the visual inspection process of the PV modules by making sure that irradiation levels were close to *1000 W/m*^{2} for the duration of the study. Table 2 shows the results of the visual inspection.

Table 2. Results of visual inspection

PV module component	Observation/remark	Image
Front of PV module	Shows no sign of delamination, or browning. Glass still feels smooth. Except for accumulated dirt in the lower end and the edges.	
PV cells	All cells uncracked and not broken. Each cell shows some level of discoloration of encapsulant (>70%). EVA discoloration was observed in all the modules.	
Cell metallization	Shows no sign of burns or having been oxidized except for browning or coloration of cell interconnects ribbons.	
Module frame	Well intact with no scratches or broken parts and not askew. Some discoloration as a result of accumulation of dirt and water mostly at the bottom half of the module.	
Junction box	Intact and all well closed but rusting observed at portions when opened. This was observed in the junction boxes for all four modules at same spots. This may be due to moisture ingress.	
Junction box	Evidence of bad wiring was observed. (Module wire touching conducting components within the box). This may lead to internal arcing in the box. This was seen for only module 4.	

The IEC 61215 standard of testing for degradation requires only a total irradiation of *15 kWh/m*^{2} of UV energy. With this requirement, modules pass the

test. However, under real operation conditions, some modules have the potential of *5%* or more power degradation and browning of encapsulant material just under UV irradiation of *150 kWh/m²* or more. The yearly average horizontal irradiation for the site is *1,733.75 kWh/m²*. Thus, the high possibility of browning of the modules. Table 5 shows the level of browning or discoloration of EVA covering about 70% of each cell area. EVA browning which is a commonly reported defect is directly proportional to the Ultraviolet (UV) light, leading to transmittance loss hence drop in performance output (Oliveira et al., 2017; Ndiaye et al., 2014).

Bypass diode test

The partial shading procedure was employed to assess the state of the bypass diodes. Modules are partially shaded one at a time whiles tracing the I-V and P-V curves. In cases where the bypass diodes are malfunctioning, there is a decrease in the current flow in the shaded string of cells when they are not protected. However, in the presence of normal functioning diodes, the decrease is transformed to inflection points. It is observed from the output that all modules deviate from the normal I-V curves with a drastic decrease in current to the extent of being negligible or no current in the case of module three (3) whiles voltage remains unaffected. This indicates open circuit performance for the modules. A condition which may be as a result of defective bypass diodes, or soldering disconnection between the bypass diode and the metal contact inside the junction box (IEA-PVPS, 2014).

Temperature measurement

Thermography was applied to determine the operating temperatures of the modules for the period of the study. The expanse of the modules is captured during the process. Results show module 3 had the highest temperature of 59.5°C whiles the lowest temperature of 45.9°C was measured for module 4 during the period. The highest mean temperature of 56.3°C was obtained by module 1 with module 4 recording the least mean temperature of 52.4°C. Modules 2 and 3 recorded average temperatures of 55.3°C and 55.03°C respectively. Module 4 had the biggest temperature dissimilarity of 10.7°C as well as the lowest mean temperature. Module 3, 2 and 1 respectively recorded temperature dissimilarity of 10.0, 6.5 and 4.2°C. The standard deviation calculated showed values of 1.5905, 2.8557, 3.8676, and 4.7545 for modules 1, 2, 3 and 4 respectively. The red line in the boxes in Fig. 3 indicates the values of the average temperatures of the module. The average temperatures were 56.28, 55.25, 55.03 and 52.38 for modules 1, 2, 3 and 4 respectively.

Degradation rates

Translation of module parameters to the corresponding STC values was done by adopting the JRC approach. Results show module 2 to have the highest Isc (2.94 A) and closest to the nameplate value. The lowest Isc (2.6 A) was observed for module 1. The average Isc for the array was 2.78 A, whiles the mean decline in

Isc was determined as 11.7%. Module 1 had the highest decline of 16.4% in Isc and the lowest decline of 7% was observed for module 2 as illustrated in Fig. 3. The annual average decline in the Isc was found to be 0.98%.

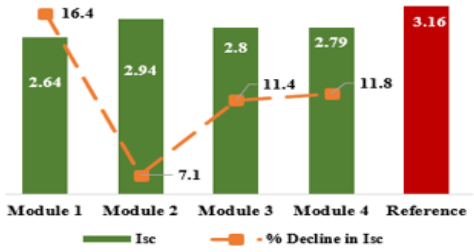
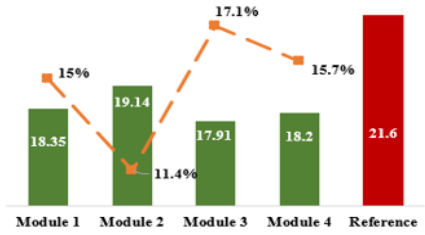
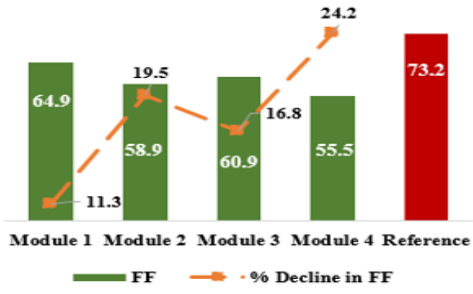


Figure 3. Translated short circuit current at STC



Figre 4. Translated open circuit voltage at STC

The average Voc for the array is 18.4 V which is 14.8% lower than the nameplate value of 21.6 V as shown in Fig. 4. The highest Voc of 19.4 V is recorded by module 2 and the least Voc is observed for module 3. The highest decline of 17.1% in Voc is determined for module 3. The average decline in Voc is 14.8% which presents an annual decline in Voc of 1.23%. The average fill factor determined for the array is 60.05. The highest decline in fill factor of 24.2% is observed for module 3 whiles the least decline of 11.3% is recorded by module 1 as illustrated by Fig 5. The average decline in FF is 18.0%. This shows an annual average decline in FF to be 1.5%.



Figre 5. Fill factor of modules at STC

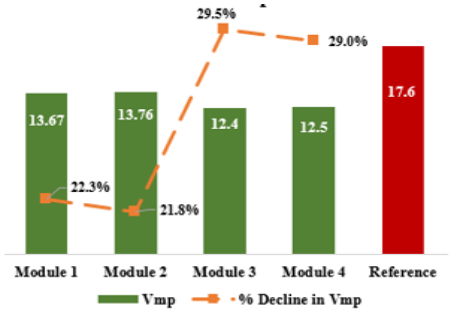


Figure 6. Translated maximum point voltage at STC

Module 2 recorded the highest Vmp of 13.76 V whiles the lowest Vmp of 12.4 V is observed for module 3 and the average for the array is found to be 13.08 V. The average decline in Vmp is found to be 25.7% with an annual decline being 1.09 V as shown in Fig. 6. Decline in *Imp* is relatively lower than is recorded by Vmp which is as a result of the high declines in the observed Voc. The highest observed Imp is 2.40 A for module 4 and the least Imp of 2.30 A recorded for module 1. The mean Imp for the studied array is found to be 2.36 A as shown in Fig 7. Average decline in Imp is 18.6% with an annual decline of 1.55%.

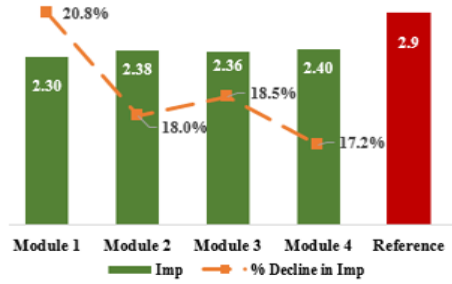


Figure 7. Translated maximum point current at STC

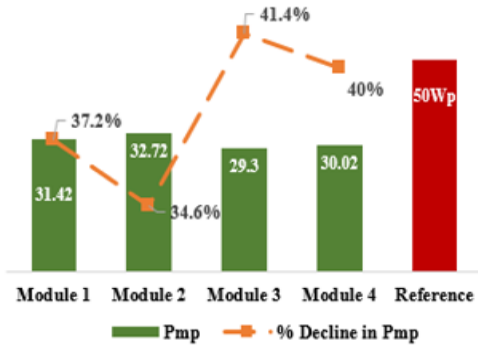


Figure 8. Translated nominal power at STC

Mean power output observed for the modules is 30.86 *W*. The highest and lowest power of 32.72 *Wp* and 29.3 *Wp* are observed for modules 2 and 3 respectively. Power decline is the highest as it is the product of the other parameters. The highest decline in power output of 41.4% is recorded by module 3. The least decline is 34.6% for module 2 as depicted in Fig. 8. The average decline in the nominal power for the array is 38.3% which indicates an average annual decline of 3.19% for the 12 years in operation. The greatest contributing factors are found to be the FF and the Voc considering their average declines. According to Köntges et al. (2017), the order of impact of failure modes are the potential induced degradation, failure of bypass diodes and discoloration of EVA, the encapsulant material of the module. The reason given for this is that, there are not appropriate tests yet approved for these failure mechanisms. It is therefore not unexpected the high degradation levels of the modules which demonstrated acute EVA discoloration and bypass diode failures. The level of discoloration of EVA determines the change in the transmittance of the light reaching the solar cells and thus a decrease in the power generated (Munoz et al., 2011).

Module degradation factor (MDF)
This presents an estimation of the total degradation which indicates the reduction in Isc as a result of an increase in Rs. Since module degradation is directly related to Isc, the MDF is defined as the level of degradation in a module and is obtained by the relation presented by Eqn. 5 (Dhoke et al., 2018).

$$\%MDF = \left(1 - \frac{I_{SC(\mathrm{deg}raded\,\mathrm{mod}ule)}}{I_{SC(ideal\,\mathrm{mod}ule)}}\right) \times 100\,. \tag{5}$$

The estimated MDF of the modules are 16.46%, 6.96%, 11.39% and 11.71% for modules 1, 2, 3 and 4 respectively.

Conclusion

This work presents the failures and degradation levels in 12-year ground mount solar PV modules in the dry humid climate of the sub Saharan. The power decline observed ranges from 34.6% to 41.4% with a mean decline in power output per year being 3.19%. Compared with the manufacturer's values, the performance decline of the other parameters for the 12 years of outdoor exposure are Isc, 7.1 to 16.4%, Voc, 11.4 to 17.1%, FF, 11.3 to 24.2%. All four modules have malfunctioning bypass diodes with high levels of EVA discoloration of all cells of the modules. Thermal evaluation of the modules shows temperature dissimilarities of ranging from 4.2 to 10.7 ºC. This work provides further insights into the varying effects of specific climates on the long-term performance of solar PV modules and the prevalent source of degradation of PV modules in outdoor operation.

Acknowledgement

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System-oriented study of the conversion of an outdated internal combustion engine powered passenger car

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Abstract

The challenges of the global natural and economic environment are increasingly affecting the daily life. In the case of private transport, the volume and proportion of sales of hybrid and electric vehicles are also increasing. However, many of the vehicles currently on the roads are outdated, highly polluting, and can be operated uneconomically, but being able to perform their function. If the vehicle's general technical condition is good, it is possible to replace the engine with an electric motor. There is no need to build a new vehicle, which can significantly reduce the environmental impact. The main task of the reconstruction is to create the power transmission and energy storage units, and the technical and documentation preparation which is compliance with the official regulations. The complex process of converting a car with an outdated engine into an electric vehicle has many technical, economic and legal aspects. This articleis based on the experience of a successful electric vehicle development project. We provide an overview of the reconstruction planning and execution tasks to support the preparation of a decision for similar technical development work.

Keywords

e-mobility, electric vehicle development, green power utilization, eco-friendly transport

1. Introduction

By converting outdated internal combustion engine vehicles to electrically-operated ones, their service life can be extended and, at the same time,technologies which represent a decisive trend in the field of vehicle drive can be used so that other values of the vehicle are not lost. The development of electric cars is progressing at an unprecedented fast pace, but reconstructions encounter limitations in many cases. Before starting such works a decision should be made on boundary conditions which determine technical development

and, at the same time, the existing Hungarian and European Union legislations should also be taken into account.The complexity of the work is resulted from responding to related economic, legal and environmental issues, in addition to designing and implementing technical modifications. As a result of the intensive research workin thefield of electrical mobility a number of system elements (motor, control system, battery, charger, energy recovery and operations control systems) have become commercially available, but the adaptation of certain technological solutions and implementation of necessary specific developments require a prudent system design, and this can only be accomplished by complex technical and economic examination of constructional specificities and operation-related expectations.

Specifying the purpose of the conversion, and factors influencing the decision
The set of purposes of converting a vehicle toelectric drive is very complex. Taking only economic considerations into account the conversion can be deemed rational, but there are technical, environmental, social and political aspects as well, and the authors will set aside the political considerations in the framework of this study. From the way of utilization after reconstruction, preliminary conclusions can be drawnwith respect to the following characteristics: (1) required minimum range, (2) maximum speed, (3) minimum required loadability, (4) number of persons who may be carried, (5) necessary driver-assistance system(s), (6) necessary convenient systems.

From technical point of view the construction of a vehicle converted to electric is simpler, which means more reliable operation and simplified operation and maintenance. The new construction is composed of considerably fewer moving parts thereby the maintenance of the motor is much easier. What is more, there are units which are practically maintenance-free. If during rebuilding the gearbox is also demounted, the number of the elements in the power train is drastically reduced, and the probability of a failure drops accordingly. With the removal of the gearbox the clutch distance piece and the part for shifting from engine to electric motor will no longer be required, and this will result in weight reduction, in addition to technical simplicity, but in the domestic legal environment it is not an ideal solution with respect to the licensing procedure. Right before and after the millennium the construction, space efficiency and technology (e.g. CAN BUS system) of vehicles designed with CAD supportcontain especially complex, precisely dimensioned and harmonized elements.Rebuilding such vehicles poses a demanding challenge from technological point of view as well, and the factory-made functions and characteristics cannot be improved significantly with electric drive either, with the exception of the impact on the environment. In case of vehicles manufactured until themid-‘90s, due to the particularities of contemporary design principles and production technology, the conversion can make a significant step forward, because technically simplified constructions are involved, composed of parts designed and manufactured with large tolerance. Electric drives consist of fewer elements, but a large amount of batteries is

required to store energy needed for driving. Depending on the size of the batteries, the weight advantage obtained from removing fuel, cooling and exhaustion systems can even disappear, but the factory-made point of gravity can be altered therefore a lot of constructional specificities (e.g. the adhesion loss of front-engine, rear-wheel drive cars) can be corrected. Owing to the size of the batteries, for the time being, balancing can only be performed at the expense of the useful (luggage) space.

Concerning environmental aspects, after conversion the car can run without emitting any local pollutants therefore it contributes to sustainable mobility. There is no need to manufacture bodywork and interior space elements, because the old ones can be used and are able to fulfil their function perfectly. The extension of the service life of the vehicles in this way significantly reduces CO_2 emissions in automotive industry, but in case of batteries the situation is not so simple. Mining of raw materials needed for production of modern cells gives rise to significant environmental impacts, and the battery production process is still not CO_2 neutral, and the treatment of worn-out batteries requires great care.

Table 1. Costs related to electric drive

Electric drive			
Number of charge cycles	2 000		
Driving range per charge	100	km	
Distance travelled	200 000	km	
Electricity price	38	HUF/kWh	
Battery pack performance	10	kWh	
Price of all charges	1 140 000	HUF	
Parts	**piece**	**HUF/piece**	**HUF**
DC motor	1	250 000	250 000
Motor control system	1	250 000	250 000
DC-DC converter	1	100 000	100 000
Battery charger	1	100 000	100 000
LiFePo4 batteries	32	35 000	1 120 000
Vacuum pump	1	116 000	116 000
Battery monitoring system	1	100 000	100 000
Other parts (cables, etc.)	1	90 000	90 000
12V battery	1	12 000	12 000
Heating	1	100 000	100 000
Carbon brush replacement	20	10 000	200 000
Man-hours required	240	3 000	720 000
Total			4 298 000

It is a growing social expectation that people do not pollute unnecessarily and directly the environment, and even indirectly just to a reasonable extent, and they have to organize their lives and works consciouslyso that scarce natural resources are used as effectively as possible. In addition to preserving the values of our past, the conversion of a polluting vehicle contributes to the protection of a liveable environment and thereby protects the interests of the society, which is can be detected at individual level, too.

Table 2. Costs related to petrol drive

Internal combustion drive			
Distance travelled	200 000	km	
Fuel consumption	8	l/100km	
Fuel price	375	HUF/l	
Total fuel price	6 000 000	HUF	
Description	piece	HUF/piece	HUF
Engine oil change	20	7 000	140 000
Air filter replacement	10	3 500	35 000
Oil filter replacement	20	2 700	54 000
Fuel filter replacement	10	1 800	18 000
Control system replacement	2	20 000	40 000
Total			6 287 000

The economic approach is based on utility, i.e. its maximization. In this case overall awareness must be assumed, i.e. the differences between utilities can be correctly determined and the results can be maximized. In case of objective rationality or rational decision the criteria are constant, all alternatives are knowledgeable and assessable and the best alternative can be chosen. Despite thorough research work it cannot be asserted that in each case the technically satisfactory and economically rational solution has been chosen because of the unavailability of resources sufficient for collecting all information at a given date, and the prices of certain system elements are subject to variation over time (e.g. exchange rate movements). When making decisions other problems have also arisen such as human factors, assessment on the basis of previous experience, accidental (unpredictable) effects, routine (conventions). Accordingly, the decisions we have made are limitedly rational, and though criteria have not changed continuously and the problem is well structured, we could not get to know all alternatives therefore the best alternative could not be chosen. During our work we were seeking a solution which is both technically appropriate and economically satisfactory. Since the rebuilding has been carried

out recently, we have no measurements related to future costs of operation for a long period therefore now we have only estimations on several cost elements. The table below includes the costs of rebuilding, the costs related to the fuel and battery pack which will probably the most significant items of the costs incurred. For the time being we obviously cannot know exact additional service requirements for the vehicle rebuilt as well as associated costs. (Zsámboki et.al. 2019)

Table 3. Relationship of costs related to drives

Total cost of operation with electric drive	4 298 000	HUF
Total cost of operation with internal combustion engine	6 287 000	HUF
Difference	**1 989 000**	**HUF**

It can be seen that in case of the original drive fuel cost is the most significant expense. In our calculation costs for 200,000 km of distance travelled were taken into account because this is the appropriate distance which can be driven by a battery pack and the petrol-fuelled vehicle should be renewed after that mileage. The cost of electricity consumed will be approximately one-fifth of fuel expenses, and another one-fifth corresponds to the price of the battery pack. The total cost of rebuilding and operation is approximately HUF 2,000,000 less than fuel savings, considering 2,000 charging cycles. (Zsámboki et.al. 2019)

Technical challenges stemming from the change of technology

The conversion of a vehicle to pure electric involves incorporation of several systems whose functions were fulfilled by an internal combustion engine. These systems include the vacuum needed for the brake booster and the heating unit that makes use of the waste heat of the engine and the generator, which was also driven by the engine, used to provide power to the 12V system. A generator mounted on the engine provided power to the low voltage system of the vehicle. This generator can be replaced by a DC-DC converter which has sufficient capacity to operate the original systems of the car.

The vacuum brake booster is operated through a vacuum servo unit, based on the pressure difference. The necessarypressure difference or vacuum used to be generated by the engine by making use of the decompression of the intake manifold or through a vacuum pump mounted on the engine. Since the internal combustion engine has been removed, and the electric motor does not have to rotate continuously, the installation of an individually driven vacuum pump can be a solution. In order to facilitate reliable operation, it is reasonable to use a microcomputer to control the vacuum pump, i.e. to turn out and on the vacuum pump when the preset maximum and minimum pressure levels are reached.

The waste-heat of the internal combustion engine used to provide the thermal energy needed for the heating of the vehicle, but this waste-heat is not available

after the engine has been dismounted. The ventilation is ensured by the factory-made system. It is true that an electric motor also needs cooling, but it does not provide as much thermal energy as needed to heat the passenger compartment of a car. This problem can also be solved by a purely electric and independent system. Four PTC (Positive Temperature Coefficient) heating elements, each has a capacity of 1000 watts, will be installed in the place of the original heating radiator of the vehicle. Such heating elements are used also in internal combustion engine cars to provide supplementary heating, and the entire heating for electric cars is also solved by this technology. One of the most important characteristics of these heating elements is that their resistance increases with increasing temperature, this is the reason why their temperature must not exceed a level specified by the manufacturer.

An air-conditioning system used in the majority of the cars can also be usedfor cooling purposes. It is important to note that this system is operated on the principle of heat pump, and this process can be reversed. Accordingly, the vehicle can be heated and cooled by the same system.A disadvantage of this system is that a high energy input is required to achieve our aim, because the air with a desired temperature is not produced directly, but first mechanical energy is produced from electrical energy then it is used to produce thermal energy, and this way the efficiency of the system decreases to a large extent.

If we treat the heating/cooling system as a complex unit, a novel concept can be developed. The passenger compartment and the load compartment of the internal combustion engine vehicles are typically heated with thermal energy obtained fromthe coolant, and while the engine is running cold complementary electric heaters are used to warm up the compartments in a short time. The cold air needed for air-conditioning is typically produced by means of a compressor driven by the crankshaft. In case of electric drive, due to the high efficiency of electric motors, a high amount of waste heat is not generated and there is no crankshaft in the traditional sense. Both heating and cooling requires a great amount of energy equal to several kilowatts, which considerably reduces the range of the vehicle if it uses only the energy stored by the built-in batteries. The negative effect of the heating/cooling process on the range can be reduced to a large extent. If a complex heating system not based on waste heat and a highly efficient cooling system are incorporated then the unit is able to store hot & cold energies in parallel with charging the batteries. If this system is a well-insulated network filled with a liquid with high heat capacity which can be heated or cooled during charging, according to what is needed. The control function is performed by a microcomputer which can be integrated into the original OBD system of the vehicle and can be adapted to the battery supervision assembly and the elements of the charging control unit. The system has a modular structure and is composed of several elements.Its central element is a heating/cooling tank which contains a sufficient volume of heating/cooling medium. The tank is pressure resistant and well insulated and includes the active heating/cooling units and the circulating pumps are located at its connections. The connections

and the pipes of the system are also equipped with thermal insulation and the heat exchangers have high efficiency so the stored energy can be extracted while the vehicle is in motion, without reducing the range significantly, because only the electricity demand of the circulating pump and the controller microcomputers should be satisfied, which is only a fraction of the energy demand of the heating/cooling process.

Documentation and legal aspects of the conversion

During an earlier work of the authors a documentation required for the conversion of a Lada 2105-3 type car to electric car had been compiled. This documentation was submitted to the National Transport Authority and was finalized according to the instructions received from the Authority.Experience has shown that the documentation shall cover, in detail, the following items:

- Subject of the conversion
- A detailed description of the vehicle
- A concept for reconstruction
- A presentation of elements removed during rebuilding
- A presentation of system elements installed for electric drive
- An itemized presentation of system elements removed and installed
- Components removed
- Components installed
- A description of the systems not modified during the rebuilding process
- The battery charging system
- A description of the systems modified during rebuilding
- Brake booster (a description of the technical solution installed)
- Heating-ventilation
- Technical characteristics of the reconstructed vehicle

In order to ensure that the authority can access the technical conformity of the conversion, the following appendices should be attached in a way that the plans are drawn up in a uniform manner, preferably with a CAD program:

- Technical specification for the DCT10-96 10kWseries electric motor
- Technical specification for the MC96-400 96V 400A DC motor control system
- Technical specification for the DC-DC converter
- Technical specification for the 3.2V 100Ah LiFePO4 battery
- Cut-out switch
- A technical drawing for the fixation of the drive motor
- A technical drawing for the bracket of the drive motor
- A bracket for the motor control system
- The method for fixing the DC-DC converter
- A sketch of wooden frames containing the batteries
- The method for fixing wooden frames containing the batteries
- Determining holding forces at the suspension points
- Fixing the flywheel and the clutch assembly to the motor
- The method for locating the batteries
- Support bracket for the battery charger
- Technical specifications for the battery charger

During the conversion process the following three laws should be considered and their provisions shall be fully observed:

1) KöHÉM Decree No. 5/1990. (IV. 12.) (on technical inspection of road vehicles)
2) KöHÉM Decree No. 6/1990. (IV. 12.) (on the technical conditions for the placing on the market and putting into service of road vehicles)
3) Regulation No 100 of the Economic Commission for Europe of the United Nations (UNECE) — Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric powertrain [2015/505]

The licensing procedure is relatively simple and includes back-to-back sub-processes. In the first step the aforementioned technical documentation should be prepared then submitted to the National Transport Authority, and based on this documentation the Authority will specify the official examinations to be conducted. In case of petrol-fuelled vehicles equipped with vacuum brake booster the vacuum no longer exists after the engine has been removed therefore it should be replaced by finding an electric solution. Besides, in case of internal combustion engines the passenger compartment is heated by the waste heat of the engine, while in case of electric drive systems no or just a very small amount of waste heat is produced. Accordingly, at least two official examinations shall be carried out by accredited laboratories so that the authority gives permission for the participation of the vehicle in road traffic. In case of vehicles without vacuum brake booster any examination to this effect is irrelevant. The examinations should be carried out within one year. In possession of the results of the examinations the MOT test can be performed for the vehicle,during which the elements included in the licensing documentation are checked in an itemized manner at the MOT testing station. Following this, the vehicle is subject to the same rules as any other road vehicles. It is however important to note that if any of the permitted elements is subsequently modified the licensing procedure shall be repeated. Unfortunately, the duration of the licensing procedure is not stipulated in any law therefore theNational Transport Authority is not bound by time limits based on which the time required for the licensing process could be estimated.

A description of the conversion process

This process starts with determining boundary conditions, followed by selecting the vehicle to be converted. It is followed by determining components/systems not needed for electric operation and the components and systems needed for electric operation. On the basis of known boundary conditions, the components/systemsneeded for electric operation are designed, andthe components and systems not needed for electric operation are removed. The installation of the systemsandcomponents needed for electric operationis followed by a test, whose results constitute the basis for necessary modifications. After the modifications are executed, a re-testing is performed. During the rebuilding process the technical documentation covers all details of the work,

and these will be used for the licensing documentation. Then the National Transport Authority determines the examinations required for the licensing procedure, and after the examinations have been performed, the next tasks to be done areroadworthiness testing and putting into circulation. The final step of the work is to finalize documentation. Below is a description of the conversion process:

1. Determination of boundary conditions
   1.1. minimum required range
   1.2. maximum speed
   1.3. minimum required loadability
   1.4. number of persons who may be carried
   1.5. necessary driver-assistance system(s)
   1.6.necessary convenience systems
2. Selection of the vehicle to be converted
   2.1. surveyingadditional availability of space
   2.2. selecting the centre of gravity position
3. Determining the components/systems not needed for electric operation
   3.1. internal combustion engine
   3.2. fuel system
   3.3. cooling system
   3.4. exhaustion system
4. Determining the components/systems needed for electric operation
   4.1. in accordance with the vehicle and operating conditions
5. Designing the components/systemsneeded for electric operation
6. Removing the components/systemsnot needed for electric operation
7. Installingthe components/systemsneeded for electric operation
8. Testing
9. Carrying out all necessary modifications
10. Retesting
11. Finalizing the licensing documentation
12. Determining the examinations required for the licensing process
   12.1. Brake booster
   12.2. Heating-ventilation
   12.3. Other necessary examinations
13. Roadworthiness testing and putting into circulation
14. Finalizing the documentation

Conclusions

A substantial part of the outdated internal combustion engine vehicles still in circulation is highly polluting and can be operated uneconomically. If the vehicle's general condition is good, after taking into account technical economic and legal considerations, it is possible to replace the internal combustion engine with an electric motor and to continue the operation of

the vehicle, now with electric drive. Since there is no need to manufacture a completely new vehicle the extent of environmental pollution can be reduced significantly. After the purpose of the conversion has been specified, the factors influencing the decision have been presented, outlining in particular the technical, environmental, social and political aspects. After the challenges stemming from the change of technology have been described, the authors suggested a concept whose examination requires additional analyses and researches.The system-oriented study is closed by the documentation and legal aspects of the conversion and a detailed description of the conversion process.

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Two years operation of small scale solar power plant system at the Itenas Campus Indonesia

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Abstract

Some research activities during 2 (two) years, since started operation of the small scale solar power plant (SPP) at campus of Institut Teknologi Nasional (ITENAS) Bandung, will be elaborated in this paper, but the focus will be emphasized on the evaluation of the performance of the SPP in view of energetic and exergetic, based on 2 days operation data. The main components of the SPP consist of 4 pieces mono-crystalline photovoltaic (PV) modules and grid tie inverter, which synchronized the voltage of the SPP and the public electricity. Until the present, the energy production of the SPP was 1.9 MWh, and the greenhouses gases avoided were equal with 4,778.66 kg CO_2 (carbon dioxide), 3.54 kg NO_x (nitrogen oxide) and 0.04 kg SO_2 (sulphur dioxide).

Keywords

photovoltaic, inverter, grid connected type, energy production, greenhouse gases

1. Introduction

PV modules

Inverter

Figure 1. PV modules and inverter of the SPP

A small scale system of solar power plant (SPP) system has been installed at the campus of Institut Teknologi Nasional (ITENAS) Bandung, West Java – Indonesia, since the beginning of 2018. The capacity of the SPP is 1000 Watt peak (1 kWp), and the type of the SPP is grid connected system. The main components of the existing SPP consisted of photovoltaic (PV) module (crystalline technology) and inverter. The PV modules had a 12^o tilt referring to the Earth's surface and facing to North (Rusirawan et al., 2019). The SPP installation existing is shown in Fig. 1.

The main specifications of the PV module and inverter based on manufacturer catalogue can be seen in Table 1 (Hidayat et al., 2019).

Table 1. Main specification of PV modules - Monocrystalline Silicone type JAM6 60-265 and Inverter model UNO 2.0 TL OUTD specifications

PV module electrical parameters			
Reted Maximum Power at STC (W)		265	
Open Circuit Voltage (Voc/V)		38.26	
Maximum Power Voltage (Vmp/V)		31.11	
Short Circuit Current (Isc/A)		9.00	
Maximum Power Current (Imp/A)		8.52	
Module Efficiency (%)		16.21	
PV module operation condition			
Maximum system voltage		DC 1000 V (IEC)	
Operating temperature		-40^oC - $+85^oC$	
NOCT (Nominal Operating Cell Temperature)		45 ± 2^oC	
Input Inverter specification		**Output Inverter specification**	
Maximum Input voltage (DC)	600 V	Output voltage (AC)	230 V
Input start-up voltage (DC)	100 – 300 V	Output Current Maximum (AC)	12.5 A
Input Current Maximum (DC)	12.5 A	Output Power Maximum	2200 W
Input Power Maximum (DC)	2200 W		

Until the present (in the middle of September 2019), the energy production of the SPP was 1.9 MWh, and the greenhouses gases avoided were equal with 4,778.66 kg CO_2 (carbon dioxide), 3.54 kg NO_x (nitrogen oxide) and 0.04 kg SO_2 (sulphur dioxide).

In principle, the existing of small scale the SPP will be used for the research and also as for the education purpose, not only for the university but also for the public. Presently, some research activities related to the existing SPP at the campus of ITENAS can be explained as follow:

1. Modelling of the PV module of the SPP by single and double diode using visual basic for application (VBA) Microsoft excel;
2. Modelling of the SPP characteristic using fuzzy time series;
3. Development of data acquisition system for performance evaluation of grid connected system SPP;

4. Energetic and exergetic evaluation of the existing SPP;
5. Evaluation of saving energy of the university building, as an outcome of the SPP implementation.

Nevertheless, in this paper, focused will be emphasized on the performance of the SPP, particularly in term of energetic and exergetic point of view.

2. System description

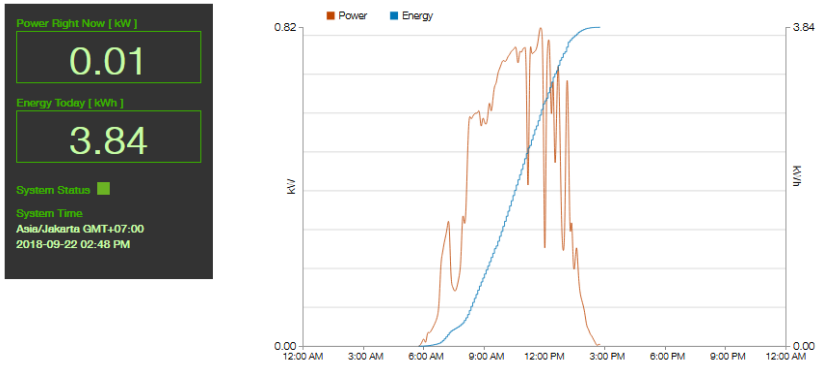

Figure 2. The feature of daily operation of 1 kWp SPP (data for September 22, 2018)

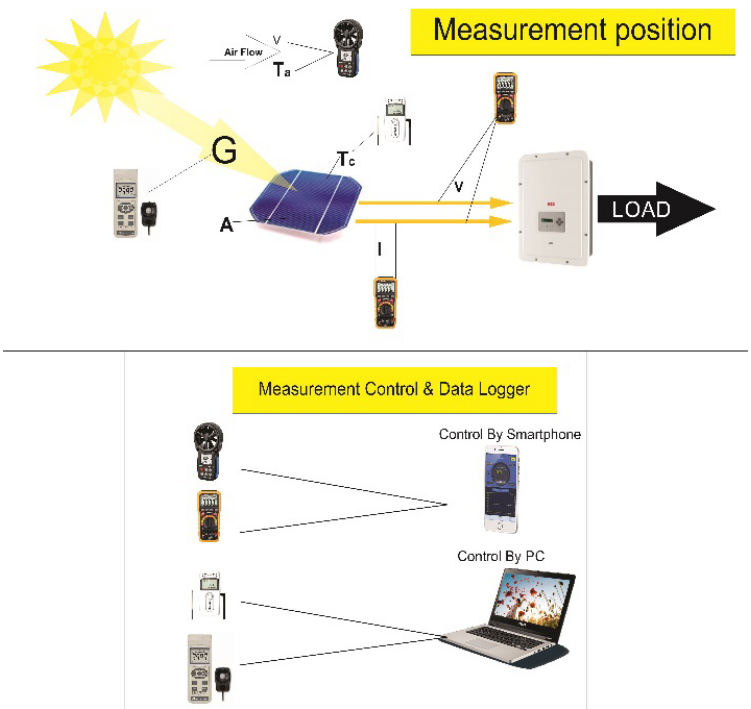

Figure 3. Data acquisition schematic diagram

During operation, daily data of the 1 kWp SPP is monitored using online data logger system (monitoring logger system: VSN300 WIFI Logger Card). Daily operation data of 1 kWp SPP is monitored by online data logger system (monitoring logger system: VSN300 WIFI Logger Card). At the existing data logger system, the data acquisitions are emphasized on the power (Watt) and energy (kWh), as can be seen in Fig. 2.

For the purpose of exergetic evaluation, additional parameters such as irradiation (G), velocity (v), ambient temperature (T_a) and cell temperature(T_c), current (I) and voltage (V) are needed. Therefore additional measuring instruments should be installed in the existing system. The schematic of measuring system can be seen in Fig. 3, and the actual measuring system is shown in Fig. 4.

Data acquisition system for measuring I, V and T_c

Data acquisition system for measuring G, T_a and v

Figure 4. Data acquisition system

3. The experimental results and evaluations

Table 2. Measured data for December 29, 2018

Time	G (W/m^2)	V (Volt)	I (Ampere)	T_c (^{o}C)	T_a (^{o}C)	v (m/s)
06:00	56.50	119.10	0.36	19.00	21.00	0.30
07:00	195.55	121.68	1.05	24.85	23.50	0.48
08:00	400.11	119.23	2.68	36.59	30.66	0.49
09:00	528.59	117.14	3.78	40.70	33.06	0.75
10:00	784.32	116.01	5.67	43.36	35.01	1.04
11:00	795.65	118.54	6.07	41.45	36.63	0.98
12:00	702.15	116.81	5.92	42.08	36.50	1.32
13:00	915.72	120.05	6.84	37.50	37.57	1.09
14:00	744.48	122.12	5.91	37.60	37.80	1.46
15:00	408.60	118.01	3.60	36.29	34.76	1.75
16:00	110.54	115.81	0.87	29.21	29.03	1.78
17:00	126.20	119.46	1.08	31.25	31.60	1.95
18:00	38.13	112.01	0.36	28.05	30.72	2.23

The measuring of data is taken every 1 (one) hour, since 06:00 a.m. – 18:00 p.m. Data used for energetic and exergetic evaluation were taken in two days, i.e. December 29-30, 2018. Based on measurement, all parameters data, which describes in Fig. 3 are shown in Tables 2-3.

Table 3. Measured data for December 30, 2018

Time	G (W/m^2)	V (Volt)	I (Ampere)	T_c (^{o}C)	T_a (^{o}C)	v (m/s)
6:00	21.41	104.4	0.16	22.2	22.50	0.70
7:00	81.09	116.64	0.61	23.84	23.38	1.01
8:00	297.75	121.29	2.14	29.79	26.79	1.25
9:00	486.80	120.11	3.53	34.06	29.11	1.37
10:00	579.61	118.83	4.32	35.70	30.41	1.23
11:00	710.69	116.35	5.22	41.42	33.62	1.51
12:00	433.18	120.47	3.48	34.09	32.90	1.80
13:00	676.95	120.10	5.21	35.60	39.45	1.54
14:00	529.32	117.74	4.38	39.35	35.32	1.76
15:00	436.16	118.74	3.64	38.75	35.38	1.76
16:00	258.44	121.29	3.02	37.24	36.38	1.76
17:00	81.61	122.39	1.32	30.79	33.21	2.03
18:00	56.35	114.14	0.51	27.20	28.72	1.79

Based on these data, the set equations for energetic and exergetic evaluation, which is available in previous article, could be implemented (Rusirawan and Farkas, 2015).

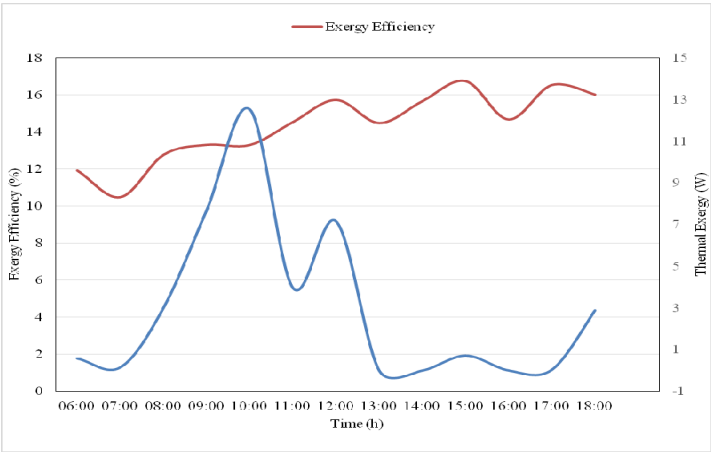

Figure 5. The characteristic exergy an efficiency as a function of thermal exergy (December 29, 2018)

The main feature of exergy efficiency of 1 kWp SPP, for two days operational based on data in Table 2-3, can be described in Figs 5-6.

Based on Figs 5-6, it is found that the exergy efficiency tends to decrease, in line with increasing the thermal energy. It can be stated also that increasing of the ambient and cell temperature, great affecting on the exergy efficiency. The proof of this statement can be shown in both figures, at 09:00-10:00 in Fig. 5 and at 10:00-12:00 in Fig 6.

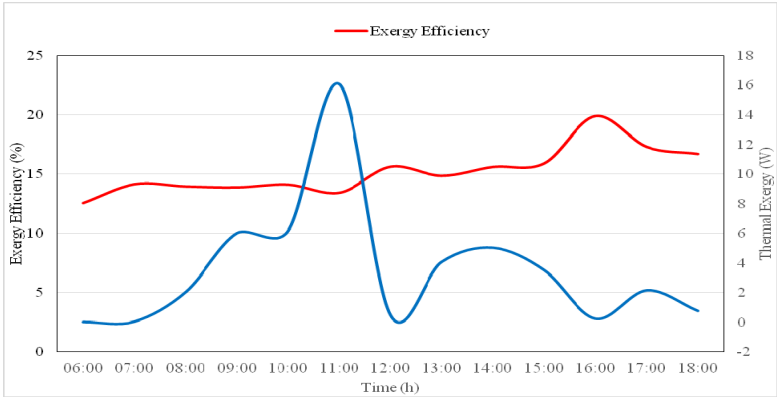

Figure 6. The characteristic exergy an efficiency as a function of thermal exergy (December 30, 2018)

It is fact that the energy analysis is more suitable for energy balance in design a system, and exergy analysis is more appropriate for evaluate the performance of a system qualitatively (Rusirawan, 2015). Figs. 7-8 show the comparison about energy and exergy efficiencies of the SPP 1 kWp.

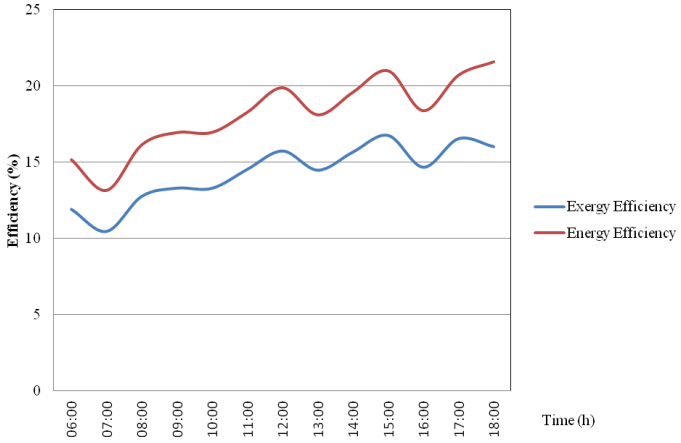

Figure 7. Comparison of exergy and energy efficiencies (December 29, 2018)

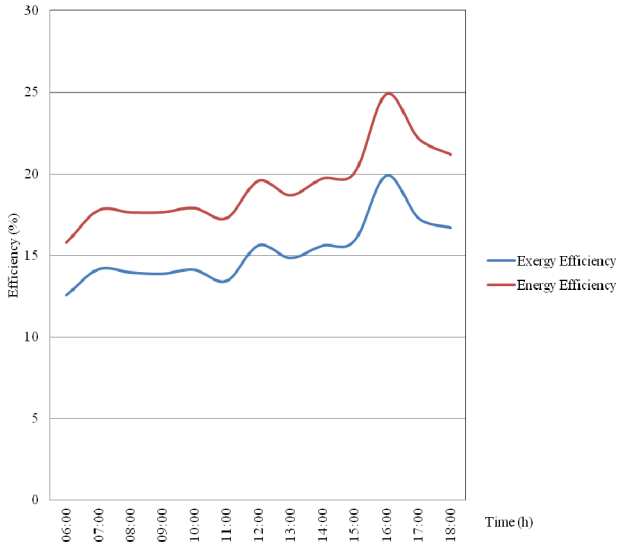

Figure 8. Comparison of exergy and energy efficiencies (December 30, 2018)

Conclusions

Some research activities have been performed, related to the existing 1 kWp SPP installation at the campus of ITENAS Bandung, after 2 years operation. Energy and exergy analysis of the SPP 1 kWp has been evaluated in this research, which represented by energy and exergy efficiencies. In two days operation analysis, it is found that exergy efficiency less than 27.5% and 43.8% comparing to energy efficiency, respectively.

Acknowledgements

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Measuring possibilities of the effect of refrigerant change in heat pump systems

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Abstract

An essential component of a heat pump system is the refrigerant, which carries many environmental risks. Refrigerant replacement may be feasible in some cases, but the effect of replacement must be investigated. In this work, I wish to explore the necessary measurement capabilities for a given refrigeration circuit. In cases where the measurement of the characteristic to be examined is too complicated, I suggest a calculation procedure to determine the characteristic in question.

Keywords

natural refrigerant, heat pump, multiple heat sources, HC, HFC

1. Introduction

Various legislations (517/2014/EU) and specification (EN 378:2016) have been put in place to reduce the harmful effects and reduce the risks of the refrigerant used, which basically determines the environmental load caused by the heat pump during its lifespan. (AIRAH, 2012.) These specifications limit the potential for certain refrigerants, and thus the application of certain types of equipment, pro and contra: Certain solutions are being gradually phased out, such as HFC-type refrigerants, which present an increased environmental risk but have very low health risks. (Nawaz et. al. 2017.) Others have their limitations, but these are the so-called natural refrigerants, many of which carry direct health risks, such as toxic effects or indirect effects, such as flammable and explosive. (Harby, 2017.)

Environmentally friendly cooling solutions are already being used even extensively in the industry (Campbell et. al. 2007) and due to the regulations the spread of these solutions is expected to continue in the future. The introduction of these solutions is facilitated by the fact that their specific energy consumption is lower than traditional solutions, so that despite the construction of a more complicated and dangerous system, their use can be economically and environmentally beneficial. (Hermanucz et. al. 2018.)

The economical operation of a heat pump is primarily feasible by using multiple heat sources, such as solar and ground heat. (Liang et al. 2011.) Parallel utilisation of energy resources have been previously investigated by Bartha et. al. (2002) in topic of renewable energy. Our goal is to introduce the parameters and the modifications needed to measure them in a heat pump system that has at least two parallel energy sources. Where the measurement process would be too complicated, I present a solution to determine the given parameter by calculation. Given that there is currently no widely used, standardized measuring device for real-world refrigerant testing, the development of a suitable device for this purpose is an important part of the research.

2. Experimental setup and methods

In our work, we have developed a custom-built heat pump system. The original equipment we started off requires a number of modifications, but now it meets the following requirements:

- The condenser side is a refrigerant-water heat exchanger
- There is an air- and water-heated evaporator built in the system
- The water side performance of the water-heated evaporator and condenser can be measured
- The temperatures and pressures on the suction and discharge sides of the compressor can be measured
- The temperature and pressure of the heat exchanger inlet and outlet can be measured
- It is easy to replace the refrigerant

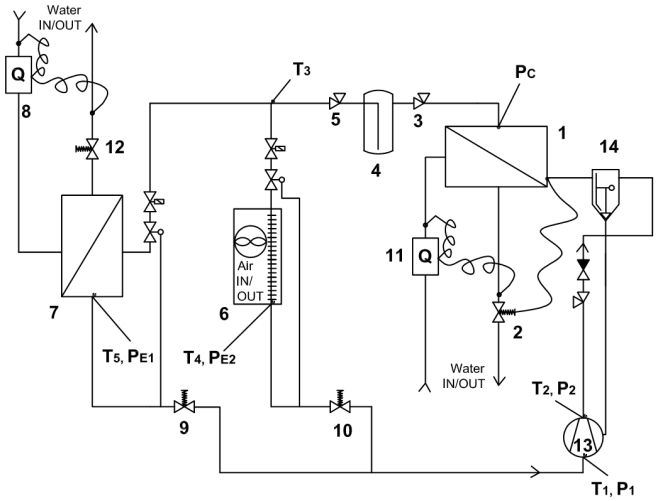

Figure 1. Experimental system layout and measuring points

1-custom built coaxial-type condenser, 2-condensing pressure regulator, 3/5-refrigerant manifold, 4-liquid receiver, 6-air-heated evaporator, 8-evaporator side heat meter, 9/10-evaporating pressure regulator, 11-condenser side heat meter, 12-water supply control valve, 13-compressor, 14-oil separator

Easy change of refrigerant is very important, because (Mian et. al. 2018) investigate several refrigerants in a same system, but no natural refrigerants were investigated. The system we present in Figure 1. is capable to investigate natural refrigerants, like R290 or R600a.

3. Results

At this stage of the research, we do not have comparable data series for multiple refrigerants. We are currently at the beginning of the work, so we were testing with a specific refrigerant (R404a). Thus, only a few measurements will be presented below, rather the interventions carried out during the modification of the experimental apparatus will be described.

Exploring and conversion of heat and pressure measuring points
The apparatus originally was for illustration purposes only, and despite have numerous measuring points. Some of them had to be modified. This primarily involves measuring the temperatures T_5 and T_6. I solved the problem by re-wiring two existing heat sensors so that the same probe and instrument can be applied at both measuring points, see Table 1.

Table 1. The applied instruments and their accuracy

Parameter	Designation	Instrument	Accuracy
Pressure	P_1,P_3	Dixell XC440c with Honeywell transducer	+/- 1%
	P_{E1}, P_{E2}, P_2	Refco analog pressure meter	Accuracy class: 1.
Temperature	T_1,T_2,T_3,T_5,T_6	Dixell XR01cx with PTC probe	+/- 0,7°C
Electric power	W_{KOMP}	Everflourish EMT 707CTL	+/- 1%
Thermal power	$\dot{Q}_k$ $\dot{Q}_{EZ}$	Techem Compact V e. heat meter	Effective: ΔT>0,2K

Building a special condenser
The condenser is designed to be suitable for measurement purposes and accordingly has refrigerant side pressure measurement points that are not commercially available. The built-in condensing pressure regulator is also connected to this point so that it can adjust and maintain the desired condensation pressure. The volume of the heat exchanger on the water side has been minimized, so after a short time, the unit works with a stable condensation pressure and temperature difference. This was proved during the test measurements, it took only 40… 60 seconds to reach the stationary condensation pressure and the values were kept without oscillation. However, heat measurement results require a much longer time to become stable, as described below.

Heat measurements

The amount of heat transferred by the condenser and the water-heated evaporator was measured on the water side by means of heat meters. The stability, accuracy, and especially the resolution of the instruments make them suitable for accurate measurements. Instantaneous power values that are very important to the task are read at a resolution of 0.001 kW in 20 s intervals. Utilizing this feature, the test measurements were able to determine the time required for the system to reach a stable operation, which took approximately 600 s. Only minor modifications such as re-placing the bulb of thermostatic expansion valve and minimal adjusting in the set values of the regulating valves for example at evaporation pressure regulator resulted in significant changes in the curves of thermal power. This process can be tracked in Figure 2.

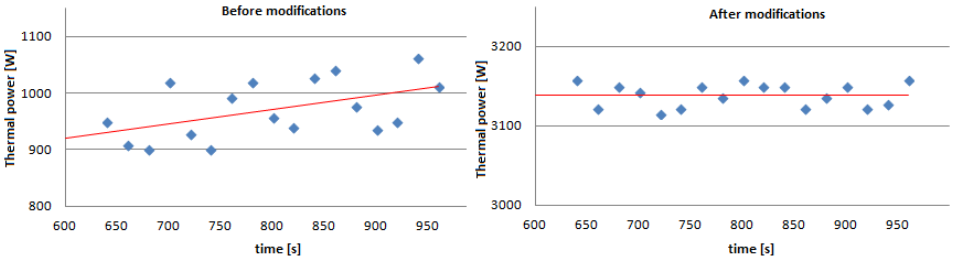

Figure 2. Absorbed thermal power by the water-heated evaporator in function of time

Parameters with complicated measuring method

Measuring the power taken from the air heat source is difficult: air velocity and temperature should be measured at several points on the evaporator front face, air density should be calculated and many measurement points should be evaluated in a single operating condition. The effect of moisture condensing from the air would also be very difficult to consider. This would significantly complicate the measurement and would introduce uncertainty, so the power absorbed from the air heat source is calculated. For the calculations, it is essential to know the amount of heat released in the condenser and the enthalpy of the refrigerant at the inlet and outlet of the heat exchanger. This requires the values of T_2, T_3, and P_C, followed by the logP-h diagram and the graph presented in Figure 3. Special software can be used to determine enthalpy values. For this purpose we use the Solkane 7.0 database of Solvay Fluor. In order to calculate the power absorbed by the air-heated evaporator, the mass flow rate of refrigerant $\dot{m}_{R2}$ fed to the heat exchanger shall first be determined:

$$\dot{m}_{R2} = \dot{m}_R - \dot{m}_{R1} \quad [kg/h] \tag{1}$$

$$\dot{m}_R = \frac{\dot{Q}_K}{h_2 - h_3} \quad [kg/s] \tag{2}$$

$$\dot{m}_{R1} = \frac{\dot{Q}_{E1}}{(h_5 - h_3)} \quad [kg/s] \tag{3}$$

h_2, h_3, h_5 can be accurately determined by the software based on the measured pressures and temperatures, and $\dot{Q}_K$, $\dot{Q}_{E1}$ are known from the thermal power measurement so the mass flow rate of refrigerant in the air-heated evaporator can be calculated, from which the power absorbed in the evaporator can be determined:

$$\dot{Q}_{E2} = \dot{m}_{R2} \cdot (h_6 - h_3) \quad [kW] \tag{4}$$

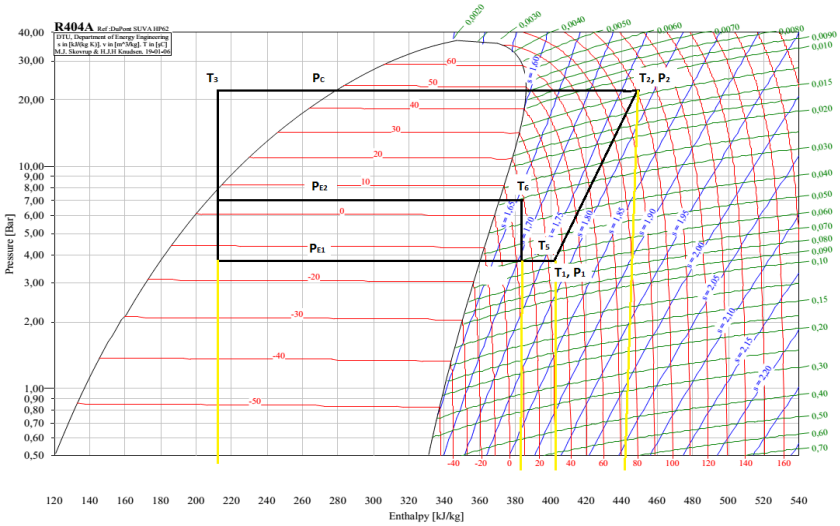

Figure 3. The cycle and the measuring points in logP-h diagram

The designation of the measured characteristics is the same as in the Fig. 1. For presentation of the logP-h diagram we use the Solkane 7.0 database of Solvay Fluor.

Conclusions

The most important test parameter for refrigerant change, in addition to the pressure and temperature values at the points characteristic of the cycle, is ultimately the power factor. (COP) In our study, we used the easily quantifiable "comparable" performance factor (Jakab, 2006) to calculate:

$$COP = \frac{h_2 - h_3}{h_2 - h_1} \quad [-] \tag{5}$$

Thus, in practice, higher than usual, in our case values between 6.5 and 6.8 were found, as opposed to the real calculation method (which take in account all losses, for example the efficiency of the driving motor), where the value of the power factor is between 3.5 and 3.8. Nevertheless, we consider the calculation method according to (5) to be advantageous, since its results are independent from the compressor type, internal efficiency and drive mode. Comparing the results even with a completely different compressor cycle, thus facilitating the examination of different refrigerants (Makhnatcha, 2014).

The modified experimental equipment has been shown to be able to measure, adjust, and reproduce the energy characteristics that can be used to measure the thermodynamic effects of various refrigerants on the heat pump cycle. The use of two evaporator circuits allows two or more heat sources to be utilized individually or even in parallel. This solution can even optimize the cycle for the application of certain refrigerants.

Nomenclature

h_1	enthalpy at compressor inlet	kj/kg
h_2	enthalpy at compressor outlet	kj/kg
h_3	enthalpy at condenser outlet	kj/kg
h_5	enthalpy at air-heated evaporator outlet	kj/kg
h_6	enthalpy at water-heated evaporator outlet	kj/kg
P_C	pressure in the condenser	kPa
T_2	temperature at compressor outlet	°C
T_3	temperature at condenser outlet	°C
$\dot{Q}_K$	thermal power rejected by condnser	W
$\dot{Q}_{E1}$	thermal power absorbed by air-heated evap.	kg/s
$\dot{Q}_{E2}$	thermal power absorbed by water-heat. evap.	kg/s
$\dot{m}_{R1}$	refrigerant mass flow rate in air-heated evap.	kg/s
$\dot{m}_{R2}$	refrigerant mass flow in water-heated evap.	kg/s
$\dot{m}_R$	general refrigerant mass flow rate	kg/s

Subscripts

COP	Coefficient Of Performance	-

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Research the comfort optimum in the Military Camp

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Abstract

The operation of temporary military camps is a special operation task. In any case, it can be said that it is installed for a specific purpose and for a foreseeable (short) period.

In our work, we study the most characteristic parameter of a complex camp operation: how well the internal environment provided in the installed facility is suitable for the rest of the soldiers. We studied the history of the development of military camps, the structure of the currently used technology and the design needs. Based on all these, the direction of development can be determined, while maintaining functionality, rapid deployment and transport is also important.

Keywords

Inside comfort, temporary facility, internal environment, military camp

1. Introduction

NATO member states must play a larger role in peace operations, where Soldiers will be deployed in Temporary Facilities - Military Camps. Based on the experience of the last 20 years, the concept of Temporary Facilities as Military Camps needs to be recreated. Special attention should be paid to the planning of the camp support and the facility management. The basic design data and requirements that help to build a temporary infrastructure have generally been determined from practical data, that can be considered to be incorrect today. Therefore, a comprehensive review of camp facilities is needed to ensure that the basic planning data that meets today's requirements is well established. Despite the eco-conscious engineering of the XXI. century, energy efficiency and recyclability are an increased requirement for military facilities.

The aim of our research is to investigate the effect of internal Air Quality (hereinafter: AQ) of the military camp placement area on a soldier's well-being and combat field performance. Secondly, comparing the energy transport

required to achieve the desired AQ to a military camp that can be built on a permanent basis, can be built into a container camp and the easy and quick to use tent equipment. These comparative measurements are required to determine the boundary of the application time interval. Finally, with the help of Network Science tools, we intend to explore the effective accomplishment of the basic purpose of military camp facility management, and more specifically, the relationships that accommodation comfort is maintaining maximum combat capability of soldiers in a military-designated camp.

2. Internal environment

Planning the optimal capacity for the operational infrastructure requires measurements to determine the number of people dissatisfied with the carbon-dioxide [CO_2] concentration and the perceived air quality of the room based on the contaminant balance of the site. Based on the results of the measurements, the number of people to be accommodated can be determined. In order to optimize the military application, measurements are needed to determine the proportion of those expected to be dissatisfied with the temperature and the expected temperature of the indoor air. Expected internal environmental parameters can be used to empirically describe the energy or cost requirements, to operate and maintain the base buildings. Based on all these, the expected and necessary needs of the infrastructure designed for military use can be determined (see Fig. 1).

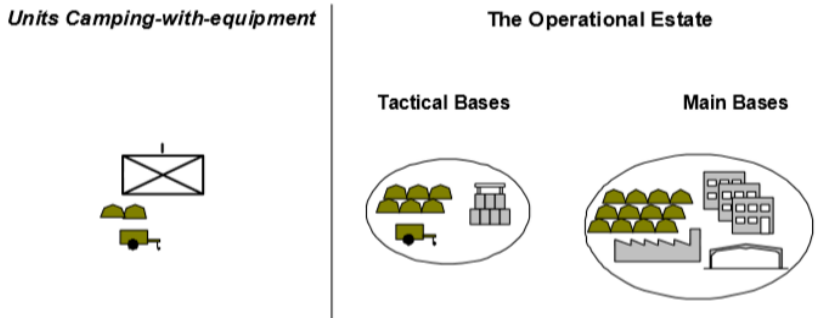

Figure 1. Infrastructure on operation

Internal Air Quality

AQ refers to any non-thermal characteristic of the air in a comfort space that affects a person's well-being. Contaminants affecting AQ quality (Bánhidi and Kajtár, 2000) include gases and steams (CO, CO_2, SO_2, NO_x, O_3, Radon), odors (organic matter; human-, animal- and plant odors) and aerosols (dust, suspended solids) materials, pollen, etc.).

There are also two ways of absorbing and transporting carbon dioxide: 1).: dissolution in the blood and 2).: chemical bonding. In the blood that enters to the lungs, the partial pressure of carbon dioxide is 6.1 kPa, and in the gas space of the vesicles the partial pressure of carbon dioxide is 5.3 kPa. The diffusion constant is 3000 ml/min kPa. The proportion of carbon dioxide in the blood is also higher than that calculated by the diffuse process. This is because during muscle work, carbon dioxide produced in tissues diffuses into red blood cells. The descriptive equation for this process is:

$$CO2 + H2O \Leftrightarrow H + + HCO\text{-}3,$$

$$H + + Hb\text{-} \Leftrightarrow HHb$$

Data on human CO_2 emissions are presented in Table 1.

Table 1. Human production of carbon dioxide (Kajtár and Szekeres, 2011)

Activity	ΣQ [W/pax]	breathing $\dot{V}$ [m^3/h]	KCO_2 [l/h]	O_2 consumption. [l/h]
rest position		0,3	12	14
I. sit, read	120	0,375	15	18
II. very easy work	150	0,575	23	27
III. easy work	190	0,75	30	35
IV hard work	>270	>0,75	>30	>35

Max von Pettenkofer in the 19th century he examined the air of comfort premises and rooms, which he used to classify the quality of indoor air by its CO_2 content in his 1858 publication. It has been shown that indoor air quality (flats, schools, lecture halls) differs from outdoor air, with outdoor air having a carbon dioxide concentration of 0.03-0.04 vol% (300-400 ppm), in flats measured 0.09 vol%, while it showed significantly higher values in the lecture halls. Accordingly, it has been established that a maximum CO_2 concentration of 0.1 vol% (1000 ppm) in air is the criterion for "good air". This value was named by the profession as Pettenkofer number (Pettenkofer 1858).

Based on further studies, the effect of airborne concentrations of CO_2 on humans can be described like bellow (Kajtár and Szekeres 2011):

- 1 000 ppm (0,1 tf %) Pettenkofer number,
- 25 000 ppm (2,5 %) no effect,
- 30 000 ppm (3 %) strong deep breathing,
- 40 000 ppm (4 %) causes headaches, tinnitus, palpitations, dizziness, psychological excitement for hours,
- 50 000 ppm (5 %) May cause death after 0.5 to 1 hour,
- 80 000-100 000 ppm (8-10 %) immediate death.

The effect of carbon dioxide concentration on a person's well-being Herceg (2008) examined the connection between the indoor air quality of office spaces and the performance of office work. He examined and quantified the effect of carbon dioxide concentration on human well-being. He found that, after staying indoors for more than 3,000 ppm of carbon dioxide for 2 times 70 minutes, healthy young people were rapidly deteriorating their well-being.

When learning about thermal comfort factors, it is important to clarify the various temperature values and effects that can be used to classify and evaluate the heat loads that affect people. Thermal environment refers to the property of the environment that influences the heat exchange between the human body and the environment. According to Magyar (2011), the thermal environment can be characterized by the following factors:

- relative humidity.
- local discomfort factors (surface temperature, vertical air temperature difference, radiation temperature asymmetry, draft);
- operating temperature;
- general thermal comfort characteristics (PMV-PPD);

Local discomfort factors need to be investigated, since interior space often meets the general criteria for thermal comfort, but local discomfort may occur at some points in the space (Fanger et al. 1980) and (Madsen 1980). Other standards also describe the indoor air condition with the operating temperature (MSZ EN 15251: 2008, ASHRAE 55: 2010).

General thermal comfort is characterized by PMV-PPD (Predicted Mean Vote / Predicted Percentage Dissatisfied) values (see Fig.2) (MSZ EN ISO 7730: 2006, MSZ CR 1752: 2000, MSZ EN 15251: 2008, Ashrae 55: 2010). Fanger developed his theory by collecting subjective heat sensory data from many individuals (Fanger, 1970). The so-called Fanger-diagrams are used to dimension the interiors, which we can use to provide PMV = 0.

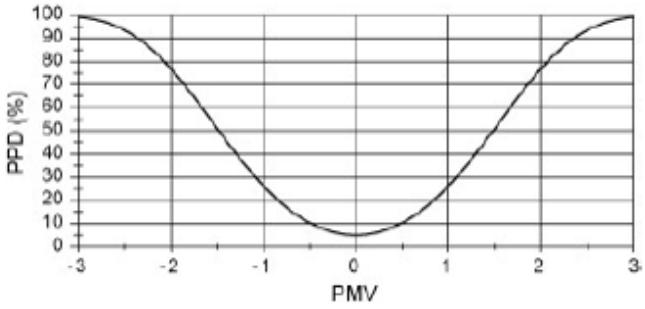

Figure 2. A PMV és a PPD elméleti kapcsolata (Fanger 1970)

Fanger has developed comfort diagrams based on the heat balance equation, which can be used to scale the interior environment from a heat sensing perspective.

The connections between accommodation comfort parameters and soldier individual combat field performance should be determined by the relation connections recently discovered by network science. In our research, we need to assess what soldiers consider important to themselves in the foreign mission, according to their individual interests, for which a priority order can be set. It is also a matter of importance that the Commanding Staff attaches importance to the provision of subordinate personnel in a foreign mission, which is expected to maintain a high level of military morale.

Tested facility and test method

Objective investigations are primarily carried out by monitoring the interiors of the Border Guard Bases (see Fig.3) installed at the southern border of Hungary, at 4 locations. The facility under investigation is a mobile building complex consisting of containers for up to 150 people. Containers have dimensions and benefits that conform to the ISO standard system. The construction is based on a stable frame structure and a removable panel system. The container carrier system is designed and assembled on the basis of the Mobilbox Ltd. (http://mobilbox.hu) type design. As a foundation, the compacted crushed stone bed will be laid with 3 concrete pavement slabs on top of each other, at 6 points for 20' containers.

Figure 3. Observed Temporary Facility

In our tests we measure the parameters of indoor air quality. To determine the amount of fresh air, we plan to measure the CO_2 concentration in the air during sleep, primarily in a 20' ISO (2mx6mx2.5m) container suitable for transportation, are equipped to accommodate 4 people, with 2 bunk beds, meeting minimum requirements specified in 1436.2007-HDF HC. Observation of sleep of the 4 people is planned during 6-8 hours of sleep without the use of ventilation equipment. The measures how the concentration of CO_2 in the 30 m^3

room air changes. At constant AQ, we adjust the CO_2 concentration (500-800-1500-2000-3000 ppm) to test the soldiers for freshness, well-being and performance in the following two ways:

- The participants fill out a questionnaire about the freshness and well-being of the subjects.
- The subjects perform a shooting exercise to test their performance, while measuring the results.

In the course of our research, we are investigating the AQ comfort required for accommodation as a place for relaxation and preparation in a facility set up on the southern border of Hungary. We measure the temperature set by the soldiers. According to the average of the measured temperature, a questionnaire is filled out about the satisfaction with the set temperature value. We plan to carry out the measurements continuously, while we pay special attention to the hottest - ie July - and the coldest - January.

Based on the expected temperatures measured during our research and the characteristics of the various camp building materials and equipment used, such as containers and tents, we determine the need for heating or cooling (thermal)energy. Based on our results, simulating the average daily temperature at the site of application, we determine a proportionality factor for the use of different camping materials, one of the highest rates of energy demand among operational tasks, the internal temperature to be provided. The connection between the proportional differences in energy requirements identified in our research with the military use duration assignment, is generally applicable and can be compared to the transport and installation resource requirements of various camp building materials.

The connection between accommodation comfort parameters and soldier individual combat field performance should be determined by the relation connections recently discovered by network science. Soldiers fill out a questionnaire about the issues of interest to them in the Foreign Mission, with priority and preference order established. The Command Staff questionnaire should be used to assess what is important to serving the subordinate staff in a foreign mission, and what is expected of maintaining a high level of military morale.

Results

In the first phase of our research work, we measure the temperature sensed by the soldiers in the military camp, office and accommodation (see Fig.4). The desired thermal comfort indices can be determined from the measured data.

When evaluating the data measured in office containers, one should take into account the working time schedule, which is usually between 08.00 and 17.00 daily. From the measured data it can be stated that the temperature of the indoor air gets warm every day when the working time start and decreases monotonically after the working hours. (see Fig. 5).

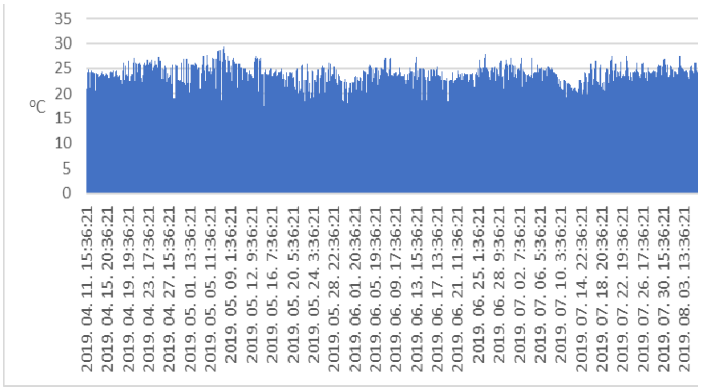

Figure 4. Measured internal temperature in an accommodation container

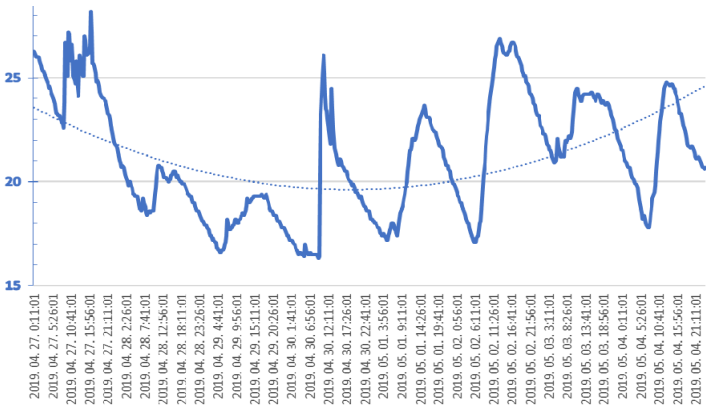

Figure 5. Measured internal temperature in an office container

To simulate the real expected internal temperatures, by simulating the average annual outdoor temperature depending on the location, we set up a mathematical model to determine the energy requirements of the camp constructed with different materials. The model can accurately determine the geographic location of military camps and the duration of their use, as well as the amount of energy required to meet the seasonal outdoor temperature.

Summary

An important part of our research is the study of Indoor Air Quality (AQ) in military camps. On the one hand, we assess carbon dioxide (CO_2) contamination in the rest areas of military camps and its impact on soldiers' morale. The internal unit air space of the accommodation unit container is 30lm^3, which can accommodate up to 4 persons in the field, according to the installation requirements. Measurements determine the heating or cooling energy demand of the military camp. Based on the

data, we will simulate the energy requirements for different camp constructing materials over time. The results of the time difference simulated energy demand show a generally applicable correlation with the duration of military assignment.

The relationship between accommodation comfort parameters and individual soldier performance should be determined in the context of the recent discovery of network science. In our research, we assess the importance and importance of soldiers in foreign mission, according to their interests, for which is prioritized. Overall, we determine the effect of military camp accommodation comfort on military morale and the corresponding accommodation comfort optimum based on the issues of comfort theory and network science.

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The different transmission of air pollutants in Morocco

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Abstract

The dispersion of air pollutants in the atmosphere is becoming an obsession for many researchers, and it is one of the most critical issues nowadays. Morocco has been engaged in many international agreements, to decrease the emission of air pollutants. But until now the modeling of the dispersion of air pollutants in Morocco is still an open field for research.

Figure 2. Moroccan Map (Rough guides)

The diversity of the geography in Morocco makes the modeling a challenge for any researcher because it includes different types of nature like oceans, mountains, urban, desert and plains areas that each of those need a different model with many different parameters that control the dispersion of air pollutants.

In this paper, we will present all the geography of Morocco, and the changing of the climate and the air pollution measurements available. Also, it will contain some mathematical models that could be used and developed to control and predict the transmission of the pollutants in the atmosphere.

Keywords

Pollutant transmission, desert, mountains, plains, climate

1. Introduction

Situated in the top northwest of Africa, and about 14km from Spain, The Kingdom of Morocco has a strategic position that places the country as an important partner for the European Union.

With an area of 712 550 km2 and a coastline of 3600 km, Morocco benefits of a remarkable diversity of nature that meet snow-capped mountains and palm forests, Saharan hills, and green plains. The population is about 35,670,299 according to the High Commission for Planning of Morocco (HAUT COMMISSARIAT AU PLAN MAROC).

Since its appointment in April, 2017, Morocco's government coalition led by the Justice and Development Party (PJD) has moved along with rolling out the pro-poor reforms initiated under the previous government, focusing mainly on social protection programs, job creation and reducing economic disparities across the country.

Following up on Royal guidance, the government is currently working to develop a new Development model for the country based on enhanced education and vocational training programs and bolder policies to boost job creation and promote inclusive growth through a modernized Social protection system.

Real GDP growth slowed down in 2018 to an estimated 3 percent compared to 4.1 percent in 2017, owing to the decline of agricultural value-added growth, which was only partially compensated by otherwise good performance of nonagricultural activities. Mining activities contributed the most to growth apart from agriculture, mostly driven by phosphates production and exports. The unemployment rate slightly decreased to 9.8 percent, yet it masked a protracted decline in the labor force participation, which dropped by 0.5 percentage point to 46.2 percent. With an exchange rate pegged to a basket of euro and U.S. dollar, inflation remained below 2 percent. (The world bank IBRD, 2019)

The transmission of the air pollutants in the atmosphere is now a problematic that attract the attention of many researchers around the world, and the

understanding and the modeling of the transmission of the pollutants in the atmosphere allow the developing many ways to decrease the percentage of the pollution in our atmosphere.

Fewer are the research that was done for this purpose in Morocco. The challenges that represent the nature of Morocco make the research very wide and have a lot of branches and work that need to be done according of the available data from Moroccan government.

The Figure 2 shows the process of emission, transmission, immersion and deposition of the air pollution.

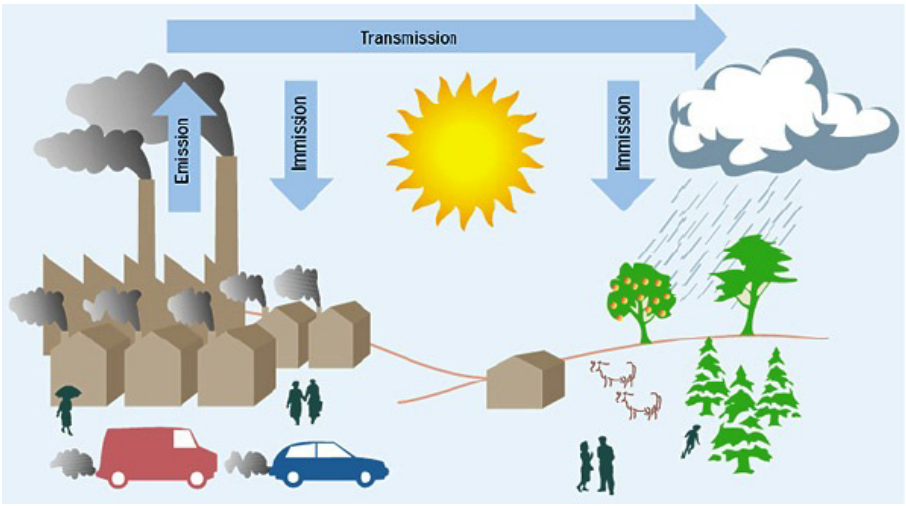

Figure 3. The process of emission, transmission, immersion and deposition of the air pollution (Westliche Riederwaldsiedlung, 2011)

The purpose of the research will be to build mathematical models for many region of Morocco, using many basic mathematical models for Air transmission and taking into consideration all the possible parameters. Our focus will be on the industrial and big regions like Casablanca, Rabat, Tangier and other that contain the phosphate industries and mines, and try to cover as many regions that have a data for air pollution statistics.

2. Mountains of Morocco

Morocco has four mountains chains formed at different times that succeed each other from north to south of the country very dissimilar in extent and altitude.

Starting with the Rif Mountains that extends in an arc of the Atlantic Ocean to the west, in the country of the lower Moulouya to the east. The Rif falls on the Mediterranean by a rocky coast; to the south, it gently descends into low hills, called pre Rifean hills. Although low overall, although the Tidirhine peaks at

2,465 m, the Rif is very compartmentalized with narrow, short, narrow valleys and steep-sided clumps, very much eroded. This results in great difficulties for crops, for road equipment as for the development of urban centers often landed on steep hills like Chefchaouen and Taounate.

The Atlas Mountains, where the highest chains of North Africa are located, extend on a south-west/north-east axis, on the Atlantic Ocean and the Rif the Taza depression. This massif is composed of 3 chains:

1. The High Atlas, about 80 km wide, covers a length of 700 km. The relief is diversified. There are in turn of the west, plateaus of altitude lower than 2.000m, then ancient massifs (among which Djebel Toubkal, the highest point with 4.165 m of altitude).
2. The Middle Atlas is composed of 2 parts: The calcareous hills in the northwest (2,100 m) and the east are pleated mountains (with the Djebel Bounaceur at 3,326 m of altitude).
3. The Anti-Atlas, meanwhile, is an older massif extending to the west with wide radii of curvature direction east-west to the north-west (djebel Aklim with 2,531 m altitude). (Seconde Communication Nationale , 2001)

Figure 4. Geographic map of Morocco (LAROUSSE)

3. Plains of Morocco

The plains extend over large areas of the territory: they are located along the Atlantic coast (Gharb, Chaouia, Doukkala, Souss), along the Mediterranean coast (Martil, Laou, Triffa), inside, like the plains of Tadla and Haouz, and in the Oriental as the plain of Moulouya.

The plateaus occupy most of the territory and are located at varying altitudes: 200-400m near the Atlantic coast (Larache zone, Zemmours, Zaer), 500-900m west of the Middle and High Atlas ranges (Saïs and phosphate plateaus) and altitudes up to 1500m (Zaïan, Causses of the Middle Atlas, and Highlands of the Oriental). This is how we can distinguish, among the different plateaus and plains:

The large ensemble located in the central plateau bordered by coastal plains (Chaouia, Doukala, Abda) or phosphate plateaus.

The plains and highlands like that of eastern Morocco located between the Atlantic slopes, the Mediterranean coast, and Algeria.

The vast pre-Saharan areas in the form of dips dotted with elevations or hard rocks. (Seconde Communication Nationale , 2001)

4. Moroccan Climate

Morocco is a country in the subtropical zone of northwest Africa. It is characterized by a very different climate depending on the region. In fact, coastal areas have a temperate climate, while the climate is desert in the south and east of the country. The Moroccan climate has many distinctions: the Mediterranean in the North, Atlantic Ocean in the West, continental inland and Saharan in the South. The climate also varies according to the seasons.

First, the Coastal regions spring in these regions is characterized by a bright sun with a sea breeze that refreshes the atmosphere. The month of March is well watered near the Mediterranean and North Atlantic. The rains are less important down towards the south. During the summer the sunshine reaches 9 to 10 hours with good weather on the coastal areas. The temperatures reach their peaks during the summer. This season is considered the driest of all the year. At the end of summer, the south is subject to strong south to southeast winds, hot, dry and loaded with sand, while the Atlantic seaboard experiences northwesterly winds. In autumn, the majority of the Atlantic coast is subject to a strong northwesterly wind. The temperatures are pleasant and the rains reappear at this time, they are more frequent in November. The winter season has an average sunshine of 5 to 6 hours a day. Temperatures are relatively temperate. January is considered the coldest month. This season is the rainiest, especially at the footing of the Rif as well as from Tangier to Kenitra. On the rest of the Atlantic coast, the rains are less and less strong down towards the south.

Second, the highlands and mountains, from Rif to Atlas, spring in these regions is characterized by fairly high temperatures, despite a few cool mornings accompanied by frosts. A few stormy showers of rain still regularly bring some water, or snow in the high mountains. In summer, the weather is often stifling in

the highlands but sometimes tempered with violent isolated storms. In the mountains, the atmosphere is more pleasant with cool nights. During the autumn season, the climate on the highlands is pleasant, despite the presence of some stormy rains. In the mountains, the first snow appears in early November. Winter is cold and very wet in these areas. This is the period of water reserve required for irrigation for the following seasons.

Finally, the desert of Sahara is characterized by the clouds and the rains are rarer in spring period, and the temperatures are quite high. Summer in the Sahara desert has a very hot and very dry climate. On the other hand, autumn is more humid. In winter, the average sunshine is 5 to 6 hours per day. The temperatures can have very important differences during the days. During these three months, the rains in the form of a violent storm remain very rare. The Moroccan climate is mostly arid. Two exceptions are recorded: the extreme north where the climate is subhumid, and the region of Ifrane where the climate is humid. The further you go to the south and southeast of Morocco, the more arid is the climate. (Direction de la Météorologie Nationale, 2011)

5. Pollution of the Air:

Over the last fifteen years, the development of Morocco has been accompanied by a very rapid increase in local and global air pollutant emissions to the point that they have become today a national concern with repercussions on health and on the living environment of the population living in highly urbanized or industrial areas. (Ministère Délégué auprès du Ministre de l'Energie des Mines, de l'Eau et de l'Environnement Chargé de l'Environnement, April, 2016)

Morocco is also part of emission of Green House Gases (CO2, N2O and CH4) (See Figure 3).

The Energy sector is responsible for emission of more than 50% of the total GHG every year in Morocco, that's why the country is taking the way to invest in many projects of Renewable energy stations (Solar and Wind energy), benefiting of more than 3,000 hours per year of sunshine and an annual average wind speed of 9m/s.

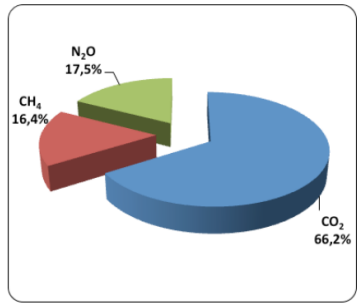

Figure 5. Distribution of the Green House Gase emissions in 2012 (Ministère Délégué auprès du Ministre de l'Energie des Mines, de l'Eau et de l' Environnement Chargé de l'Environnement, April, 2016)

The atmospheric pollution in Morocco:

The main air pollutants emitted by human activities are carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter and dust (PM), sulfur dioxide (SO_2) and volatile organic compounds (VOCs).

Their excessive concentrations in the ambient air are harmful for the human health but also the fauna and the forest. Human activities also emit heavy metals such as lead (Pb), mercury (Hg), cadmium (Cd), arsenic (As) into the atmosphere, chromium (Cr), copper (Cu), nickel (Ni), selenium (Se) and zinc (Zn). These pollutants and their combinations can be highly toxic and significantly degrade soils, surface waters, forests and crops.

The increase in NO_x and SO_2 emissions is proportional to the development of the industry's activities, particularly in the phosphates and refineries sector, and the development of electricity generation using high sulfur fuels, including heavy fuel oil (4% sulfur) and coal (1.5%). It should also be noted that some industries also do not respect the emission standards. (Ministère Délégué auprès du Ministre de l'Energie des Mines, de l'Eau et de l'Environnement Chargé de l'Environnement, 2015)

NO_x emissions are also largely generated by the road transport sector, and emissions of carbon monoxide (CO) and benzene (C_6H_6) are mainly from the same sector. Between 2000 and 2010, emissions of NO_x and SO_2 from transport nearly doubled (Figure: 4). Growth in the number of cars (from 1.6 million in 2000 to 3.4 million cars in 2014) and more particularly the increase in the number of trucks, as well as the aging of the fleet and its poor maintenance are at the base of this growth in emissions. In addition, the use of individual vehicles has developed in cities, increasing automobile congestion, ultimately resulting in an additional increase in fuel consumption and pollutant emissions. The number of millions of vehicles - kilometers / day traveled annually increased from 47 to 84 million between 2002 and 2011. Lead emissions have nevertheless stabilized a direct effect of fuel quality legislation.

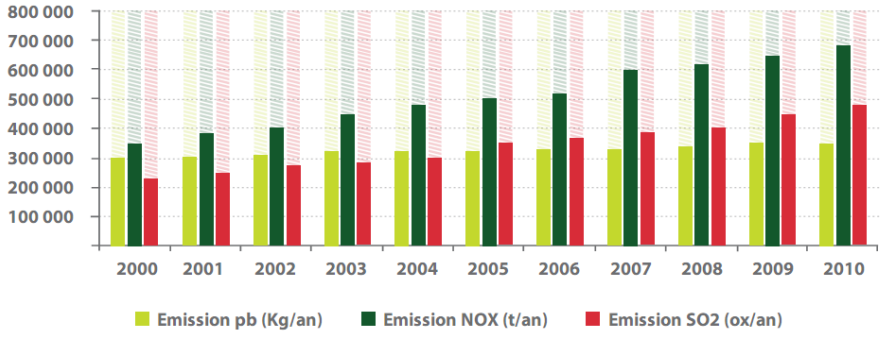

Figure 6. Air pollutant emissions by the transport sector (Ministère Délégué auprès du Ministre de l'Energie des Mines, de l'Eau et de l'Environnement Chargé de l'Environnement, 2015)

6. Model of transmission

The Gaussian model

The Gaussian plume model is a commonly used model for air pollution transmission. It is based on a simple formula that describes the three-dimensional concentration field generated by a point source under stationary meteorological and emission conditions. (Zannetti, 1990)

The Gaussian plume model is charachterized by the following equation (1):

$$c = \frac{Q}{2\pi\sigma_h\sigma_z|\overline{u}|}\exp\left[-\frac{1}{2}\left(\frac{\Delta_{cv}}{\sigma_h}\right)^2\right]\cdot\exp\left[-\frac{1}{2}\left(\frac{z_s+\Delta_h-z_r}{\sigma_z}\right)\right] \quad (1)$$

where c(s, r) is the concentration at r = (x_r, y_r, z_r) due to the emissions at s = (x_s, y_s, z_s); Q is the emission rate; $\sigma_h(j_h, d)$ and $\sigma_z(j_z, d)$ are the standard deviations (horizontal and vertical) of the plume concentration spatial distribution; j_h and j_z are the horizontal and vertical turbulence states ; d is the downwind distance of the receptor from the source.

Eulerian model

Eulerian model is based on fixed grid in space, each grad point represent the dispersion of pollutants calculated based on local concentration gradients. The main advantage of this model is that it can handle complex chemistry pollutants. (Visscher, 2014)

$$\frac{\partial\langle c_i\rangle}{\partial t} = \overline{U}\cdot\nabla\langle c_i\rangle - \nabla\left\langle c_i'\overline{U}'\right\rangle + D\nabla\langle c_i\rangle + \langle s_i\rangle \quad (2)$$

Where U is wind field vector U(x,y,z), $\overline{U}$ is average wind field vector, U' is fluctuating wind field vector, c_i is concentration of pollutant for i^{th} species, <c> is average pollutant concentration, c' is fluctuating pollutant concentration, D is molecular diffusivity and S_i is source or sink term. (Ravi , Zengdi, & Jeremy, 2016)

Conclusion

Developing and using the two mathematical models presented in this paper to control and predict the transmission of the air pollutants will be the future task for this research. Other models can be used if the Gaussian and Eulerian model are not valid or have big marge of error. Also further experiments will take a part in order to validate and compare the theoretical results.

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Agricultural flexible driving in precision machine function relevant operating parameters

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Abstract

The efficiency of V-belt drives is determined by several factors collectively: the slip, the external and inner friction. In this paper the slip of the V-belt was studied as loss intensity as a function of drive parameters. The individual effects of V-belt drive parameters on speed loss are determined using one-factor-at-a-time (OFAT) test method. It was justified in the scope of the major characteristics affecting power loss that by ideally selecting the parameters of the V-belt drive power loss can be measurably reduced. Based on earlier results as well, a regression model was used to examine the slip of the V-belt. On the bases of the test results optimal parameters can be calculated to give references for V-belt drive design.

Keywords

precision machine management, V-belt, Power loss

1. Introduction

In order to increase productivity the agricultural sector is characterized by a high degree of mechanization as of the mid-20th century, thus agricultural machines have had to meet high expectations. Proper operation is essential for the optimal utilization of valuable equipment. Machine operation can be optimized based on data collected about the CAN-bus system of the power machine. Our goal is to determine the data necessary for this.

In the development of agricultural machines in addition to the enhancement of performance and reliability an important aspect is economical operation, which is true of all the parts of the machine structure. In order to increase efficiency producers put great emphasis on the development of engines as well as the components of working units and power transmission, which are aimed at improving the overall performance of the machines. In agricultural practice flexible tractive element drive is widely used for the power supply of the units, which encourages our research in the field of belt drives. Through in-depth

analysis of the functioning of the drives an accurate picture of the important drive characteristics relevant for the operation can be obtained.

2. Literature overview

The efficiency of V-belt drive (η) is the ratio of useful and input power. The useful power appears on the driven shaft, which is the product of the peripheral force (F_{t2}) and the peripheral speed (v_2) delivered to the pulley. The input power is fed into the system on the drive side, via the drive pulley (Kátai and Szabó, 2015):

$$\eta = \frac{P_h}{P_b} = \frac{F_{t2} \cdot v_2}{F_{t1} \cdot v1} \tag{1}$$

belt slip occurring during power transmission:

$$s = \frac{v_1 - v_2}{v_1} \tag{2}$$

By further converting the efficiency equation, we get an equation of two members. The part in the bracket means the lost motion, and κ means the losses occurring on the peripheral force.

$$\eta = \frac{F_{t2}}{F_{t1}} \cdot (1 - s) = \kappa \cdot (1 - s) \tag{3}$$

Typically, the studies published so far have dealt with the power loss of V-belts through the study of lost motion and other torque losses. According to Gervas and Pronin (Gervas and Pronin, 1967, 1969) the torque loss of V-belt drives is partly derived from the inner friction of the tractive element, which in addition to the deformation caused by the belt side forces mainly comes from its bending, and from the radial friction loss, which is generated by the belt element entering and exiting the pulley groove. The loss of motion is made up of the circumferential belt slips.

3. Material and method

In order to study the drive parameter the measurement program was compiled on the basis of a standard test method (One-Factor-at-a-Time), where at one time one of the drive parameters was modified with the fixed value of the other drive characteristics. A multivariate regression model was used to qualitatively

analyze the measured data. The adequacy of the models was verified by variance analysis (ANOVA), and the value of the coefficients of the variables in the model was calculated. The weight of the individual factors was determined i.e. how each drive characteristic affects the dependent variable compared to the other independent variables. The data were analyzed using the software Statistical Package for Social Science (SPSS).

4. Results and evaluation

The factors influencing the torque loss among the drive parameters were determined with the help of the the temperature rise of the V-belt, i.e. the difference between the initial and saturation temperature. The model of the increase in temperature of the belt:

$$\Delta T = -17.1 + \frac{2317.476}{d} + 0.472 \cdot f + 4.430 \cdot M \tag{4}$$

During the study of the drive parameters in addition to the belt temperature the drive slippage was measured continuously, by which the existence of operational state was monitored at the same time. The model based on the regression equation set up during the temperature tests:

$$s = 1.147 \cdot M + \frac{49.144}{d} - 0.379 \cdot F_H \tag{5}$$

By studying the drive parameters it is possible to create the energy balance of the drives included in the experiment. The efficiency of drive is the ratio of useful P_h and input power P_b:

$$\eta = \frac{P_h}{P_b} = \frac{M_2 \cdot \omega_2}{M_1 \cdot \omega_1} \tag{6}$$

where the input power is the product of the torque (M_1) measured on the drive side and angular speed (ω_1). The useful power was determined from the torque (M_2) and angular speed (ω_2) values of the driven shaft. During the experiments carried out the efficiency of the V-belt drive varied between η=0.82 and 0.97. Power loss can be determined with the help of the drive parameters measured during the tests:

$$P_v = P_b - P_h = M_1 \cdot \omega_1 - M_2 \cdot \omega_2 \tag{7}$$

The loss can be further subdivided into power losses resulting from torque and motion loss according to the three equations:

$$P_v=P_{nyv}+P_{mv} \tag{8}$$

where the torque loss can be determined by the product of the difference of the measured torques and the angular speed of the driving side:

$$P_{nyv}=(M_1-M_2)\cdot\omega_1 \tag{9}$$

The motion loss reduces the theoretically determined angular speed of the driven shaft, thereby also contributing to the power loss:

$$P_{mv}=M_2\cdot(\omega_1-\omega_2) \tag{10}$$

By substituting equations 9 and 10 in equation 8 equation 7 is obtained:

$$P_v=(M_1-M_2)\cdot\omega_1+M_2\cdot(\omega_1-\omega_2)=M_1\cdot\omega_1-M_2\cdot\omega_1+M_2\cdot\omega_1-M_2\cdot\omega_2=M_1\cdot\omega_1-M_2\cdot\omega_2 \tag{11}$$

The power transmission of the test settings varied between 450 and 1660 W, where the power loss (20-153 W) is also a setting dependent value. The further resolution of the loss is estimated by variance analysis, based on the variance of the independent variables (Figure 1).

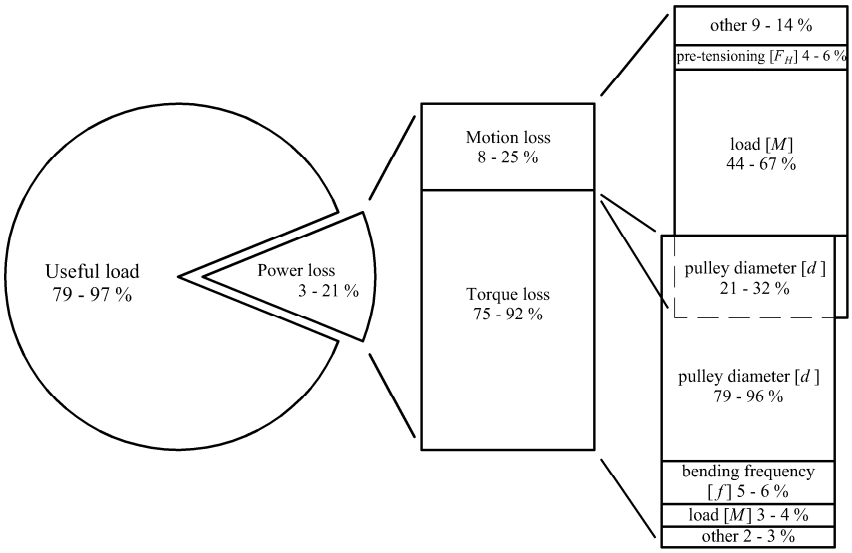

Figure 1. The qualitative energy balance of the V-belt drive
(Profile Z/10; d=60-180 mm; i=1; f=10-20s^{-1}; M_1=3-18.3 Nm; F_H=50-300 N; a=345±10 mm)

3-21% of the input power of the tested V-belt drives is loss. Most of the power loss, 75-92% is torque loss and the remaining part is motion loss. The

torque loss originated mainly from the bending of the V-belt (internal friction) determined by the radius of the bending of the belt and its frequency. The frictional loss of the contact surfaces of the force-locking drive is manifested in a complex manner. On the one hand, from the repeated deformation of the surface of the V-belt, which is realized as torque loss and made up of the relative displacement of the belt element. Motion loss is influenced by the frictional conditions of the contacting surfaces determined by the size or change of the transferred peripheral force (the course of the deformation along the curve length) and the pre-tensioning of the V-belt.

Conclusions

The power loss of V-belt drives comes from the loss occurring on the motion and peripheral force. The mathematical model of the temperature rise of belts was created as a function of the drive parameters, and the impact of each parameter was determined by weighting the individual variables. As a result of the series of experiments the mathematical model of the drive slippage was set up for the whole system, and the impact of the drive parameters on the studied phenomenon was also determined. Using the results the energy balance of the V-belt drive was created, and the impact of each component was analyzed, in this way the drive characteristics important in terms of the operation can be determined.

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Application of neural networks in assessing ecological systems

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Abstract

In this study neural networks were applied to analyse parameters of ecological systems. The research targeted the aerobic parameters of Danube, with special focus on dissolved oxygen concentration. For the purposes of hydrological analysis a reference model containing all sampling points on the river randomly allocated to either the training or the test set and a spatial configuration were developed. This latter assessed data from three alternative locations, two of them were homogenous stations and the third one as the last neighbouring station down the river was non-homogeneous. The objective was to define the most efficient data structure for the training set. Using results from the configuration implementing the spatial optimisation of Danube we justified that if the training set was of mixed structure (it contained data from both homogenous and non-homogeneous stations) then this yielded a more efficient estimation.

Keywords

Combined cluster and discriminant analysis, General Regression Neural Network, Radial Basic Function Neural Network, spatial forecasting, spatial optimisation

1. Introduction

Industrial activity in the last centuries, utilisation of artificial fertilisers in agriculture, effect of urbanisation and the increasing utilisation of fossil energy caused a harmful change in the water quality of surface waters, therefore the supervision of water quality parameters is becoming an important task. Dissolved oxygen concentration (DO) is a very significant parameter in characterising the condition of aquatic ecosystems, thus forecasting its concentration using easily available and measureable parameters can be considered an important scientific achievement.

The estimation and forecasting of the water quality parameters (WQPs) is frequently performed by researchers with various types of artificial neural network (ANN) based techniques relying on machine learning. This is reasonable as the application of neural networks require only data input and no other preconditions (Chen et al., 2014). Furthermore these models are able to map the complex relationship between input and output data (Najah et al., 2011) and generalise the results appropriately (Wen et al., 2013).

The application of ANNs require the breakdown of the total dataset into the training and the test sets, the training sets configure the parameter of the models, and the test sets are used to measure the general goodness of these models. The performance and ability to generalise crucially depends on the definition of these sets. Partitioning of the data set can be undertaken in three alternative approaches. The first approach randomly distributes the data into the training and the test set, in this case the given outcome is simulated and modelled for the whole system. The second approach breaks down the data set into two temporally distinct sets of data, the larger, earlier time interval contains the training set, the narrower interval contains data from the later period, this can be considered a temporal forecast. The third partitioning method distributes the data set by neighbouring sampling locations into the training and the test set, this can be called a spatial forecast.

The articles studies mostly assess parameters typical for aerobic conditions of surface waters, among others biological oxygen demand, chemical oxygen demand and dissolved oxygen content. Most researchers estimate this latter parameter in riverine waters with different input variables and alternative models (Antanasijević et al., 2014; Ay and Kisi, 2012; Bayram and Kankal, 2015; Csábrági et al., 2015, 2017, 2019; He et al., 2011; Keshtegar and Heddam, 2017; Najah et al., 2014; Šiljić Tomić et al., 2018; Wen et al., 2013).

Studies typically distribute data randomly into the training and test set (Antanasijević et al., 2014; Bayram and Kankal, 2015; Keshtegar and Heddam, 2017; Najah et al., 2014; Wen et al., 2013), some used a single model (Multilayer Perceptron Neural Network or General Regression Neural Network (GRNN)) (Antanasijević et al., 2014; Wen et al., 2013), while others applied two types of models (Bayram and Kankal, 2015; Keshtegar and Heddam, 2017; Najah et al., 2014) to compare the results gained.

In some cases temporal forecast was implemented (Ay and Kisi, 2012; Csábrági et al., 2015, 2017; He et al., 2011; Šiljić Tomić et al., 2018) with one (Šiljić Tomić et al., 2018) two (He et al., 2011) or three (Ay and Kisi, 2012, Csábrági et al., 2015) models applied. There is also an example for the application of four models (Csábrági et al., 2017).

Although there are countless examples for random allocation, and many examples for temporal forecasts, spatial forecasts are not frequent in the literature. One source dealt with spatial forecast beyond temporal forecast using two sampling sites to estimate dissolved oxygen content of riverine waters (Ay and Kisi, 2012), furthermore there is one case, where spatial forecast for dissolved oxygen content of multiple sampling sites was implemented using

neural networks (Csábrági et al., 2019) but there is an example of spatial interpolation too (Mitrović et al., 2019). Our goal here is to implement spatial forecast for DO of the sampling points of the River Danube and define the most efficient structure for the training set.

2. Materials and methods

Study area

Danube is the second largest river in Europe with a containment area of 817 000 km^2, its length is 2 817 from the Black Forest (Germany) to the Black Sea (Romania). The Hungarian section is 417 km long, with an average run-off of 2 000 m^3/s. There are 12 sampling sites in Hungary (Fig. 1).

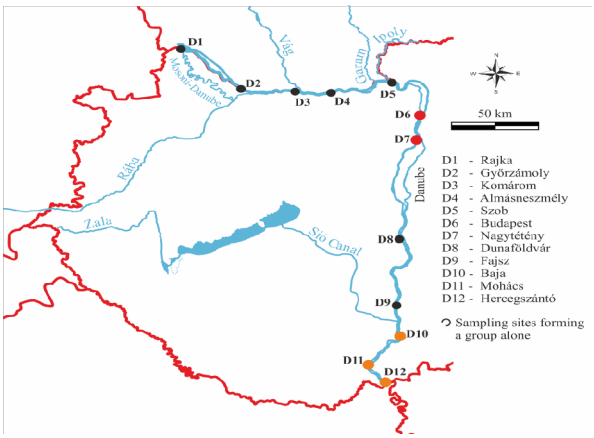


Figure 1. Homogenous groups defined by CCDA on Hungarian section of the River Danube (Kovács et al., 2015)

Input parameters and preprocessing

To estimate dissolved oxygen concentration (output: DO) on Danube the following four WQPs were used as input: runoff (RF, Q, m^{3}sec^{-1}), water temperature (WT, T_w, ^{o}C), pH and electrical conductivity (EC, µScm^{-1}) as easily measureable non-specific standard parameters. The data were preprocessed and standardised before the application of neural networks. The equidistance of data is not a precondition thus data filtering means the control of data availability for all input parameters. If the dataset has any missing values the element has to be deleted.

Applied models

A radial basis function neural network (RBFNN) is a frequently used type of artificial neural network, which contains a feed-forward structure including one input layer, a single hidden layer, and one output layer (Broomhead and Lowe, 1988). The models are trained in two stages, in the unsupervised first stage the

parameters of the Gaussian kernel functions (GKF) are set (Kim and Kim, 2008). In the second stage the weights of the output and hidden layer, the distortion factor and hidden layer's neuron count is defined by the algorithm to minimise mean square error (Gourine et al., 2012). The smoothing factor (σ) must be given before training the model (Demuth and Beale, 2000); it represents the shape of the calculated GKF. The hidden layer neuron count and the respective smoothing factor are provided for all computation result of the RBFNN model.

GRNN is a modified form of the RBFNN model (Kim and Kim, 2008), but unlike the RBFNN, GRNN is a one-pass network (Antanasijević et al., 2014). GRNN is a feed-forward supervised learning neural network, which consists of four layer, including the input layer, pattern layer, summation layer and output layer (Specht, 1991). Each input unit in the first layer corresponds to an independent parameter in the model and the number of pattern neurons is equal to the number of data samples. The training between the input layer and the pattern layer corresponds to the learning between the input and the hidden layer of the RBFNN. The smoothing factor is the only "unknown" parameter in the GRNN training and needs to be determined manually or using an iterative algorithm (Antanasijević et al., 2014). The pattern neurons are connected to two neurons in the summation layer: the S-summation neuron and the D-summation neuron. The weights between the S-summation-neuron and pattern neurons are equal to the measured value of the output parameter and the weights between the D-summation-neuron and pattern neurons are equal to 1. The output layer simply divides the S-summation neuron by the D-summation neuron to gain the predicted value. Values of sigma-factors for each result calculated by the GRNN-model will be provided in our paper. Both neural networks were run in a MATLAB environment.

Multivariate Linear Regression (MLR) is used to estimate the linear association between the dependent and one or more independent variables. MLR is based on least squares (Reddy, 2011); and it expresses the value the predicted variable as a linear function of one or more predictor variables. The theory is based on the least square method, the dependent parameter is expressed as the linear function of the independent parameters. This model was first applied to the training set to check if the individual parameters are significant in the models. These were used later to estimate the test set and to calculate statistical parameters describing the fitness of the estimation. The list of surviving parameters is provided for all MLR-based results in our paper.

The performance of applied models was assessed by two statistical parameters as follows. The root mean square error (RMSE) and the coefficient of determination (R^2) were used to provide an indication of goodness of fit between the observed and predicted values.

Application of the CCDA method on Danube

The Combined Cluster and Discriminant Analysis (CCDA) method defines homogenous groups of sampling sites. The elements of these groups are assumed to be not only similar but identical and presumed to observe the same process (Kovács et al., 2014).

The 12 sampling sites on the Danube can be allocated into 9 homogenous groups (Kovács et al., 2015), 7 are single element (D1, D2, D3, D4, D5, D8, D9) groups, one contains two elements ((D6 and D7) and one has three elements (D10, D11 and D12) (Fig. 1). The two-element (D6, D7) homogeneous group and the neighbouring downstream non-homogenous station (D8) were chosen for further assessment.

Water quality data set

The total sample size is 2028, the examined data are from 1998-2003 and approximately bi-weekly frequency. The basic characteristics of the fundamental parameters show (Table 1, *r* is the correlation factor between input parameters and DO) that temperature and water run-off have the largest variance. For the correlation factor it is enough to monitor significance for the lowest sample size station. From the three selected stations the Budapest location has the smallest sample size (136) for this sample size the correlation factor calculated from the *t*-value is significant if $|r|>0.17$. Examining data from all stations it seems that dissolved oxygen concentration and temperature have the largest correlation and all stations show significant correlation factor values. Other parameters especially water run-off are not significantly correlated.

Table 1. Descriptive statistics for the totality of stations on the River Danube and sampling sites Budapest, Nagytétény and Dunaföldvár

Stations	Sample size	Parameter	Max	Min	Average	Std. dev.	*r*
All stations	2028	Q	7590.00	237.00	2150.71	0.48	0.00
		T_w	26.20	0.00	12.14	0.58	-0.40
		pH	9.20	6.90	8.21	0.03	0.21
		EC	901.00	244.00	384.16	0.17	0.30
		DO	17.70	5.76	10.49	0.16	1.00
D6	136	Q	6550.00	908.00	2301.15	0.43	-0.01
		T_w	24.70	0.00	11.99	0.60	-0.52
		pH	9.20	6.90	8.26	0.05	0.12
		EC	570.00	280.00	383.21	0.17	0.43
		DO	13.00	6.20	9.94	0.15	1.00
D7	146	Q	6550.00	908.00	2360.60	0.43	0.00
		T_w	25.40	0.00	11.96	0.61	-0.54
		pH	9.20	7.00	8.28	0.04	0.13
		EC	570.00	280.00	386.27	0.17	0.46
		DO	13.40	6.00	10.05	0.15	1.00
D8	153	Q	5350.00	915.00	2299.28	0.39	-0.17
		T_w	25.30	0.00	12.36	0.58	-0.35
		pH	8.80	7.85	8.26	0.03	0.22
		EC	520.00	256.00	373.10	0.15	0.33
		DO	15.70	6.50	11.16	0.15	1.00

Steps of analysis of the examination

Based on the applied data set and the method of the training and the test set allocation we used two configurations. In both cases we strived to approach a 2:1 proportion of the training and the test set size for comparability. In the first configuration (Reference model, denoted with D_R) the total data set was randomly allocated into the training and the test set, this case modelled the dissolved oxygen content for the complete Hungarian section of the river (417 km). Selection was made with a random number generator using a predefined initialisation value (2000). This (D_R) model is used as a reference model and its results are the reference values.

In the second configuration the CCDA method was used to formulate homogenous groups (Fig. 1). From these groups a two-element group was used to define the most effective data structure for the training set. This necessitated the use of two homogenous stations and the next downstream non-homogenous station. This group was the homogenous group of D6 (Budapest) and D7 (Nagytétény) stations followed by their downstream neighbour D8 (Dunaföldvár) which could be considered non-homogenous. Therefore this configuration use data from D6, D7 and D8 with the training set using data from two stations and the third station serving data for the test set in order to ensure the 2:1 proportion required. This meant that altogether three cases were developed where respectively D6 and D8 (D_A) then D7 and D8 (D_B) and finally D6 and D7 (D_C) were used for the training set.

In both configurations, for the reference model and for the spatial forecasting and optimisation three models were applied, MLR and two types of ANNs: RBFNN and GRNN.

3. Results

We estimated the dissolved oxygen content of the Danube with four input parameters and in two configurations considering the spatial characteristics in selecting the training and the test sets. The first configuration used a random allocation of the total data set for the training and the test sets maintaining a 2:1 ratio. In this case the complete section of the river was modelled for the DO-concentration. The results of the D_R configuration are shown in Table 2, where the „parameters" term refers to the input variables which were used in the MLR estimation and the sigma-factor used for the GRNN and RBFNN models. In brackets the hidden layer neuron count is shown for the RBFNN models.

Results of the first configuration highlight that neural networks provide much better estimations than the multivariate linear models. The most effective estimation for the test set was achieved by the GRNN model thus our reference value will be the RMSE value from this model – 1.22 mgL^{-1}.

For all three cases of the second configuration the RMSE values were assessed to find which model was the most efficient. Results show that case D_A with the GRNN model gave the best estimation (RMSE=0.93 mgL^{-1}). For case

D_B the most efficient estimation was also provide by the GRNN model while for D_C the RBFNN turned out to be the most efficient (RMSE=1.75 mgL^{-1}). Consecutively all three cases gave better results with neural networks than with an MLR model.

Table 2. Results from the reference model (D_R) and D_A, D_B and D_C cases on the test set

Configurations	Training set + test set	Model	MLR	GRNN	RBFNN
D_R	2/3 + 1/3	RMSE (mg L^{-1})	1.39	1.22	1.27
		R^2	0.33	0.50	0.45
		Parameters	T_w, pH, EC	0.26	0.48(26)
D_A	D6, D8 + D7	RMSE (mg L^{-1})	1.27	0.93	1.08
		R^2	0.48	0.69	0.59
		Parameters	T_w, pH	0.26	0.42(32)
D_B	D7, D8 + D6	RMSE (mg L^{-1})	1.41	0.96	1.01
		R^2	0.37	0.66	0.65
		Parameters	T_w, pH	0.18	0.26(84)
D_C	D6, D7 + D8	RMSE (mg L^{-1})	1.89	1.79	1.75
		R^2	0.32	0.39	0.41
		Parameters	T_w, pH	0.34	0.15(71)

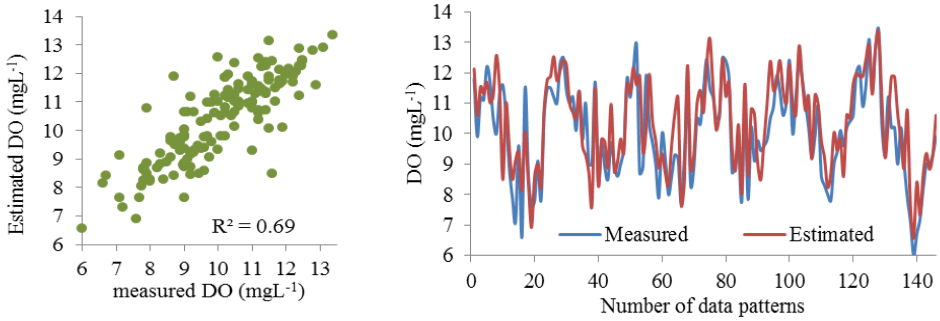
Conclusions

Results based on the second configuration (Table 2) show that the worst performance was achieved in case D_C and although the RBFNN model was the most efficient the RMSE values gained here were 88% and 82% worse than the best RMSE values of cases D_A and D_B, respectively.

The results of estimations for the D_A and D_B cases show similar statistical properties, the most efficient estimation was from case D_A and the GRNN model (Fig. 2) where data from Nagytétény station was used for the test set. The training set used for cases D_A and D_B, is of mixed structure as it contains a homogenous and non-homogenous station. The mixed structure cases thus provide a far more efficient estimation than the third (D_C) case when the training set contains the data of both homogeneous stations and the test set contains the data of non-homogeneous station. The same observation was published in our previous study (Csábrági et al., 2019).

The RMSE-values for cases D_A and D_B show an improvement of 31% and 27% over the reference value, however for the D_C case a 43% drop of performance is observed compared to the reference model. As the entire dataset in the second configuration is less than one quarter of the first configuration's dataset thus the improvement in estimation efficiency for cases D_A and D_B is quite significant. The utilisation of spatial homogeneity allowed for higher efficiency despite the reduced dataset. It has to be noted nevertheless that it

matters how the homogenous and non-homogenous sampling locations are grouped into the training and test set, a degradation of results is also possible.



a) b)

Figure 2. Scatterplot (a) and line chart (b) diagrams of measured and estimated DO at D_A

Summary

We used four input parameters to assess the dissolved oxygen content of the Danube with the aid of two neural networks and multivariate linear regression. In the first case – the baseline model – the complete dataset of sampling locations were randomly allocated into the training and test set in a 2:1 proportion. In the second case only three stations' data were used – with two homogenous and one non-homogenous station – two being the training set and one being the test set. It was found that we get a more efficient estimation if the training set contains data from one homogenous and one non-homogenous sampling site, i.e. if the training set has mixed structure.

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A novel approach to market anomaly sensing using neural networks

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Abstract

In oligopoly markets players have the incentive for collusion to increase their profit as this is typically more lucrative than a competitive attitude. As a counterpoint to the creation of cartels, legislative institutes monitor economic behaviour, within the EU the European Commission is responsible. Cartel activity is very difficult to detect and therefore some of the cooperations may have a very long lifetime. Our theoretical research investigates that if a cartel is established on an oligopolistic market, certain market tendencies or their temporal variation relative to competitive dynamics would change. Thus the existence of a cartel can be demonstrated by the changes in market share and the speed, amplitude and direction of that movement.

Keywords

oligopolies, collusion, artificial neural networks, pattern recognition

1. Introduction

The study proposes a novel approach for the identification of market anomalies. Many markets operate in an oligopolistic structure. These structures carry the inherent risk of collusion of the market players which results in loss of market efficiency, high prices and low sales volume compared to benchmark scenarios [3][5]. The detection of such structures which are illegal in most of the developed states and subject to legal prosecution turn out to be quite difficult and require a lengthy procedure to conclude [6]. In this paper the authors propose a possible approach to support this process. After providing a simple model with random cost effects and adjustment dynamics, some simulations are suggested to provide alternate market scenarios. Following these the potential

application of neural networks is discussed for the recognition of collusion patterns in the behaviour of market actors.

2. Background

Enterprises are able to distort competition by cooperating with their competitors, by fixing prices or by partitioning the market in such a way that they have a given participant monopoly. Anti-competitive agreements may be open or secret (e.g. cartels). They may take the form of a written agreement (whether it be an agreement between enterprises, or decisions or regulations of trade unions), but there may be less formal agreements as well. Enterprises involved in price-control or market-sharing cartels are relieved of the pressure to introduce new products, improve quality and set low prices [2] [4]. In the end, consumers pay more for poorer quality.

Agreements are almost always unlawful if the participants agree to:

- price fixing,
- limiting production,
- sharing markets or consumers,
- fixing resale prices (between producer and distributors).

However, the agreement may be authorized if:

- it has a positive effect rather than an unfavorable effect,
- not bound by competitors,
- collectively it is only tied to companies with a small market share,
- necessary for the development of products or services, the development of new products or the development of new and more appropriate methods of delivering products to consumers.

A cartel is a group of independent and similar, companies which join together to fix prices, to limit production or to share markets or customers between them. Action against cartels is a specific type of antitrust enforcement.

Instead of competing with each other, cartel members rely on each others' agreed course of action, which reduces their incentives to provide new or better products and services at competitive prices [18]. As a consequence, their clients (consumers or other businesses) end up paying more for less quality.

European Union competition law prohibits cartels and the European Commission imposes heavy fines on the enterprises concerned. Because cartels are illegal, their existence is generally very secret and it is not easy to find evidence.

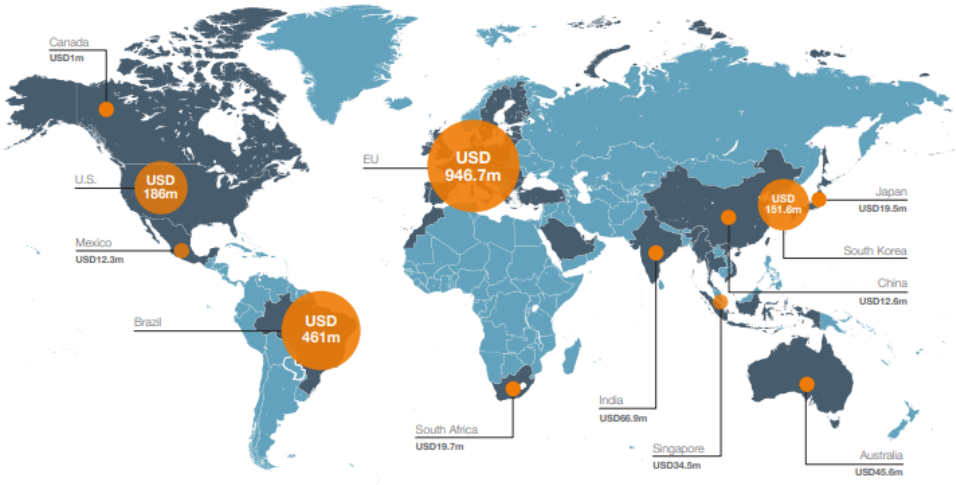
The penalties for enterprises that breach the competition rules can be very severe. For cartel infringements, the largest fine imposed on a single firm is over €896 million; the largest fine imposed on all members of a single cartel is over €1,3 billion.

Competition encourages enterprises to offer consumers goods and services at the most favourable terms. It encourages efficiency and innovation and reduces prices. To be effective, competition requires enterprises to do things independently of each other, but subject to the competitive pressure exerted by the others [19].

Cartels are the most harmful type of competition infringement. As they are secret – hidden in particular from customers – public enforcement is vitally important as otherwise many cartels would never come to light [23]. Rigorous enforcement action against cartels has therefore been the top priority of the Commission throughout the last ten years [20].

Effective public enforcement requires a mix of both ex officio and leniency cases; without ex officio cases, the incentive on undertakings to apply for leniency may be reduced. Leniency programmes are important to detect secret cartels, to collect the necessary evidence to sanction cartels and to de-stabilise cartels. Enforcement therefore requires adequate protection of leniency statements by companies – without such protection the incentive to apply for leniency is again reduced. Over the past ten years, the Commission has maintained both a good track record of ex officio cases and strong protection of leniency statements, with the result that leniency applications have continued at a high level throughout the period.

Due to the globalisation of the economy, cartels are also becoming more and more global nowadays, as it is shown in Figure 1. This implies that the geographic scope of investigations is often much wider than was previously the case. Investigation of worldwide cartels, which is undertaken alongside non-EU competition authorities, has become the norm rather than the exception.



	EU	U.S.	Brazil	South Korea	China	Mexico	Japan	India	Australia	South Africa	Canada	Singapore
USD	946.7m	186m	461m	151.6m	12.6m	12.3m	19.5m	66.9m	45.6m	19.7m	1m	34.5m
EUR	801m	156m	390m	128.4m	10.7m	10.4m	16.5m	59.2m	38.6m	16.7m	0.85m	29.2m

Figure 1. Global Cartel Fine Levels in 2019 ([1])

3. Problem analysis

Many studies propose (see e.g.[9],[11]) that the behaviour of an oligopolistic market can be assessed from how quickly an exogenous cost change is reflected in the behaviour (price or output movement) of the market participants. Furthermore, since a cartel has a strong incentive to hide its existence, we can expect that they would try to imitate at least partially the behaviour of a competitive market [10].

It would be possible to address the speeed of reaction to exogenous changes like cost shocks and test the assumed presence of a cartel [14].

It would be also possible to examine market share and its change by assessing the gradients of change in the proportion of the market held by a firm [12,13].

The problem with these approaches is that there is no quantifiable objective measure or value which could serve as a clear indication to decide if collusion is present. Instead we propose an alternative approach.

Our suggestion is to apply neural networks for the identification of anomalous market behaviour. Artificial neural networks (ANNs) are frequently used in spatial and temporal forecasting (see e.g. Csábrági et al.) and are indeed quite capable to identify relationships based on known inputs and outcomes even though the precise model or mapping remains unknown.

In real life the participants of any cartel try to hide the very existence of their cooperation. It can be very difficult without direct evidence to identify the operation of cartels. It seems to be a good area of application for neural networks due to the following reasons.

4. Application of neural networks to detection of cartels

The estimation and forecasting of several modeling parameters is frequently performed by researchers with various types of artificial neural network (ANN) based techniques relying on machine learning [8]. This is reasonable as the application of neural networks require only data input and no other preconditions. Furthermore these models are able to map the complex relationship between input and output data and generalise the results appropriately. The application of ANNs require the breakdown of the total dataset into training and test sets, the training sets configure the parameter of the models, and the test sets are used to masure the general goodness of these models.

Two types of ANNs were adopted for our study, radial basis function neural networks (RBFNNs) and generalised regression neural networks (GRNNs) (see e.g. [7]). A radial basis function neural network (RBFNN) is a very frequently used artificial neural network, which contains a feed-forward structure with one input layer, a single hidden layer, and one output layer. A layer of output neurons calculates a linear combination of the radial basis functions ($\phi(.)$) . The hidden layer is self-organizing; the training between the input layer and the

hidden layer is performed by defining the weights (the center of the RBF) with the help of a special clustering algorithm, such as the k-means algorithm . GRNN models are a modified form of the radial basic function neural network model.

Unlike the RBFNN, GRNN is a one-pass network, namely it can be trained in one stage without using an iterative process. Therefore GRNN training time is relatively short. GRNN is a feed-forward supervised learning neural network, which consists of four layers: the input layer, the pattern layer, the aggregation layer and the output layer. Each input unit in the first layer corresponds to an independent parameter in the model and the number of pattern neurons is equal to the number of data samples. The training between the input layer and the pattern layer corresponds to the learning between the input and the hidden layer of the RBFNN.

Unlike other kinds of neural networks, GRNN does not require the pre-configuration of learning parameters, instead smoothing factor or bandwidth of all the parameters are required to be calculated manually or using an iterative algorithm.

Considering these qualities, artificial neural networks (and perhaps other machine learning tools) could be an ideal means of addressing this problem.

In the followings we propose a model of oligopolistic markets capable of representing the above mentioned velocity of adaptation and cost shocks. Afterwards the potential application of machine learning models, namely artificial neural networks is discussed over this model. Finally, some simulation results are presented and a follow-up research is discussed.

5. The proposed model

For the present state we propose the following model based on earlier models (see e.g. Molnár et al, 2004). The oligopolistic market has a finite number (*N)* players, $N \geq 2$. The market has a homogenous good. Assume a linear demand function:

$$Q_d = A - bP, \quad A, b > 0 \tag{1}$$

For the sake of simplicity consider the classical Cournot model [15] with price function

$$f\left(\sum_{l=1}^{n} x_l\right) = b - A\sum_{l=1}^{n} x_l \tag{2}$$

and cost functions $c_k\,(x_k) = c_k\,x_k + d_k$. Here b, A, c_k , are all positive constants. Furthermore d_k follows a random walk, $d_t = d_{t-1} + \varepsilon_t$ where the error term is a

white noise process. This means that costs can go up or down randomly, boundaries are $d_t>0$, upper boundary is the zero profit condition.

Assume that the adjustment parameter (*u)* effects the proportion of cost inclusion in the firm's output decision, that is, how rapidly and to what extent companies react to changes in their costs. Then the profit of firm *k* can be formulated as follows

$$\phi_k(x_1,...,x_n) = x_k\left(b - A\sum_{l=1}^{n} x_e\right) - \left(c_k x_k u + d_k\right), \tag{3}$$

where *u* is the (control) variable affecting unit production costs. Other types of controls can be examined in a similar way [17]. In developing the relevant dynamic models assume first that the time scale is discrete. At each time period each firm maximizes its predicted profit functions

$$x_k(b - Ax_k - A\sum_{l\neq k}^{n} x_l(t-1)) - \left(c_k x_k u + d_k\right) \tag{4}$$

where we assume that each firm expects all rivals to produce the same output as they produced in the previous time period. This type of expectations is called static in the economic literature. Other types of expectations, such as adaptive extrapolative i.e. delayed, can be examined in a similar way [16]. It is also assumed that each firm selects the profit maximizing output of each time period. Assuming that it is positive, simple differentiation shows that

$$x_k = -\frac{1}{2}\sum_{l\neq k} x_l(t-1) + \frac{b - c_k u(t-1)}{2A}, \quad k = 1..n \tag{5}$$

We can rewrite these equations into the usual systems form by introducing the new state variables

$$z_k(t) = x_k(t) - \frac{b}{(N+1)A} \tag{6}$$

to have

$$z_k(t) = -\frac{1}{2}\sum_{l\neq k} z_k(t-1) - \frac{c_k}{2A}u(t-1). \tag{7}$$

This is a linear system with system coefficients

$$\begin{pmatrix} 0 & -\frac{1}{2} & \cdots & -\frac{1}{2} \\ -\frac{1}{2} & 0 & \cdots & -\frac{1}{2} \\ \vdots & \vdots & & \vdots \\ -\frac{1}{2} & -\frac{1}{2} & \cdots & 0 \end{pmatrix} \text{ and } \underline{b}\begin{pmatrix} -\frac{c_1}{2A} \\ -\frac{c_2}{2A} \\ \vdots \\ -\frac{c_n}{2A} \end{pmatrix}. \tag{8}$$

If the different firm are controlled differently, then the cost term in equation (6) is ($c_k x_k u_k + d_k$), so the equation (9) modify as

$$z_k(t) = -\frac{1}{2}\sum_{l \neq k} z_l(t-1) - \frac{c_k}{2A}u_k(t-1) \tag{9}$$

with system coefficients

$$\underline{A} = \begin{pmatrix} 0 & -\frac{1}{2} & \cdots & -\frac{1}{2} \\ -\frac{1}{2} & 0 & \cdots & -\frac{1}{2} \\ \vdots & \vdots & & \vdots \\ -\frac{1}{2} & -\frac{1}{2} & \cdots & 0 \end{pmatrix} \text{ and } \underline{B} = diag\left(-\frac{c_1}{2A}, -\frac{c_2}{2A}, \ldots, -\frac{c_n}{2A}\right). \tag{10}$$

Assume next that the time-scale is continuous, and that at each time period each firm adjusts its output proportionally to the marginal profit. If the firms are controlled in the same way, then the dynamic model has the form

$$\dot{x}_k(t) = S_k\left(-2Ax_k(t) - A\sum_{l \neq k} x_l(t) + b - c_k u(t)\right) \tag{11}$$

where $S_k > 0$ is given speed of adjustment of firm k. Notice that

$$\underline{A} = \underline{S}\begin{pmatrix} -2A & -A & \cdots & -A \\ -A & -2A & \cdots & -A \\ \vdots & \vdots & & \vdots \\ -A & -A & \cdots & -2A \end{pmatrix} \text{ and } \underline{b} = \underline{S}\begin{pmatrix} -c \\ -c_2 \\ \vdots \\ -c_n \end{pmatrix} \tag{12}$$

with $S=diag(S_1, S_2, \ldots, S_n)$.

If the firms react diferently, then the cost term in equation (11) is $c_k \cdot u_k$ instead of $c_k \cdot u$, therefore the system coefficients are

$$\underline{A} = \underline{S} \begin{pmatrix} -2A & -A & \cdots & -A \\ -A & -2A & \cdots & -A \\ \vdots & \vdots & & \vdots \\ -A & -A & \cdots & -2A \end{pmatrix} \text{and } \underline{B} = diag\left(-S_1 c_1, -S_2 c_2, \ldots, -S_n c_n\right). \quad (13)$$

6. Application of neural networks to detection of cartels

In the model discussed previously we have assumed that we could assign parameters to the speed of cost adjustment and speed of marginal profit adjustment. The first parameter can be used to describe the behaviour of the market actors to an exogenous cost shock. It is assumed that whenever a collusive structure is present, adjustment is sluggish.

The latter can also be easily translated to a practical behavioural parameter for collusive patterns. If and when a market actor raises its market share by increasing its output (or perhaps entering the market as a new player), it also infringes the interests of the other players [22]. Thus in this case the profit of the other companies is reduced. The reaction speed to this unfavourable step can also be a marker for a cartel. We expect a competitive environment to be more "punishing" and overly reactive [21].

For this purpose it is necessary to gather market data from existing examples of uncovered cartels and utilise these to train the neural network. Then the trained network can be used to identify and assess the behavioural parameters and thus the nature of any existing oligopolistic market structure. Availability of data is limited however to commercial databases to which access requires significant financial resources.

Conclusions

We have presented a market anomaly, cartelling, which can be typical to a certain market structure, oligopolies. This anomaly is based on the collusion of the market players and causes significant loss of consumer benefit. We proposed a novel approach to identify such, typically hidden activities based on machine learning methods. The further research would target model training and data acquirement. In case of lack of data, market simulations are capable of filling the gap and providing model training data.

The significance of the proposed method is it would enable the detection and earmarking of cartel-suspicious cases based on available market data. Most probably the method, even if it was functional and operable would not provide

sufficient proof for legal cases but would be a very handy tool for consumers and legislative enforcement agencies for whistleblowing activities.

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Relations of soil laboratory tests and NDVI remote sensing measurements in GIS environment

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Abstract

Impact of macroelements in soil on NDVI parameter was analyzed in the paper. Remote sensing and laboratory soil analysis results were compared. Macroelements and NDVI parameter values are variables which relations are not linear. Statistic was used in order to define the relations more clearly. Results of soil sampling and laboratory analysis were compared with NDVI values collected by remote sensing. Main causes of variation of the NDVI parameter are the content of organic matter i.e. humus, soil acidity and content of nitrate nitrogen.

Keywords

remote sensing, soil, GIS, NDVI, analysis

1. Introduction

The daily increase in population and standard of living will lead to the need to increase food production. In order to ensure that demands to increase growth of food production and supplies, as well as to maintain the safety of sufficient quantities of healthy food, it is necessary to find a way to achieve these goals from the same area of arable land. One way to increase production is to make more intensive use of basic agricultural resources, such as land. Deforestation, drainage of ponds and wetlands can increase the area of arable land. However, this would not fully meet the increasing needs. Another way would be to increase the use of other agricultural inputs, such as labor, mechanization, fertilizers, pesticides and water. Changes in the technology that farmers use to transform inputs into edible products are also possible. Each of these responses to demand growth is, in fact, a feature of the progress of agriculture in different parts of the world over the last century.

2. Literature

The earth is to disperse the surface layer of the lithosphere. It is located above a solid rock mass and its upper limit is its biosphere, hydrosphere and atmosphere.

Physically speaking, land is a multiphase system. It consists of particles (grains) and pores (cavities) (Fig. 1.). Soil is created by a process called pedogenesis, and it takes two stages. The first phase begins with the decomposition of the rocks and the second with the decomposition of dead remains of plant and animal origin. Soil types include: dust, clay, sand, gravel, but also their combinations (Miller, 1953).

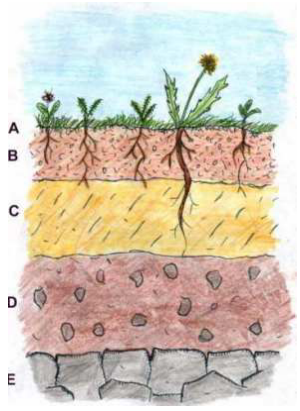

Figure 1. General land profile

Soil as a substrate for plant cultivation is the largest chemical industry in the world. Proper growth and development of plants requires equal balance of nutrients found in the soil. According to the physiological role, the nutrients are divided into macro (essential) and microelements. Macros can be divided into primary and secondary macros. Primary macronutrients are those without which plants cannot grow or develop. Without them, the plants cannot complete the vegetative and reproductive phase of their life cycle, which is why they are present in larger quantities in the plants. The most significant of these are nitrogen (N), phosphorus (P) and potassium (K). Secondary macroelements by role are the same as primary macroelements, but plants need those in smaller quantities. These include sulfur (S), magnesium (Mg) and calcium (Ca). Certain secondary elements are dominant in determining the yield of a given culture (Licina, 2009).

Geographic Information System is a system for managing spatial data and associated properties. This system is a computer system capable of integrating, editing, storing, analyzing and displaying geographically defined information. GIS can be considered as a tool for creating a "smart" map that allows users to set up interactive queries, analyze spatial information and edit data. (Magó-Cvetanovski 2019a) GIS technology is nowadays widely used in various fields and can primarily be used for scientific research, development planning, spatial planning, cartography (Bolstad, 2005) (Magó 2009). The use of a geographical information system in the fields of agricultural production is very important.

Today the integration of this system with conventional agriculture enables the development of a completely new direction in agriculture called precision agriculture. (Magó-Cvetanovski 2019b) Precision agriculture is not a term that has emerged in the last 20 years; This is supported by the fact that the basic principles of modern precision agriculture were used around 400 years ago, when colonizers of the Americas noticed that local tribes applied different practices in individual places on the plot (Negovanovic, 2018). Further development of this technology has made it possible to gain an understanding of the spatial variability that characterizes most agricultural arable land. Based on this knowledge, there is a need to manage these variability. In addition to GIS, there has been an increasing presence of global positioning systems (GPS) and remote sensing technologies (RS). Remote detection or teledetection is a modern method of gathering information through systems that are not in direct physical contact with the investigated phenomenon or object (Campbell, 2002).

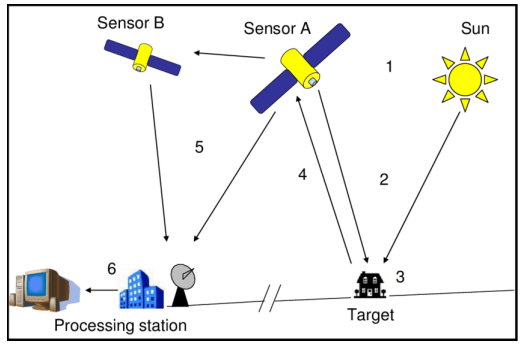

Figure 2. Remote sensing principle

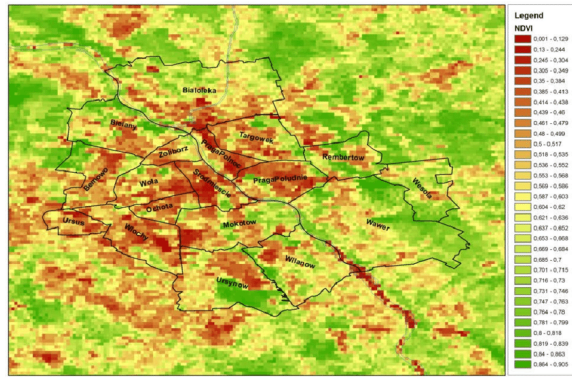

Figure 3. Thematic map of the NDVI parameter values

The principle of remote sensing (Fig. 2.) comes down to the systematic measurement of a certain part of the electromagnetic spectrum and the

interpretation of the anomalies found by differences in the properties of the object under study. Remote sensing relies on the wavelengths of reflected light and does not come in direct contact with the object being observed.

The Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to analyze measurements obtained by remote detection. The aim of such analyzes is to estimate the amount of green space on the total observed area (Fig. 3). The values of this index vary in the range from -1 to +1. Values approaching the negative extreme indicate the fields where water is on the surface of the earth, and the opposite is the positive extreme indicating the parts with intensive green vegetation.

3. Material and methods

The basic indicators of soil fertility are: total nitrogen, readily available phosphorus and potassium, humus and calcium carbonate content, pH in water and potassium chloride, all of which are determined on the basis of soil analyzes. These fertility indicators are changing during the period of land exploitation in the agricultural production process. Therefore, monitoring them is of great importance for proper land management. Fertility checks must be carried out every four years.

In this fertility control process, the first and very important step is certainly the soil sampling process (Fig. 4.). The soil sampling process consists of several stages: determination of sampling time, preparation for sampling, sampling, preparation and packaging of the soil sample. The best time to sample the soil is after the crop is harvested.

Figure 4. Soil sampling

There are several land sampling systems: diagonal, chess, circle method, combined method, control plots. All of the above systems should aim to have the best coverage of the sampled soil with individual stitches in order to better represent the given plot. The above mentioned sampling systems are in practice the most commonly used systems so far. However, being limited with the

approved number of soil samples for laboratory analysis, we have used an adapted sampling method. Namely, through the Internet platform we created thematic maps with values of the NDVI parameter, and in accordance with individual stress and healthy zones, we determined the points from which we took soil samples (Fig. 5.).

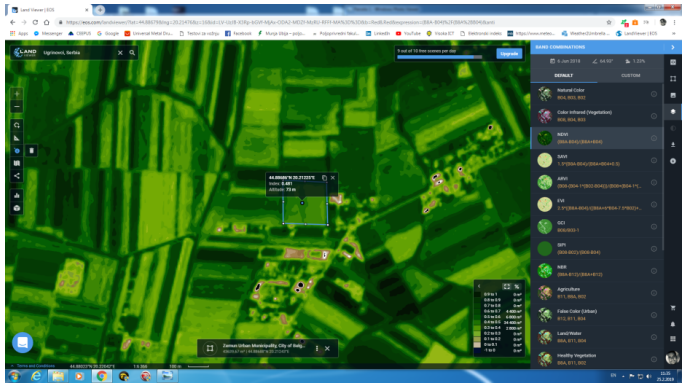

Figure 5. Determining the location for soil sampling

Stress areas are parts of the plot where the value of the NDVI parameter is quite low, which practically means that vegetation in that part of the plot is extremely poor, which further leads to lower yields. On the contrary, there are portions of the plot where healthy and intensive green vegetation is represented, and these portions are destined to carry higher yields than in the case described previously. Once the points bearing the coordinates are marked, it was necessary to find those locations using a GPS unit on the plot (Fig. 6.).

Figure 6. Exact location of the measuring point using the GPS unit

Chemical, biological and micro-biological methods were used to determine soil fertility in order to apply fertilizers for proper plant nutrition. Chemical methods are based on the effect of certain chemical reagents on the soil sample

by which the elements are converted into a solution from which the concentration of the test nutrient for plants is determined by a suitable analytical procedure. Before the chemical analysis of the soil, it is necessary to prepare properly the sample, and this procedure involves several work operations (Fig. 7.). It is necessary to dry the sample, then to grind it and remove any impurities from it.

Figure 7. Drying of samples

After drying, it is necessary to inspect the sample once more and remove any residual impurities, and then grind it manually or with special electric mill. Both methods are efficient with the capacity of the electric mill being far greater.

4. Results and discussion

The values obtained show that there are certain variations of this index within one plot. The aim of this paper is to determine the reasons for these variations through soil testing. At the time of taking this data, vegetation on these areas was not in its full stage of development, so it is understandable why the values of this index are not within maximum limits.

Table 1. Comparative presentation of the NDVI parameter value and the results of chemical analysis of soil - Plot 1

	N	E	NDVI	N am.	P_2O_5	K_2O	N ni.	C %	pH	Humus
1	44,8865	20,2135	0,392	0,0049	9,74	35,58	0,0035	1,63	7,96	2,81
2	44,8869	20,2123	0,481	0,0049	2,71	28,95	0,0042	1,89	6,3	3,26
3	44,8878	20,2112	0,576	0,0056	15,48	44,96	0,0014	2,03	6,92	3,5
4	44,8876	20,2135	0,461	0,0042	5,88	31,38	0,0049	1,44	7,89	2,48
5	44,8866	20,2119	0,445	0,0056	6,06	35,99	0,0042	1,78	6,87	3,07
6	44,8862	20,2112	0,502	0,0021	75,88	217,68	0,0091	2,56	7,26	4,41

Based on the statistical data processing, the strongest relation between the observed variables is observed for humus. Namely the content of organic matter causes variation of NDVI parameter on Plot 1. Below are presented results on other plots.

Table 2. Correlation analysis of observed phenomena - Plot 1

Correlation with NDVI	Value	Correlation
N am.	-0,033868278	Medium
P2O5	0,280301294	Medium
K2O	0,246420108	Medium
N ni.	-0,134214078	Weak
C %	0,531847099	Medium
pH	-0,481038793	Medium
HUMUS	0,53213594	Medium

Table 3. Comparative presentation of the NDVI parameter value and the results of chemical analysis of soil - Plot 2

	N	E	NDVI	N am.	P_2O_5	K_2O	N ni.	C %	pH	Humus
1	44,8912	20,2191	0,62	0,0007	8,1	40,61	0,0056	1,76	6,44	3,03
2	44,8907	20,2185	0,498	0,007	15,95	44,9	0,0056	1,95	7,88	3,36
3	44,8921	20,2192	0,526	0,0063	3,88	33,35	0,0056	1,5	7,81	2,59
4	44,8917	20,2214	0,469	0,0014	11,47	43,97	0,0007	1,75	7,55	3,02
5	44,8922	20,2221	0,431	0,0021	21,36	56,5	0,0014	2,03	7,96	3,5
6	44,8919	20,2221	0,484	0,0007	3,07	32,73	0,0007	1,58	7,86	2,72

Table 4. Correlation analysis of observed phenomena - Plot 2

Correlation with NDVI	Value	Correlation
N am.	-0,05477371	Weak
P2O5	-0,493196204	Medium
K2O	-0,461739335	Medium
N ni.	0,704542836	Strong
C %	-0,342061287	Medium
pH	-0,863729332	Strong
HUMUS	-0,346490345	Medium

Table 5. Comparative presentation of the NDVI parameter value and the results of chemical analysis of soil - Plot 3

	N	E	NDVI	N am.	P_2O_5	K_2O	N ni.	C %	pH	Humus
1	44,8976	20,2171	0,53	0,0021	7,07	39,29	0,0007	2,14	6,87	3,69
2	44,8972	20,2169	0,51	0,0014	4,77	32,33	0,0007	1,62	7,87	2,79
3	44,8974	20,2154	0,494	0,0007	7,75	31,71	0,0007	1,74	7,71	3,00
4	44,8977	20,2161	0,497	0,0014	4,38	33,46	0,0021	2,00	7,34	3,44
5	44,8979	20,2176	0,478	0,0014	9,38	35,53	0,0007	1,84	7,44	3,17
6	44,8983	20,2156	0,507	0,0007	3,65	34,49	0,0007	1,89	7,14	3,26

Table 6. Correlation analysis of observed phenomena - Plot 3

Correlation with NDVI	Value	Correlation
N am.	0,480122629	Medium
P2O5	-0,40384123	Medium
K2O	0,498105204	Medium
N ni.	-0,158422532	Weak
C %	0,418040625	Medium
pH	-0,483075237	Medium
HUMUS	0,421691476	Medium

According to the data obtained from Plot 2, significant relation was found between soil acidity and NDVI parameter value. In addition to the acidity, the nitric nitrogen content affected variations of NDVI parameter. Other parameters have the same bond strengths and in this case are not interesting for further consideration.

In Plot 3 analysis, the strength of the dependency between nitrate nitrogen and the NDVI parameter is extremely weak, which is opposite to that found at the previous plot. Other parameters have similar significances of influence to the variations of the observed NDVI parameter.

Conclusions

Data science has a strong influence on the way we consider the data obtained through remote detection, and the large amount of data obtained through this must somehow be correlated with respect to all mathematical and statistical regularities. By sampling and chemical analysis of the soil we obtain all the information that we cannot obtain by remote sensing. By remote sensing we get images that visualize data on the consequences of soil quality, while by chemical analysis we try to find the cause of certain consequences. By combining the two methods, we can come to closer conclusions more clearly, faster and more accurately. The general conclusion is that in all three plots observed, the main

causes of variation of the NDVI parameter are the content of organic matter (humus), soil acidity and nitrate nitrogen content.

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Automatic measurements and data distribution system for microclimate control

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Abstract

Plant production in a protected area is the most intensive form of production in agriculture. Plant growth is intense throughout the year to produce high yields and good product quality. By definition, microclimate represents the climatic conditions of small spaces measured up to 2m in height from the land surface. The factors of the microclimate are soil temperature, air temperature, air humidity, soil humidity, light, and the amount of carbon dioxide (CO_2). For intensive production indoors (greenhouses) it is very important that all factors of the microclimate be within the allowed limits for a particular cultivated crop. Therefore, our project aims at indicating these factors and signaling to the manufacturer if there is any reason for any of these factors to be corrected.

Keywords

microclimate, monitoring, greenhouse, computer, analysis

1. Introduction

Through this project, a device for monitoring indoor microclimate intended for intensive agricultural production was created. This device consists of 6 sensors, controlled by the ATmega328P microcontroller and an LCD display that shows the currently read values from the sensors, as well as a memory card slot and SIM module. Power is supplied by a battery, and the plan is to have it through a solar panel, which would help to preserve the ecology and reduce the cost of electricity. The data that is collected on the memory card contained in the microcontroller gives us the ability to read the measured data in real time. This way we can analyze the data for a certain period of time from one locality. The data can be sent to the user via SMS, thanks to the integrated SIM module. The ATmega328P microcontroller, through a program written for this purpose, gives the sensors precise instructions on how long and how to make measurements. The prototype of this system is housed in a wooden box on the top side of which

has an LCD display, which protects all components from external factors. For the commercial version, a 3D model of the box was made, which will be made of hard plastic.

2. Literature

Protected areas provide intensive production, combined off-season vegetable production, greater control of disease and pests with the application of biological control, which also ensures healthier food. It is known that production under sheltered conditions ensures early harvesting but requires additional costs for heating. Although the prices of early vegetable produce are higher than the open-market products, the uniformity of the products, the quality and the speed of fruiting allow for a good market and better placement. (Magó et al. 2005, Magó-Jakovác 2005, 2006) For the successful use of the buildings, it is important to choose the right place (flat surface or gentle fall, deeper groundwater level), then appropriate position and wind protection. Multiple objects are placed in parallel, so that objects with one roof on the long side are in the east-west direction, and those with two roofs in the north-south direction. This ensures that the plants are illuminated evenly throughout the day. All protected area objects should be placed in a place protected from strong and cold winds. For this purpose, fences and protective arches are erected. One meter high shelter protects ten meters behind the space (Djevic-Dimitrijevic 2009).Controlling the microclimate in greenhouses is a responsible and complicated process since there are several factors that affect the climate and are mutually dependent (Mutwiwa et al. 2006). To achieve the goal, which is the highest possible yield on given surfaces, with at the same time, we need to ensure the proper quality of the product for the cultivated plants adequate microclimate conditions while respecting the minimum energy consumption requirements (Caneppele et. al., 2016). Work on creating algorithms and software to help protect climate in a protected environment space is part of the process by which most of these factors are controlled with minimum energy costs (Popovic 2004).

Figure 1. Grenhouses

Modern microclimate control is today based on the basics of artificial technology intelligence. The programs that were developed included the expertise of experts and empirical knowledge of crop growers (Bajkin 1994). Device prototypes were tested in experimental greenhouses under controlled conditions and designed appropriately

software. A model-specific algorithm (control program) was created for predictable climate environment, to be used to simulate energy efficiency and control scheme optimization. The algorithm is designed to be used for appropriate software that provides pre-processing of meteorological data as code model (Bajkin et al. 2005). Using this approach, it is possible to simulate any enclosed structure, at an example of a greenhouse or greenhouse, where appropriate information must be provided. Controllers are devices that adjust various parameters to achieve the best possible microclimate while cultivating crops and at the same time fulfills the goal in terms of high yields and quality of fruits, with the primary goal - the least energy consumption (Radojicic 2001).

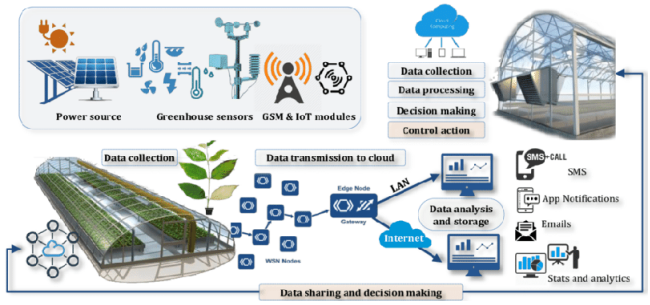


Figure 2. Smart microclimate monitoring systems

3. Material and methods

To create the project, an Arduino platform was used that contained a microcontroller to which the sensors were connected. After the sensors were connected, a program was written using which the microcontroller stores the data on the SD card, and in addition it was enabled to send data via SMS to the end user. In addition to the sd card and sms module, the project also contains an lcd that alternately displays data from the sensor.

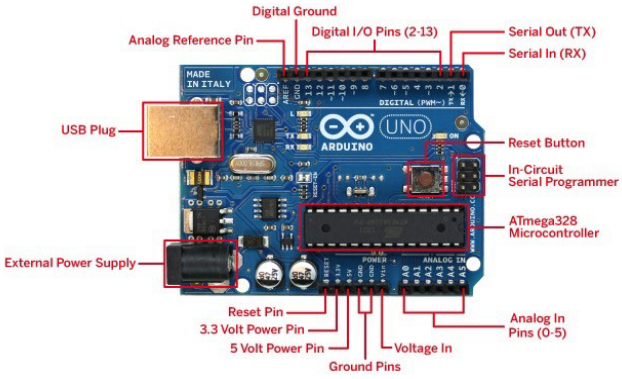


Figure 3. Arduino Uno

Sensors were also used for the project, such as soil temperature sensor, air temperature and humidity sensor, co2 content sensor, lighting sensor, soil moisture sensor, sim module and sd module.

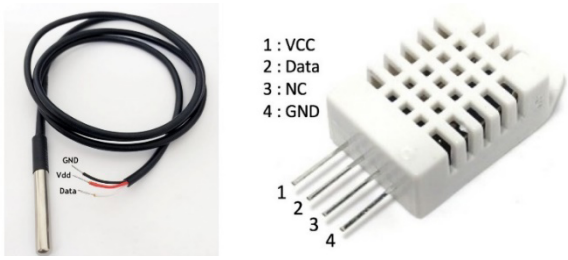


Figure 4. Soil temperature sensor and air temperature and humidity sensor

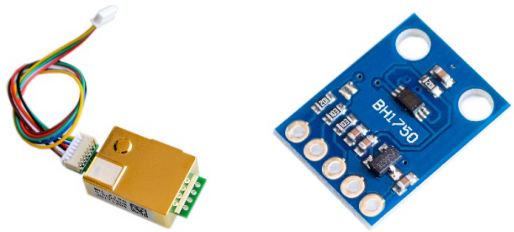


Figure 5. CO_2 content sensor and lighting sensor

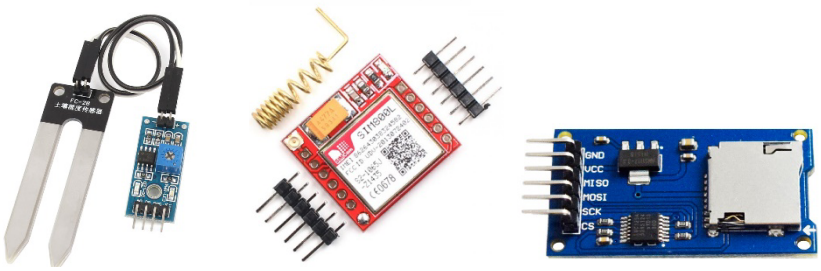


Figure 6. Soil moisture sensor, sim module and sd module

4. Results and discussion

By interconnecting all the components shown above, we obtained a prototype of a device for monitoring microclimate in a greenhouse (Fig. 7). After connecting and putting the device into operation, an analysis of the device's performance was performed. Testing of the project was carried out in a facility of semi-tall greenhouse type during the month of January 2019. The unit was installed in one part of the greenhouse for 24 hours.

The data obtained are presented in an excel table by date, time, parameter they measure and size, as well as a diagrammatic representation.

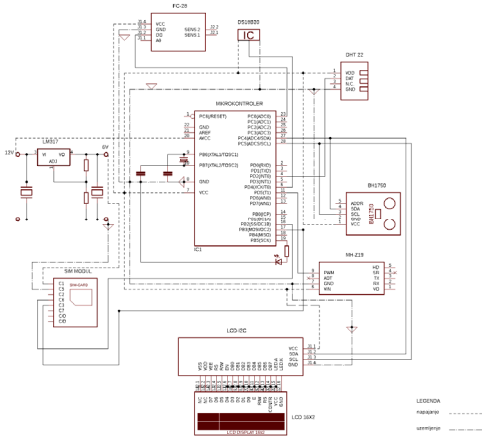


Figure 7. Electrical scheme of the device

Table 1. Values from the sensors

Time	Air humidity	Air temperature	Soil moisture	Soil temperature	Lighting	Solar radiation	CO_2
2019/1/4 (Friday) 14:24:38	55.6	1.9	68	15.19	29	0.04	14
2019/1/4 (Friday) 14:25:10	55.2	1.9	66	15.13	1	0.00	162
2019/1/4 (Friday) 14:25:42	55.3	1.9	67	15.00	3	0.00	162
2019/1/4 (Friday) 14:26:14	55.8	1.9	67	14.94	31	0.05	298
2019/1/4 (Friday) 14:26:46	55.8	1.9	66	14.88	32	0.05	292
2019/1/4 (Friday) 14:27:18	55.9	1.9	66	14.81	32	0.05	288
2019/1/4 (Friday) 14:27:50	55.8	1.9	67	14.69	33	0.05	282
2019/1/4 (Friday) 14:28:22	55.8	1.9	67	14.63	33	0.05	272
2019/1/4 (Friday) 14:28:54	56.0	1.9	66	14.50	33	0.05	268
2019/1/4 (Friday) 14:29:26	56.1	1.9	67	14.44	33	0.05	262
2019/1/4 (Friday) 14:29:58	56.1	1.9	66	14.38	33	0.05	258
2019/1/4 (Friday) 14:30:30	56.2	1.9	66	14.25	33	0.05	252
2019/1/4 (Friday) 14:31:2	56.3	1.9	67	14.19	33	0.05	248
2019/1/4 (Friday) 14:31:34	56.3	1.9	66	14.13	33	0.05	242
2019/1/4 (Friday) 14:32:6	56.4	1.9	66	14.06	33	0.05	234
2019/1/4 (Friday) 14:32:38	56.4	1.9	66	13.94	32	0.05	236
2019/1/4 (Friday) 14:33:10	56.5	1.9	65	13.88	32	0.05	238
2019/1/4 (Friday) 14:33:42	56.6	1.9	66	13.75	32	0.05	236
2019/1/4 (Friday) 14:34:14	56.8	1.9	66	13.69	32	0.05	234
2019/1/4 (Friday) 14:34:46	56.9	1.9	66	13.63	31	0.05	230
2019/1/4 (Friday) 14:35:17	57.1	1.9	66	13.50	31	0.05	234
2019/1/4 (Friday) 14:35:49	57.2	1.9	66	13.44	31	0.05	232
2019/1/4 (Friday) 14:36:21	57.4	1.9	66	13.38	31	0.05	236
2019/1/4 (Friday) 14:36:53	57.5	1.9	65	13.31	31	0.05	236
2019/1/4 (Friday) 14:37:25	57.6	1.9	66	13.19	32	0.05	234
2019/1/4 (Friday) 14:37:57	57.6	1.9	65	13.13	32	0.05	232

The components of the system are interconnected by standard conductors, all of which are housed together in a wooden box because it is a prototype of the device. For the commercial version of the device, a 3d model of the box was made, which will be made of plasticized polymer (Fig. 8).

As mentioned earlier, this model of microclimate monitoring device is mounted in a high tunnel greenhouse. Measurements were made over a period of 24 hours and during this time the device recorded all the data from the sensors at specified intervals and stored them on the sd card. This set up (Fig. 9) allowed us to collect and use the data for further analysis of the device operation, and in addition to observe the microclimatic conditions that prevail inside the greenhouse.

Figure 8. Layout of prototype microclimate monitoring device

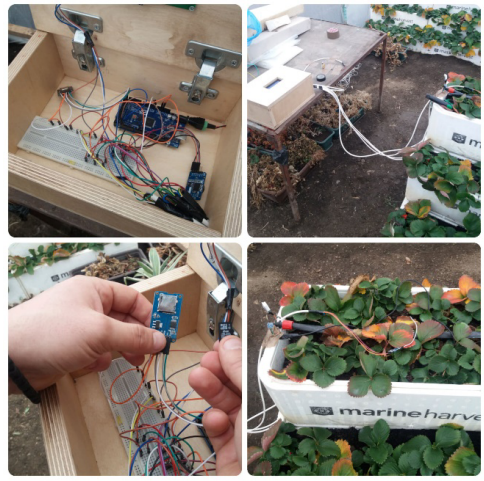
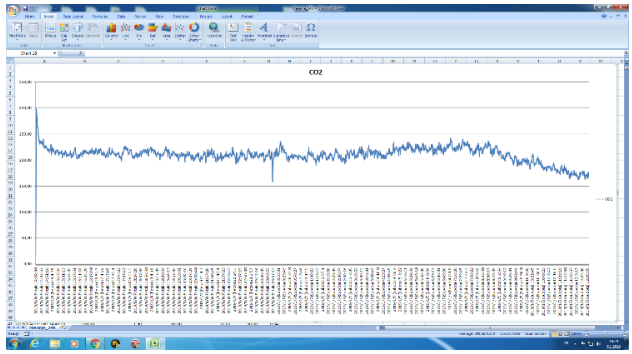
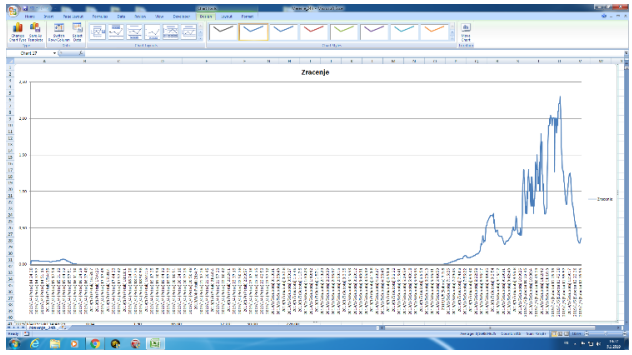
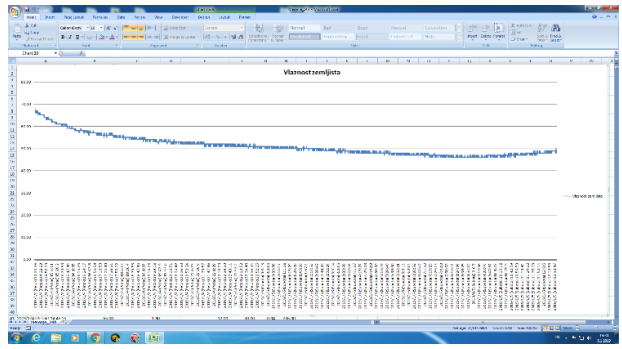


Figure 9. Setting up measurements







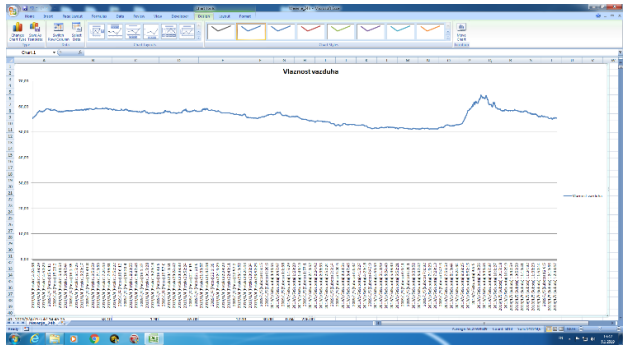


Figure 10. Graphical display of values from the sensor

After 24 hours of measurement the sd card was removed and data was collected from it, what we received is shown in the following table (Table 1).

The table shows only part of the data because the total number of data exceeds the number of 2500 of consecutive measurements. In addition to the classic table, graphs of the measured magnitude were made (Fig. 10).

Conclusions

The country of Serbia has great potential in agricultural production. However, our manufacturers do not have material resources in quantities as is the case in Western European countries. Therefore, the device we made may be available to Serbian manufacturers because his cost price is much lower compared to a similar product in e.g. Germany. This device is intended to help manufacturers to understand all the important microclimatic factors that affect the growth and development of their products and so respond in a timely manner to maintain all parameters within the limits allowed for the culture they grow. This device can also analyze data measured over a period of time and determine why a particular breeding problem occurs.

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The importance of coaching based leadership amongst engineering managers

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Abstract

In this study we wish to present the importance and efficiency of coaching based management. This competence development communication process could be associated with training, therapy, mentoring or counselling which is essential for engineers to get to know. This is a topic well-known amongst graduates of management sciences but it is assumed that people with technical orientation are less experienced in it. With the arrival of coaching leadership, a new approach and methodology could be learned, which treats every person within a frame of a customized method while keeping their own personalities unchanged/intact. It helps them get to know themselves better, so they are more conscious and productive at work. It supports leaders, who are dissatisfied with their own performance in the organization and have leadership and cooperation issues, isolated or wish to see the organizational situation and their own role from a new perspective and clarify personal and organizational visions and plans. Our goal is to highlight for leaders, working in the technical field to use the tailor-made coaching method and not to get lost in measuring and numbers only, but to be able to add this approach to their toolbox. Our research will uncover what mechanical engineers think about the coaching process.

Keywords

coaching, engineering manager, leadership

Introduction

Coaching can be utilized in numerous everyday issues; it incorporates life coaching, sports coaching, health coaching, money related coaching, and career coaching. From a management point of view, coaching can be thought about as either a discrete movement or as an administration style. At the end of the day, it very well may be done in assigned 'coaching sessions,' which the administrator and the colleague perceive in that capacity, or it very well may be coordinated into the everyday administration of a group or office. In either case, the goal is to urge individuals to take care of issues for themselves instead of alluding them back up to their director. Truth be told, chiefs who mentor will in general spot a great deal of

accentuation on building up the general population answering to them, and on making a domain where individuals can execute as freely as would be prudent.

There is no all-around accepted definition of coaching, yet in the event that you take a gander at the definition utilized by the Association for Coaching (AC) it expresses that coaching is:

"A collaborative, solution focused, result-orientated and systematic process in which the coach facilitates the enhancement of work performance, life experience, self-directed learning and person growth of the coachee". *(Association for Coaching, 2005, 8.)*.

This announcement bolsters the AC's fundamental reason for needing 'to motivate and advocate coaching perfection' in people and associations. For an increasingly succinct definition you can take a gander at those provided by Sir John Whitmore, a well-known business coaching, and Myles Downey, the author of Effective Coaching: Lessons from the Coach's Coach. For them, coaching is:

"Unlocking a person's potential to maximize their own performance. It is helping them to learn rather than teaching them" *(Whitmore, 2002, 15.)*.

"The art of facilitating the performance, learning and development of another" *(Downey, 2003, 32.)*.

The estimations of these two definitions structure the establishments of why senior administration inside associations enthusiastically invest energy and cash on expanding the commitment and efficiency of their workers. Eric Parsloe, author of The Manager as Coach and Mentor and founder of The OCM (Oxford School of Coaching and Mentoring), takes the definition of coaching further by describing the qualities of a successful coach:

"Coaching is a process that enables learning and development to occur and thus performance to improve. To be a successful a Coach requires a knowledge and understanding of process as well as the variety of styles, skills and techniques that are appropriate to the context in which the coaching takes place" (Parsloe, 1999, 57.)

2. Rewiev of the literature

Leadership in its most elementary type involves someone guiding and directing others so a task or objective is met. Whether or not leaders administer 5 individuals or fifty individuals, they have the flexibility to guide their workers within the right direction and develop them wherever improvement is required. Nice leaders' area unit is sincere and supply honest and constructive feedback to their team so growth and success will occur among their organization. (Grant et al., 2009)

Part of the leadership responsibility involves developing the leadership skills of others within the organization. Coaching and developing others may be a continuous effort specializing in the broader, a lot of long-run growth of people. A leader who encourages and conjures up their team to grow to their potential understands the importance of promoting a culture of development (Gray et al., 2011)

Concept and Definition

To be able to develop and coach others and constructively review the work of others so as to boost and advance the abilities, data and performance levels of these United Nations agency report back to them. Developing others additionally involves serving to current workers learn new skills because the nature of their work (or the organization) changes. Managers play a crucial role in serving to their workers build the abilities they must achieve success within the future. (American Management Association, 2008a)

Assessments live many innate traits that will which will that may have a sway on however effectively a pacesetter can coach and develop others. Analysis and skill have shown that four key temperament characteristics, or scales, have a link to the current competency:

Need for Recognition – How abundant regeneration and a focus do the leaders at your company want, and the way this will play into their coaching job and developing approach? Leaders with an occasional want for recognition area unit able to perform while not looking forward to praise and regeneration to drive the standard of their work. Typically, once this is often the case, those leaders' area unit is less doubtless to convey credit and recognition to their team since they don't see it as a private want. On the alternative finish of the spectrum, the leader with a high want for recognition promptly offers praise and support once required and rewards the team's accomplishments. However, this comes with the leader's personal want for recognition, which can lead to a way of aggressiveness and stinginess if they're not placed within the spotlight, instead of issues for growth among the whole team. At their worst, leaders at the United Nations agency fall terribly high on want for Recognition compared to others might want the spotlight themselves and should often fail to share credit with their team. Leaders you would like the foremost fall within the middle to high vary on this scale. among this vary a pacesetter is foretold to be pleasing enough to their team to drive improvement, however not therefore dependent on receiving recognition that they disappoint on their own duties of coaching job and developing their team.(Hagen - Peterson, 2015)

Coaching and developing others

When you think of coaches, images often come to mind of individuals who are icons of strategy and execution in the sporting world. They understand the game they're playing, they know the level of the talent available to them, they have a plan to compete, and they've cleared another place on their trophy shelf. Their specialized experience and understanding of human nature help them build on an individual's talents and prepare the individual to compete. The role of the manager as a coach, especially early in an artist's career, is very much like that of any other coach. Likewise, we look at leaders as people who have that special gift of being able to motivate people to become involved in ways that benefit their collective and common good. They are agents of change who can express a vision that draws people to them and inspires them. Crises are times when leaders step up and involve others to act for a solution. When things are falling apart, it becomes a time when we

look to a leader to become involved. Again, leadership in a manager is important to new artists who need help directing their budding careers. The following discussions about coaching and leadership are intended to present insight into those who successfully coach and lead. (Paul, 2011).

While inexperienced managers view coaching as a euphemism for discipline, in reality coaching should be seen as a positive activity. Managers must see coaching as an ongoing communication between worker and supervisor. It is an opportunity for the manager to supply feedback and support that focuses on a specific professional goal or area of development. Through personal observation and appraisal interviews, managers can identify the coaching needs of individual staff members (Lynne et al., 1999).

Peer coaching provides a number of benefits to participants, including time management skills and enhancing other professional skills as well as a deeper sense of efficacy for participants. The authors emphasize the importance of developing trust between the peer coaches, as it is the crucial element of successful peer coaching programs. The authors assert that establishing peer coaching relationships across institutions improves upon the more traditional peer coaching model set up within institutions by removing one of the largest barriers to successful peer coaching models: organizational repercussions due to a lack of organizational trust (Dawn, 2017).

The manager, who strives to be liked by all, gets trapped into avoiding unpopular decisions and ignoring disciplinary problems. In fact, the employees mostly prefer a fair, impartial, predictable, and honest administrator or leader who sets and maintains standards. The manager who ignores the opinions and advice of subordinates denies him- or herself input from the collective wisdom of the group or department. The manager who can create the climate in which employees have some voice in the things that happen and in which they participate or somehow contribute to the operation as team members gets the most out of the employees. The manager who fails to delegate the job properly becomes mired down in relatively unimportant decisions and activities. The subordinates also get easily demoralized as they know that their manager or supervisor would arbitrarily change their plans and decisions in favor of his or hers. A religious or a racial bigot manager consistently breeds discontentment and confrontation in the organization and denies himself or herself and the organization the full spectrum of talent present in the organization. The manager, who acts or overreacts too quickly and reacts to normal problems as crises, tends to blame others for the mess created by them. This leads to secrecy among the subordinates, which then cause breakdown in communications and a vicious circle that causes an unhealthy work environment (Sennewald, 2011)

Successful training ensures that employees meet the short-term needs of the employer, while further development enhances their long-term skills and career paths. Managers and executives also require further development through education at conferences, seminars, and academic courses. Training should be planned to achieve or exceed the objectives of the employer. A variety of training methods can be considered to meet the requirements of cost-effective learning. In most organizations, entry-level training receives the greatest attention. System-

based training allows managers to identify specific segments of instruction as problematic for trainees. Such training material can be reworked to facilitate learning comprehension. Workplace training requires validation and review as well as long-term evaluation and follow-up (McCrie, 2007).

The importance of managerial coaching has been highlighted by many scholars and professionals over the years. Because of its importance to organisations, managerial coaching is still an important topic for the academic debates and discussions. The study has been conducted on the 'Insurance Industry' in Turkey. Findings showed that the managerial coaching behaviour in the insurance sector had a positive effect on the better understanding of the role by employees (role clarity), satisfaction with work, career commitment, performance of the employee at work and the organizational commitment. At the same time, it was specified that a clear perception by the employee about his/her role had a positive effect on the career commitment, organizational commitment and employee's performance at work. Furthermore, it was also identified that satisfaction with work has a positive effect on the career commitment and organisational commitment. Nevertheless, no effect was identified between satisfaction with work and job performance. On the contrary, it was also found in this study that career commitment and organisational commitment has a positive effect on the job performance (Mehtap, 2014).

''There are three main components of coaching in modern management:'' (Corporate Finance Institute, 2019, 75.)

- joint awareness of the future and his vision;
- support and feedback;
- the exercise of choice and responsibility.

''The introduction of coaching as the main management style in organizations is more logical to carry out according to the "top-down" scheme. The head of the organization should assume the role of the main coach.'' (Tabarovsky, 2019, 55.)

Coaching and goal setting

"The goal is an image of the result, the achievement of which is aimed at any activity. That is why goal setting is an essential step." (Basic and Applied Social Psychology, 2019, 25.)

By asking the right questions, the manager creates a situation in which an employee develops an understanding of his goals in the organization.

At the same time, he receives a detailed action plan, which allows him to more consciously strive to implement them.

"The formulation of the correct goals should be based on the following principles:" (Mindtools.com, 2019):

- developing realistic goals in the short term;
- setting an individual goal that must be achieved independently;
- a clear delineation of own goals and those of other team members;
- understanding of the fact that the occurrence of any doubts and discomfort sensations will indicate an incorrectly chosen goal;
- conducting periodic adjustment of goals or their complete change in accordance with changes in external conditions.

Goals are a fundamental feature of all methods, strategies, and effects of NLP. They are focused and focused on all activities related to any particular impact or strategy. It is believed that if you do not want anything, then NLP is useless for you.

Since the focus of action is important, coaches should help their clients set meaningful and specific goals. In this regard, a good coach is a bit like a taxi driver. What is the first question a driver asks when a passenger gets into a taxi? The driver asks: "Where are you going?" You can answer: "I hate being here. I have a lot of problems here. It's just awful to be here." However, patiently listening to you and acknowledging your inconvenience, the driver will eventually have to politely repeat the question: "So where do you want to go?" spent time going there last time. And of course, I'm not going to go where it's cold. " Again, the driver can graciously acknowledge your worries, but will still have to ask: "So where do you want to go in this case?"

Identifying the goals and desired customer results with a coaching agent can sometimes be as difficult as in the taxi driver example described above. Often when people ask for help from a coach, they know more about what they do not want than what they really want.

Team building coaching

"The principles of coaching in creating a team are identical to the methods used in working with an individual. The duties of the coach include setting tasks for the team and facilitating the process of finding solutions." (Who.int, 2019, 42.)

However, all the same, there are some peculiarities in the work with the team, which consist in the need to apply additional interaction technologies related to group dynamics.

The main stages of the coaching approach to team building are:

- discussion and the formation of team goals;
- drawing up and adopting general rules for team interaction;
- group discussions of goals and objectives;
- discussion and fair evaluation of work;
- rejection of condemnation and criticism;
- building support system within the team;
- mutual learning and mentoring.

"The technique of teamwork can be implemented both in the direction of individual work with each of its members, and with the team as a whole." (Fast Company, 2019, 78.)

The results of effective team coaching should be the following achievements:

- the team can conduct an effective internal dialogue on solving any business problems;
- reduction of decision-making time and improvement of their quality;
- increase of indicators of responsibility, awareness, discipline both for individual employees and for the whole team;
- the understanding by each team member of the significance of the personal contribution to the achievement of common goals and the importance of internal interaction;

- disclosure of inner potential and creative abilities of each team member;
- improvement of interpersonal communications, the formation of a single field of functioning;
- each member of the team is aware of the priority importance of achieving common goals, rather than individual self-assertion;
- the formation of a respectful attitude within the team as the basis for a fruitful and comfortable activity;
- achieving unity, interaction and satisfaction with the results of this process.

Using a coaching approach to create a team provides clarity and understanding of goals, reveals the potential of all team members, awakens initiative and commitment, and strengthens self-esteem and self-motivation.

Types of coaching

Here are the distinctive sorts of coaching given:

1. Business coaching– Business training is constantly directed inside the imperatives set on the individual or gathering to meet authoritative objectives

2. One on One Coaching for Executives – One to one training is progressively being perceived as the path for associations to improve Executives for growing new aptitudes, improving execution, defeating detailers, and getting ready for headway. Offer instructing at the official dimension and attached to association objectives, frequently results in improved business results. Official training is regularly conveyed by mentors working from outside the association whose administrations are mentioned for a concurred span or number of instructing sessions.

3. Personal/Life Coaching – The individual/life mentor enables people to pick up consciousness of and clear up their own objectives and needs, better comprehend their contemplations, sentiments, and alternatives, and take suitable activities to transform them, achieve their objectives, and feel progressively satisfied.

4. Career Coaching – The profession mentor enables people to distinguish what they need and need from their vocation, at that point settle on choices and take the required activities to achieve their vocation destinations in offset with different pieces of their lives.

5. Group Coaching – Group mentors work with people in gatherings. The center can go from authority advancement to profession improvement, stress the board to group building. Gathering instructing joins the advantages of individual training with the assets of gatherings. People gain from one another and the cooperation that happen inside the gathering setting.

6. Performance Coaching – Performance mentors help representatives at all dimensions better comprehend the prerequisites of their occupations, the capabilities expected to satisfy those necessities, any holes in their present execution, and chances to improve execution. Mentors at that point work with the representatives, their managers, and others in their work environment to enable the workers to fill execution holes and create plans for further proficient improvement.

7. Newly Assigned Leader Coaching – Coaches of people doled out or enlisted into new positions of authority help these pioneers to "locally available." The objective of the training is to clear up with the pioneer's key constituents the most vital duties of his/her new job, the expectations in the initial couple of months of the new task, and approaches to coordinate the group (s)he will lead with the association. The significant focal point of this kind of training is on helping the new pioneer to absorb and accomplish his/her business goals.

8. Relationship Coaching – The relationship mentor enables at least two individuals to shape, to change, or improve their associations. The setting can be work, individual, or different settings.

9. High-Potential or Developmental Coaching – The mentor works with associations to build up the capability of people who have been distinguished as key to the association's future or are a piece of the association's progression plan. The focal point of the instructing may incorporate appraisal, competency advancement, or help arranging and executing key undertakings.

10. Coaching to Provide Feedback Debriefing and Development Planning – Organizations that utilization appraisal or 360 input forms frequently use mentors to enable workers to translate the consequences of their evaluations and criticism. Moreover, mentors work with people to settle on vocation choices and build up proficient advancement plans dependent on criticism, evaluation results, and other applicable information.

11. Targeted Behavioral Coaching – Coaches who give focused on conduct training help people to change explicit practices or propensities or adapt new, progressively powerful approaches to work and interface with others. This sort of training frequently helps people who are generally extremely effective in their present occupations or are taking on new duties that require an adjustment in explicit practices.

12. Legacy Coaching – The heritage mentor helps pioneers who are resigning from a key job to settle on the heritage they might want to desert. The mentor likewise gives counsel on progressing out of the position of authority.

13. Succession Coaching – The progression mentor evaluates potential contender for senior administration positions and sets them up for advancement to increasingly senior jobs. This sort of instructing might be utilized in any association that is encountering development or turnover in its authority positions. It is particularly useful in privately-owned companies to keep up the reasonability of the firm. Since evaluation is frequently part of this mediation, clear desires and standard procedures for privacy are basic. It might be fundamental in certain organizations to utilize separate experts for appraisal and training.

14. Presentation/Communication Skills Coaching – This kind of instructing enables people to increase mindfulness about how they are seen by others and why they are seen in that manner. Customers adapt better approaches to communicate with others. The utilization of video recording with criticism enables customers to consider themselves to be others do. The mentor enables customers to change the manner in which they impart and impact others by

changing their words, how they state those words, and the non-verbal communication they use to pass on their expected messages.

15. Team Coaching – at least one group mentors work with the pioneer and individuals from a group to set up their group mission, vision, procedure, and guidelines of commitment with each other. The group head and individuals might be trained independently to encourage group gatherings and different connections, fabricate the viability of the gathering as a superior group, and accomplish group objectives.

Contingent upon the need of the Executive or Individual, you will most likely give a few kinds of training. As far as I can tell, I mentor Leaders on five dimensions – business, organization level, leadership level, team level, interpersonal skills level, and personal level.

Research results

There are around 43,000-44,000 business coaches least working on the planet. Training is unquestionably a worldwide wonder; the best 10 nations with the most noteworthy quantities of mentors incorporate an Asian, an African and a South American nation (Japan, South Africa, Brazil). In any case, there stay extraordinary differences in the advancement and size of instructing markets relying upon every landmass and nation. Europe, North America and Australia – speaking to only 20% of the total populace - include 80% of all business mentors of the world. Multiple thirds everything being equal are situated in the European Union, USA and Canada which speak to only 13% of the total populace.

In particular: The 7 nations with the most elevated quantities of mentors (US, UK, Germany, Australia, Japan, Canada, South Africa) include just 10% of the total populace, however about 73% everything being equal.

Training is on the ascent over the globe and there are particular, profoundly created and dynamic "focuses" of instructing. Be that as it may, exhaustive region wide inclusion of training is a long way from a reality. This is valid for all landmasses.

This can be additionally represented by the accompanying discoveries:

- Coaching is as of now generally acknowledged and utilized as a business apparatus in 28 nations (of these 14 are European). Notwithstanding, in 114 nations (about 70% all things considered), it isn't. In another 20 nations, this is unsure.
- In 33 nations, training is in the development stage (7 of these in beginning periods of development). In a further 50 nations instructing has entered the presentation stage (5 of these being in the middle of pre-presentation and presentation). In the rest of the 77 nations (about half), business instructing hasn't yet obviously created. In two nations (Norway what's more, the Netherlands), coaching has just entered the development stage.
- In 27 nations from all mainland, business instructing is very much progressed towards turning into a calling (15 from Europe). In any case, in 125 nations, for example in about four fifths all things considered, it isn't. In 10 nations, this is uncertain.

- National and worldwide instructing affiliations exist in Northern America, Europe, and Australasia. There are likewise some in South America, however few in Asia and even less in Africa. In about portion of the 162 nations, there is no single individual from any national or worldwide instructing body in the nation.
- The idea of training societies is very notable in 19 nations. In a further 29 nations there is slight information and utilization of it. Be that as it may, in 111 nations, the idea is scarcely or not known by any means.
- There is a general parity of order and non-mandate training approaches on the planet. The prevalent instructing style is order in 28 nations, non-mandate in 24 nations. In 110 nations, this is uncertain.
- The utilization of mentor supervision is generally spread in 23 countries (around 15% everything being equal).

3. Results

Coaching and development in a structure concept a structured coaching and development program ensures that workers have a homogenous expertise and background. The consistency is especially relevant for the company's basic policies and procedures. All workers ought to remember of the expectations and procedures among the corporate. This includes safety, discrimination and body tasks. swing all workers through regular coaching in these areas ensures that each one employee's members a minimum of have exposure to the data.(Gray et al., 2011)

Employee job satisfaction Employees with access to coaching and development programs have the advantage over workers in different firms United Nations agency area unit left to hunt out coaching opportunities on their own. The investment in coaching that a corporation makes shows the workers they're valued. The coaching creates a collateral geographical point. workers might gain access to coaching they would not have otherwise notable regarding or sought-after out themselves. workers United Nations agency feel appreciated and challenged through coaching opportunities might feel a lot of satisfaction toward their jobs.(Mujtaba - Sungkhawan, 2016)

The company's ability to manage people to gain competitive advantage. It is having the right people with the right skills available at the right time to meet the current and future requirements to achieve the company objectives. Human Organizational Capability includes recruitment and retention of the required skills, training and competence maintenance, succession planning, and employee performance management across all levels.

Organizational effectiveness and learning measures the human organizational capability and embeds continuous improvement into the mindset of employees.

Competence is a person's ability to accurately and reliably meet the performance requirements for a defined role. Motivation and competency are essential, and so systems need to be designed to maximize the potential of every individual. Each staff member needs objectives and targets which align with the

company Vision and Mission (SMARTs: Specific, Measurable, Achievable, Repeatable, Timely). Specific competencies are required in line with other standards, such as American Society of Mechanical Engineers and American Petroleum Institute standards for welders and non-destructive testing inspectors.

Seconders boost the technical "know-how" of the company. Should experience levels drop, it is important to have structured competency-based training to operate and maintain the process within accepted risk levels? Petro skills is an industry "cooperative" that ensures competencies (knowledge and skills) in the process industry are retained for future generations.

The relationship between Health and Safety and the Integrity of the physical asset is a complex one. The common denominator is the Human. Behavior-Based Safety (BBS) needs to be embedded into each individual's responsibilities and accountabilities so they are encouraged to be open to report and discuss safety issues with anyone, even up to the CEO (Hey, 2017).

The study investigates the impact of coaching as a modern method and its connections with the organizational culture. The analysis uses the model of four types of organizational cultures, i.e. the transaction-oriented market culture, the family-oriented clan culture, the tradition-bound hierarchical culture and the innovative adhocracy culture. The study shows that the use of coaching in organization management can gradually model or change the organizational culture. Moreover, it attempts to determine possible directions of the change. It is observed that – in favorable conditions – coaching may enable transformation from the traditional to the innovative culture. The change is possible because coaching brings about changes in people's behavior, stimulates their creativity, coming up with plans and taking actions. There is a positive impact on the motivation of employees too. Coaching allows for a gradual rather than revolutionary change. The study also shows how the type of the organizational culture influences the possibility to implement coaching. Therefore, it also describes potential problems and barriers (Iluzia, 2015)

Conclusions

The coaching methodology is aimed at the continuous development of staff and its motivation to more fruitful work. Its action is aimed at identifying the personal hidden opportunities of each team member and combining them to successfully achieve their goals. The use of coaching in work with personnel allows us to reach a qualitatively new level of interaction and make progress in improving the professional skills of each employee.

The main and important difference between methods and other types of professional counseling is to work towards the realization of the potential of each person. Opening up the capabilities of each employee and his inner motivation will allow creating a single team with full understanding and taking responsibility at all levels, which ultimately will have a positive impact on the performance of the entire business.

Developing others is one in every of the most effective methodology of accelerating the economical and performance of the workers, as a result of it helps them of learning new skills and up their exist performance. Managers play a crucial role in serving to their workers build the abilities they have to achieve success within the future. therefore, it's one in every of the managers or leaders' tasks. Even developing your workers will come to you in several edges beside the organization performance, that it makes the leader smarter and provides smart business sense. There is to kinds of developing, 1st one by coaching and second by teaching. The studies showed that the primary sort that developing by coaching is more practical, as a result of its a lot of joyful and let the workers move and live the experiences that why currently most of the code searching for internships, to boost their skills and data. Each of the employee-development activities printed on top of includes a totally different purpose, however each additionally has the flexibility to vary associate degree employee's life for the higher. once electing the manoeuvre that's most applicable for a given worker, take careful stock of the present scenario moreover because the desired state of the long run. Once you've got created your assessment, you will notice that one, two, or all 3 strategies area unit applicable for your specific scenario.

Engineers need to adapt to technological developments the same way as to other disciplinaries, such as leadership management, and their qualification supports them in it. These theories and methods exist to support personal development and to increase efficiency, as well as establishing employee well-being and the development of strengthened engagement, thus basically everything a company might need. Coaching based leadership is one of these new methods. Knowing that the freshly graduated Engineering Managers will become line managers, it is highly recommended for them to familiarize with it, since a responsible line manager using coaching could prove more successful in their position. A line manager is required to keep its team together, coordinate and efficiently handle arising problems.

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The manifestations of asymmetric information in business operation

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Abstract

This study is about what asymmetric information as a phenomenon means in business operation, what are its appearances in everyday working environment, and in what way it influences the original and centrally regulated processes of an economic organizations. Focusing on the use of excel spreadsheets we look for the root causes of its penetration among the stakeholders in organizations where the advanced infrastructure and sophisticated information systems are given. The investigation covers the connection between the information system usage habits and the extent (individual importance) of excel spreadsheets use.

The survey done among the employees of a Hungarian family owned corporation examines the information system attitude of users and their expectations in relation to it.

The results show how the users' habits and the real or perceived shortcomings of the systems lead to the emergence of information asymmetry that finally may result in serious consequences in ordinary processes such as disruptions or even wrong decisions made by the management.

It becomes obvious that the spreadsheets made and used by the users were originally created to manage this type of temporary or permanent lack of information.

However, it is clear that the use of this spreadsheets by an individual or a smaller group of users beside or even instead of using corporate information systems has adverse effect on corporate processes supported by systems as the extensive availability of information is violated to a greater or lesser extent. That is why in the final section of the dissertation we suggest how to create a balanced environment in terms of information supply based on our own experiences and the propositions of users involved in the study.

Keywords

asymmetric information, business operation, efficency

1. Introduction

Nowadays, the daily operation of companies is inconceivable without the use of IT systems supporting, connecting, organizing and planning the most important activities, as well as displaying the results in required form. One of the most

important features of these - usually integrated - systems is that they store and connect information in a specific manner, based on their operational characteristics, so that they may be freely editable and accessible by interest groups specified by their entitlements. It can therefore be stated, that the integrated company information instruments form one of the most relevant bases of shared company knowledge, ensuring the integrity of business information.

However, it is a well-known fact, that some employees who use company systems create and use spreadsheets in the process of carrying out their work, which are obviously created for either personal use or for a specific group, therefore access to the information stored in or produced by them is not granted to the entirety of the organization.

This necessarily results in the emergence of asymmetric information between business operators. Which begs the question: what reasons result in the creation of these separate spreadsheets and how could the knowledge accumulated within be made accessible to every operator within the organization?

2. Rewiev of the literature

Innovation, the key to competitiveness

The emergence and subsequent indispensability of business IT systems is the result of the innovation that has materialized in all operational areas, and is sustained by an ever-intensifying competitiveness in economics. Although innovation usually brings to mind the development of products on the market, we also need to discuss process, market, supply and organizational innovation, in accordance with the definition by Schumpeter. (Piskóti, 2014) As defined by Drucker "innovation is an organized, planned and targeted activity, through which companies aim to create new values and fulfill new demands that differ from existing ones, as well as rearrange existing sources into a new and more productive form". (Drucker, 1986)

The development of business IT systems can be classified as both process and partially organizational innovation, though we can also look at it as a result of all types of innovation. It is easy to acknowledge, that in the present, highly complex economic and market situation, a business must store and process such a volume of information, which could only be done through digital tools, and must also pay mind to the continuous improvement of said digital tools, if it wishes to remain competitive among other market operators.

Expectations towards ERP systems

The ERP (Enterprise Resource Planning) system is essentially an integrated business process management software, which allows for real-time access to the data of the organization. It usually covers the activities of several, possibly all organizational units. It allows for the collection, storage, processing and interpretation of data, generated during the operation of organizational functions, on a company-wide or company group scale, resulting in a constantly update and integrated look into the company processes.

One of the defining features of the system is integration, meaning that its applications must cover all of the value-creating functional areas. In addition to this, the changes occurring in financial processes may also appear in the supporting (accounting, auditing, human resources, facility management) modules in real time, if necessary. This integration may also be interpreted outside the framework of the company, as it may be necessary to provide a connection to the systems belonging to the customers and suppliers (such as the EDI system, various inventory management systems).

The structure of this system is usually modular, which allows for gradual development, as well as providing a functional orderliness.

It must be rich in functionality and platform- (computer-) independent, so that not only would the business processes require modification to implement the ERP system, but also for the system to have some leeway when it comes to adapting to the business processes of the company in question. It can be said as a general rule, that for processes where (additional) efficiency-enhancing developments could only be achieved with difficulty and/or at a significant cost, the applications of the ERP system will need to be customized. (Wallace – Kremzar, 2006) An additional requirement of ERP systems is for them to be platform-independent, that is, it must be usable regardless of hardware or the type of operation system, so no compatibility issues would arise during use.

It is of key importance for the system to be user-friendly, which should primarily manifest in an ease of usability, as well as a logical and easy-to-understand structure, in order to minimize the expected resistance upon implementation and the amount of errors that emerge during use. At this point it should be considered, that reliable service provider support (helpdesk support) should also be available during both the implementation and daily system use. (Demeter, 2014)

Opportunities in the Excel spreadsheet applications

Usually, the main task of spreadsheet applications is to provide a suitable, well-structured interface for data entry, particularly if we are curious about correlations present within the data. All of this is made readily available by the functions and graphical tools offered by the application.

The accessibility of the application and the user-friendly design could easily result in the use of Excel becoming an alternative to users, upon discovering some form of non-conformity in the data while using business systems, or upon realizing, that the information they seek cannot be found within the system (this situation is typically the result of improper customization). In such cases, we may consider that an information asymmetry has emerged.

The emergence of asymmetric information in business operations

The emergence of asymmetric information can be identified during communication, if one of the participants in the transaction possesses data/facts/knowledge, which the other party does not.

Above all else, the bounded rationality theory of Herbert Simon should be noted as the vanguard of research into asymmetric information. To summarize

the essence of this idea: "Humans are guided by emotions in their decisions, alternatives are examined to a satisfactory level. After the decision made on an emotional (irrational) basis, they will place it within a framework of rationality. Therefore the decision is not rational, but rationalized." (Komor –Mihály, 2011)

All of this means that the information available to individuals is digested and processed differently, which results in the constant presence of information asymmetry throughout human existence.

While Professor James A. Mirrlees dealt with the issues of designing optimal taxation in an environment of asymmetric information, Rothschild and collaborator Stiglitz were primarily concerned with insurance concerns in the event of asymmetric information. The initial hypothesis was that the insurance company cannot recognize whether the insured person is low or high in risk, therefore the low risk people must undertake the same excess, which discourages high risk people from reporting themselves as low risk. (Rotschild- Stiglitz, 1976)

George Akerlof and Robert Shiller have expressed in their 2009 work, Animal Spirits: How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism, that irrational behavior is typical of humans in both the booming and declining periods of the economy. The former is characterized by excessive trust, while the later by excessive skepticism.

Another book by George A. Akerlof and Robert J. Shiller, Phishing for Phools, deals entirely with the examination of the mechanic during which the economic and social actors become the sufferers and users of deception and manipulation in everyday life.

Akerlof elaborates, that the poor quality goods ("wrecks") can ruin the markets of good quality products, due to the fact that the customers are unaware of the quality of the product/service they wish to purchase (possessing only partial information), therefore, when they make their decision, they will be unable to see the difference between a good and bad quality product. (Hirshleifer- Glazer-Hirshleifer, 2009)

Stiglitz and other prominent economists believe that the self-regulation of the market does not work properly, in part because market operators possess market information at unequal rates and this inequality cannot be decreased. In relation to this, market operators are also characterized by the fact that their behavior and decisions are not rational, they are influenced by numerous biases, distortions and heuristics. Stiglitz simplified all of this by saying: "the reason that the invisible hand seems invisible is that it is not there" (Stiglitz, 2003).

Finally, it is worth noting that newer papers have been examining the correlations between internal information asymmetry and financial losses (Chen,-Xiumin, 2018), as well as the information asymmetry between an independent upper management and shareholders. (Goh-Lee, 2016)

As it is clear from this list, the research into asymmetric information cover just about every area of economics, thereby including the operation of companies as well.

My own research involves business processes, which are usually deemed to have been solved by upper management: operational areas supported by one or more

integrated governance systems. I was looking to find an answer as to what leads to employees using such systems, to create their own work tools, namely Excel spreadsheets, which are obviously separated from the shared information base.

3. Survey

As part of the survey undertaken by the employees of 77 Elektronika Kft., I have forwarded a self-administered survey among employees using business systems, using the survey creator application of Google. I have forwarded my questions to a total of 278 people, of which 127 responded.

The survey began with 7 background questions (sex, age, qualification, etc.), which were followed by 4 warmup questions about trainings related to the systems, followed by 24 substantive questions. The final, open-ended closing question was about user expectations towards business systems.

The majority of the questions were closed-ended. The explicit warm-up questions were following by the implicit questions of the substantive portion. These were mostly evaluation questions (using a 5-point Likert scale), though they also included true-or-false statements.

In order to evaluate the results of this research, I used the Excel spreadsheet and SPSS statistical applications.

Characterization of the research samples

Most of the respondents work in manufacturing (75 people, 49%), while the organizational unit with the lowest headcount was human resources, with two people (1%). Department of Economics (4%), Sales Department (11%), Logistics (12%), Quality (15%) and Technology Department were also involved in the study.

Most of the respondents (88) have been working at the company for less than five years. 57 of them work in manufacturing, but new colleagues are also predominant in logistics, quality management and technology survey respondents. This accurately reflects the recent, significant increase in size the company had gone through.

4. Results

The most important question of the survey was the following: Would you be able to perform your daily functions exclusively via the business IT systems, if upon one morning, you could not use the mailing system or your phone and could not request any assistance from your colleagues?

With this proposal, I wished to examine how employees would perform their required daily tasks using the "centrally" provided work tools (systems). Naturally, the supposition expressed in the question pertains to a fictional situation, since it is highly unlikely as humans who have socialized within

communities, that informal communication with our colleagues would not be an essential part of our daily routine, either in person or in writing. However, by assuming such a unique situation, I considered it worthy of research whether the IT systems were capable of providing proper storage for the information most relevant to the operational functioning of the organization, and the proper processing of user needs.

Based on the answers, it seems than only 27% (34 people) feel as though they would be able to perform their duties using the systems. The rest of the employees (73%) believe that by only using the systems, they would only be able to partially perform their jobs at best, while 28% of this group would not be capable of working using only these.

The prevalence of making separate spreadsheets

It is clear, that the ratio of people, who at least occasionally create separate spreadsheets is 87%, of which 71% must repeatedly turn to this solution, over the course of their daily work.

Searching for the reasons behind the creation of spreadsheets, I performed cross-table analyses on various variable pairs, and over the course of this process, I have discovered a correlation with a proper significance level. The two variables pertain to the answers provided to the following questions.

- Do you need to make a separate (Excel) spreadsheet for your work?
- I have to assemble information from various sources (besides the system) in the spreadsheets

Cross-table analysis

The results of cross-table analysis show that the expected values almost always differ from the actual values, which indicates, that there is a correlation between the two examined variables. The close relationship between the extreme values of the variables shows, that those who can work using information primarily present in the system also need spreadsheets the least, while those who have to collect information from multiple sources create separate spreadsheets often, almost on a daily basis.

Conclusions

As I have alluded to it earlier in my paper, the most valuable place for the data and data matches displayed and the operations performed in these personal Excel spreadsheets, would be within the integrated governance system. I believe it is highly important to become aware of the existence of such spreadsheets through periodical interviews with the colleagues, as well as the reason behind their creation, and to examine the possibility of managing this information within the system.

Naturally, modifying the system is only possible in exceptional circumstances, as changes introduced alongside everyday use could result in a

significant shock to the entirety of the organization, therefore the ratio of expected benefits and the expenditure of time, money and effort required for the transition.

In those cases when modifying the system is not possible, an alternative would be to create certain interfaces (frameworks), which would make access to information as easy as possible for users, given the circumstances. All this can be achieved by making the relevant information from various sources available on an interface designed according to user needs, thereby making their daily work significantly easier.

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Machinery management by isobus system

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Abstract

ISO organization in early 90s defined an industry standard for the communication protocol among electronic devices of different manufacturers of agricultural machines. After that, all of the market actors recognised that this technology would be very important for agricultural electronics. The appearance of ISOBUS products in the market was in the mid-2000s. ISOBUS description could be found in ISO-11783. It is a very complex and large electronics protocol standard based on CAN and SAE-J1939 standards, extended for the Agricultural Industry. The standard consists of 14 different parts and more than thousands of specification pages.

Through the standards and the related technical background, the production processes and the operations could be followed and monitored by the extensive Data Management. Farmers' and users legitimate needs and developing goal is to elaborate a decision support systems that follow-up the utilisation of the machines and ensure the quality of operations. For this purpose, it is essential to determine which technical, economical, technological parameters, detection, measurement, transmission, processing, and evaluation becomes necessary.

In our work, we reviewed which mechanical characteristics, settings are monitored within the ISOBUS system by the major machine manufacturers. We developed the system of parameters and derived features that provide effective farm-, and land-management in case of attached equipment for spreading of input materials and tillage implements.

Keywords

ISOBUS, Data Management, Standardisation, agricultural mechanisation, product development

1. Introduction

Fast development of the electronics applications

Similarly to other Industries, the agricultural industry saw a significant growth of electronics application starting from mid-late 80s (Stone et al. 2008). Manufacturers with multiple development locations were also affected by the

lack of a standardized protocol. In a fast growing environment the consolidation of Product Development organizations was not always a priority and therefore the presence of a robust industry standard was significantly supported by most of the industry players to drive a more efficient product development. Each team could easier concentrate on the development of the functionalities which could provide a competitive advantage. Even companies joint ventures, partnerships and acquisitions were affected by the availability of a standard and the maturity of development in the ISOBUS technology. (Mongiardo 2017)

ISO11783 standard and the foundation of the AEF

After almost 20 years of application and development the ISOBUS (as defined in the standard ISO11783) has become a key element in the design of modern agricultural machinery. (Benneweis 2006)

Even if the "plug and play" approach was the main concept inspiring the creation of the ISO11783 standard, there have been many factors which prevented a smooth and fast introduction of the ISOBUS products in the market:

- the complexity of the standard (more the 1,000 pages divided in 14 sections) (ISO11783)
- the rapid evolution of digital technology;
- the lifecycle of components of agricultural tractors and related return of investments;

The first two items mainly drove the creation of an industry consortium called AEF (Agricultural Electronics Foundation) born to address the main industry issues coming up from the application of the ISOBUS standard. This allowed manufacturers to create a common interpretation of the standard when applied to real products. (Mongiardo 2017)

Ag Industry Electronics Foundation, the AEF, was founded in October 2008 in Frankfurt at the VDMA. The founding members were 7 equipment manufacturers (John Deere, Grimme, Pöttinger, CNH, AGCO, Claas, Kverneland) and 2 associations (VDMA and AEM). AEF's aim was and is to provide resources and know-how for the increased use of electronics and electrical systems in mobile Farming Equipment. Initially, and mainly in the first years of its existence, it was clear that a succession of important tasks associated with ISO 11783 (ISOBUS) formed the main focus of AEF's work. Primary tasks such as the development of a Conformance Test and the publication of certified products in a global database. (Vlugt 2017)

Since its founding in 2008, the AEF has grown to a mature and independent Industry Foundation with over 200 members. (AEF Website)

ISOBUS Functionalities

For increased transparency towards the end-customers as well as to developers, the AEF has defined the so-called ISOBUS Functionalities that are now also the basis for the certification of ISOBUS products. The Functionalities encapsulate the different Control Functions on the ISOBUS network, such as the Terminal, the Tractor ECU, an Auxiliary device or a Task Controller. (Figure 1.) By

splitting up the standard into these predefined functionality blocks, it is easier to explain to the end-customer what it means when a device is said to be ISOBUS compatible with a particular Functionality. One or more Functionalities can be bundled together into a product intended to interconnect with other products that contain AEF Functionalities. (Vlugt 2017)

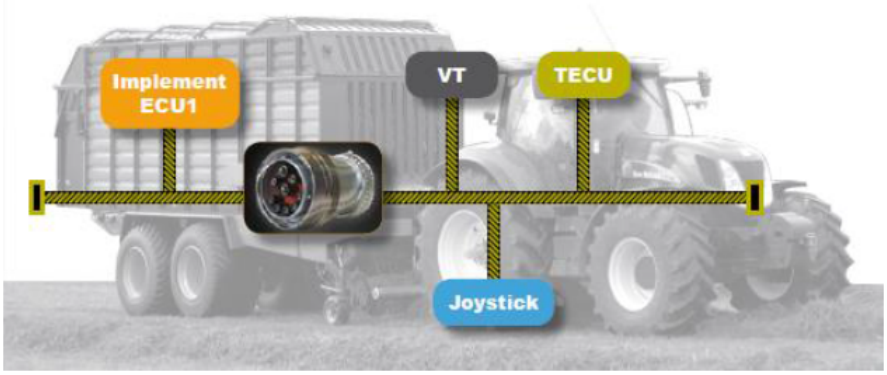

Figure 1. Typical standard ISOBUS System (Vlugt 2017)

Figure 2. AEF Certified Label (AEF Website)

After a first period in which all the ISOBus sections release levels were defined in a certain ISO11783 implementation level it become evident that a more practical approach was needed to address the increasingly complexity. Eight main functionalities, each of them with its set of ISO11783 sections release, were then released by AEF, covering the main functional aspects addressed by the standard. The maintenance of the defined functionalities and the creation of the new ones needed for the industry is one of the critical activities which prevents incompatibility issues when connecting ISOBus devices developed by different manufacturers. (Mongiardo 2017)

The AEF has released the following Functionalities that can be certified today by the Conformance Test:

- UT – Universal Terminal. The capability of operating an implement with any terminal. The capability of using one terminal for operating different implements.
- AUX – Auxiliary Control. Additional control elements, such as a joystick, that facilitate the operation of complex equipment.
- TC-BAS – Task Controller - Basic. Describes the documentation of total values that are relevant for the work performed. The implement provides the values. For the exchange of data between farm management system and Task Controller the ISO-XML data format is used.
- TC-GEO – Task Controller – GEO-based. Additional capability of acquiring location based data – or planning of location-based jobs, as for example by means of variable rate application maps.
- TS-SC – Task Controller - Section Control. Automatic switching of sections, as with a sprayer or seeder, based on GPS position and desired degree of overlap.
- TECU – Tractor ECU. The tractor ECU is the tractor‘s interface to the ISOBUS. This provides information, such as speed, power take-off RPM, etc on the ISOBUS for use by the implement.
- ISB – ISOBUS Shortcut Button. A button present on a Terminal, or in the Tractor cabin, to be used to send a global message to all connected Control Functions on the ISOBUS to go to an Idle/Shortcut state. This Functionality is not to be seen as an emergency button! The Functionality approach is flexible, and new functionalities that come up in the future can easily be added once the Guidelines are defined and released. Functionalities that are currently under development are for example: TIM / ISOBUS Automation and the TC-LOG. (AEF ISOBUS Database)

2. Material and method

Tractor Implement Management

Tractor Implement Management is one of the next steps in the near future. Within AEF manufactures are creating a robust way of opening automation to ”trusted equipment” defining rules to clarify liability and guarantee a ”plug and play” approach to the customers. (Martinov et al 2018)

Data Management

Data Management facilitates the exchange of data with the mobile equipment in the field. Through this functionality the user gets his data into a management system for registration purposes and further future planning. (Bártfai et al. 2009) Newly planned data can be generated by such systems (e.g. decision support advisory systems) and taken back into the farming equipment for planned field tasks and operations through for example a wireless service or Telematics portal of the manufacturer. It is crucial that the set of data exchange principles is standardized throughout the Ag Industry, in other words the industry must go for just one type of interface protocol between its machines and the telematics service, and from the telematics service to External API’s through a set of standardized cloud-cloud interfaces with clear and standardized data structures. (Vlugt 2017)

Connectivity

The end-customers, i.e. the farmers and contractors, expect a seamless connectivity of implements and tractors, now and in the future. Also of all systems and data, both in the field on his machines as well as to other software and services. Seamless connectivity can only be reached by industry cooperation and by acceptance and implementation of Industry Standards for communication and data exchange. An 'open' mind to connectivity with competitors and suppliers of Farm Management Software solutions and other Decision Management services is therefore a must for all companies and equipment manufacturers. (Vlugt 2017)

Future Directions

Future challenges in ISOBUS development are focused at three points:

1. COPL (Cost Optimized Physical Layer):
   Cost optimization allowing a higher diffusion of the ISOBUS technology (also more suitable for smaller machines). The goal is to reach lower volumes and smaller application.
2. WIC (Wireless Infield Communication):
3. HIS (High Speed ISOBUS):

– Distributed high-resolution position/correction signals.
– Digital Video Systems.
– Improved Service and Diagnosis (flash ECUs, Log-files, raw data streams for debugging).
– Mobile Internet on ISOBUS for dedicated server/client requests.
– High Voltage data Connection.

As technology evolves, manufacturers must take advantage of new opportunities with the end goal of providing farmers with a higher productive, higher quality and more efficient farming cycle. (Martinov et al 2018) (Bártfai et al. 2017)

3. Results

Overview of selected parameters for processing and monitoring of products of the market's leading agricultural machinery manufacturers

In first step of the research work the measured and processed parameters of most significant attached working equipment was defined. The sprayers, fertilizer spreaders and seed drills (including towed-, and attached version, and also the direct-, and mulch sowing machines) and the ploughs were selected.

For machines listed in the measurement and processing of the measured values of the following parameters were determined:

a. Worked area	e. Time in working position
b. Theoretical quantity	f. Distance in working position
c. Weighed quantity	g. Pump speed
d. Applied quantity	h. Spray pressure

i. Hopper volume j. Current speed k. Speed source l. Operating hours - motor m. Current track width n. Motor torque in % o. Motor speed in rpm p. Average consumption AdBlue in l/ha q. Average consumption Diesel in l/ha r. Current blower fan speed s. Blower fan speed setpoint	t. Minimum speed u. Maximum speed v. Target speed w. Spread rate actual value x. Spread rate setpoint y. Working position z. Setpoint in per cent aa. Theoretical residual quantity bb. Hopper content cc. Working width

The determination of monitored technical-technological parameters during the works of tractor and attached working machine combination

The next phase of work was the definition of the technical-, and technological parameters which could be measured, processed and displayed during the works of tractor and attached working machine combination. These characteristics were classified into four main groups.

The groups are:

Quality of work	Power-, and capacity-utilisation	Work safety	Cost

We denoted subgroups within the main groups, according to specificity, and the selected parameters were grouped in this way. The physical parameters which are the base of monitored technical and technological characteristics are presented in the Table 1 according to above illustrated classification.

To assure the quality of work it is important to ensure adequate working depth, tracking of the dispensed amount of input materials and analysis of energy consumption.

In terms of the power-, and capacity-utilisation the area, the time, and the quantity (by volume or weight) proves to be key factors.

The work safety can be provided by the in time detection of crash, injury or by detection of early signs of developing malfunctions e.g. the formation of irregular resonance, or limitation of overload, and the monitoring of drivers behaviour.

From the users part it is essential to take into account the cost. From this perspective the labour cost, the machine work cost, and the cost of inputs are most determinative and it is primary to follow-up them.

Table 1. Recommended follow-up ISOBUS values

Quality of work	Power-, and capacity-utilisation	Work safety	Cost
Working depth Measured value: – traction, drawbar deformation, – slip, – pitching angle of tractor	*Area* Measured value: – trip length, – Current speed, – Average speed, – attached machine width, – adjusted working width staging), – Direction of operation (coordinates)	*Crash, injury, resonance* Measured value: – engine oil viscosity, – temperature, – soot content, – hydraulic oil viscosity, – hydraulic oil temperature, – tire pressure, – vibration	*Labour* Measured value: – Number of vehicle card
Dispensed amount of input material Measured value: – PTO speed, – pump flow, – seed hopper weight, – seed plates speed, – fertiliser hopper weight, spreading disc speed	*Time* Measured value: – shift time, – engine operating hours	*Overload* Measured value: gear, – motor temperature, – 3 point hitch height (working depth), – drawbar deformation, – PTO deformation	*Machine work* Measured value: – Work operation code, – Work operation date, – duration of work operations, – correction factor of work operations
Energy consumption Measured value: – fuel quantity, – actual fuel consumption, – exhaust gas temperature, – number of fuel card, – quantity and time of refuelling	*Volume or weight* Measured value: – seed hopper weight, – seed plates speed, – fertiliser hopper weight, – spreading disc speed	*Drivers behaviour* Measured value: – cabin temperature, – time of using automated steering, – field map setting	*Input material* Measured value: – amount of spreaded input materials, – area, distance × working width – unit price of inputs, – duration of the service, – cost of service

Conclusions and recomendations

The technical solutions provided by the ISOBUS system - registering of the operating parameters of power machine and attached equipment - could review not only the technical and service characteristics of operation of each machine. There is an opportunity to overview the features on farm-management level that are the effective core devices for corporate governance, for efficient production and for successful planning too. These data in case of high-volume machine fleet, whether it is farm-fleet or contractors fleet, makes transparent the administration of machines and the performed tasks by their. These can be defined as the effective modules of the company's management systems.

From technical approach it is essential to ensure compatibility of ISOBUS communication between the products of different producers, between the power machine and attached implement, and on the level of telemetrical data transfer too. Mostly the European market of agricultural machines is the main market where the multi brand interconnectivity represents the biggest challenge. This innovative market is that where the ISOBUS has the widest application.

Acknowledgement

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The effect of the freezing time and thawing method on the rheological properties of lemon curd made of frozen liquid egg yolk

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Abstract

In this study, we examined whether slow-frozen liquid egg yolk, which undergoes a gelation process during freezing, can be used to make lemon curd. Therefore, unpasteurized liquid egg yolk was frozen and stored at -18°C for 90 days. Samples were thawed with a slow and a fast thawing rate on measurement days and lemon curds were made from them. Rheological parameters of the lemon curd samples were examined. Herschel-Bulkley equation was fitted to the flow curves. Based on our measurements, we found that the thawing method did not affect the rheological properties, but the time since freezing did.

Keywords

rheological properties, lemon curd, freezing, liquid egg yolk, thawing method

1. Introduction

Eggs are very versatile in the food industry because of their excellent nutrient content and various functional properties. Processed egg products, such as separated, homogenized and pasteurized liquid egg products are generally used for industrial purposes. Liquid egg yolk (LEY) is a popular ingredient in the food industry because of its excellent gelling, emulsifying, colouring and coagulating properties, high nutritional value and unique sensory characteristics. It is often used as a raw material of confectionery products such as lemon curd, ice cream, créme brulée and pudding (Cook, 1986; Uysal, 2019).

Liquid egg yolk serves as an excellent medium for microorganisms, therefore its shelf life is limited. Even with the addition of preservatives, it is only a few weeks (Dawson, 1998). Pasteurization is used to increase the shelf life of these products, but a relatively mild pasteurization time and temperature combination can be used. Heat processing above 60°C leads to transitions that cause changes in the microstructure, appearance, in the calorimetric and rheological properties of egg yolk (Cordobés et al., 2004).

Freezing is a traditional physical preservation process that can increase the shelf life of liquid egg yolk for up to 1 year. However, egg yolk undergoes an irreversible fluid loss, when it is frozen at -6°C or a lower temperature. This leads also to a gelation process, which affects the functionality of egg yolk (Primacella, 2020). Freezing of liquid egg products is a time-temperature-related process (Lechavalier, 2011). By increased freezing and thawing rates, smaller ice crystals are formed, that results in lower drip loss and better texture and proteins are less dehydrated (Powrie, 1963; Kolbe, 2007). Due to the gelation, the usability of frozen and thawed egg yolk changes.

Fruit curds, such as lemon curd, are traditional English spreads. They are made of fruit juice, butter, eggs, sugar and flavouring. Each ingredient plays an important role in texture and flavour forming (Elaine, 2004). Freshly made lemon curd has a shelf life of approx. 1 week in the refrigerator (Nummer, 2008). Meeten (2005) examined the rheological behaviour of Tesco Value Lemon Curd between planar and spherical surfaces. He found, that its behaviour can be described by Herschel-Bulkley equation.

In our study, we examine the effect of using frozen and thawed LEY on the rheological properties of prepared lemon curd samples. Effect of frozen storage and thawing method will be discussed, as well. Frozen storage of LEY of 90 days is performed.

2. Materials and methods

Materials

LEY was provided by Capriovus Ltd. (Szigetcsép, Hungary). Hen eggs were separated into egg white and yolk. The egg yolk was homogenized, cooled to 3°C and packaged in PET bottles under industrial circumstances. Other ingredients of lemon curd were the following: liquid egg white (LEW), butter, sugar and lemon. LEW was provided by Capriovus Ltd., butter, sugar and lemon puree were bought commercially.

Freezing and frozen storage

LEY samples were frozen with a slow freezing rate at -18°C in laboratory freezer in sterile polypropylene100.0 ml sample containers. Samples were stored in the freezer at -18°C for 3 months. On days 1, 7, 14, 30, 60 and 90 samples were taken out of the freezer and thawed with two different thawing method. One of them was thawed in tap water in two hours, one of them in a laboratory refrigerator at 5°C in 24 hours.

Making of the lemon curd

A saucepan was filled with 2 cups of water and placed on low heat when it began to boil. 15 g of thawed LEY, 28.5 g of LEW, 37,5 g sugar and 20 g freshly pressed lemon juice were mixed in a metal mixing bowl. Thereafter, the mixing bowl was placed over the saucepan and the mixture was cooked by

constant whisking for 3 minutes. After removing the bowl from the steam, 14 g of butter was mixed in the cream and lemon curd was cooled to 24°C in ice water. The addition of lemon zest was neglected since the solid pieces would have greatly influenced the rheological measurement.

Examination of the rheological behaviour of lemon curd samples was performed by MCR 92 rheometer (Anton Paar, Les Ulis, France) in rotational mode with a concentric cylinder (cup diameter 28.920 mm, bob diameter 26.651 mm, bob length 40.003 mm, active length 120.2 mm, positioning length 72.5 mm). Anton Paar RheoCompass software was used to control the measurement. The temperature of the rheological measurements was 5°C. Shear stress was measured by increasing the shear rate from 1 to 1000 1/s, then by decreasing shear rate from 1000 to 1 1/s. Herschel-Bulkley model (1926) was fitted to the slowing phase of the flow curves (shear rate-shear stress diagrams):

$$\tau = \tau_0 + K\left(\frac{d\gamma}{dt}\right)^n \tag{1}$$

Fitting was performed by using the least square fit method of Excel Solver, where τ_0, K and n were the changeable values.

Statistical analysis

Two-way ANOVA was used to analyze rheological parameters by IBM Statistics 24 software, the significance level was 5% ($P<0.05$) The normality of the error terms was examined by the Kolmogorov-Smirnov test (τ_0 ($k(42)=0.132$; $p=0.062$), K ($k(42)=0.124$; $p=0.105$), n ($k(42)=0.133$; $p=0.058$). Levene's test was used to determine whether variances are equal or not (τ_0 ($F(6;35)=7.596$; $p<0.001$), (K ($F(6;35)=2.815$; $p=0.24$), (n ($F(6;35)=0.1.870$; $p=0.114$). Post hoc tests were used to decide which groups differ. Tukey test was performed if variances were determined as equal and Games-Howell test was used in case of not equal variances.

3. Results

Examples of flow curves for lemon curds made of frozen and then thawed egg yolk are shown in Figure 1. Lemon curd samples in all cases showed non-Newtonian behaviour. The rheological characteristics could be described by Herchel-Bulkley equation. This means that they have a yield point, in addition, the shear stress decreases with increasing shear rate less and less. Applying shear stress greater than the yield stress, the material begins to flow, that is to say, a continuous deformation occurs over time. Margarine, butter and fats show such rheological behaviour. Because lemon curd contains a high amount of butter (17%) and egg yolks contain high levels of fat, it is not surprising that lemon curd samples also exhibit plastic flow. Some studies found also, that lemon curd could be described by Herchel-Bulkley model (Yan et al., 2010; Meeten, 2005; Meeten, 2007).

For each sample, hysteresis was observed, which means that the samples undergo structural transformation due to shear. Figure 1. shows that while the accelerating and decelerating sections of the control sample take about the same value at a shear rate of 1 1/s, the difference is very large for sample on day 7 that is thawed with the fast method. Besides that, the degree of hysteresis increased.

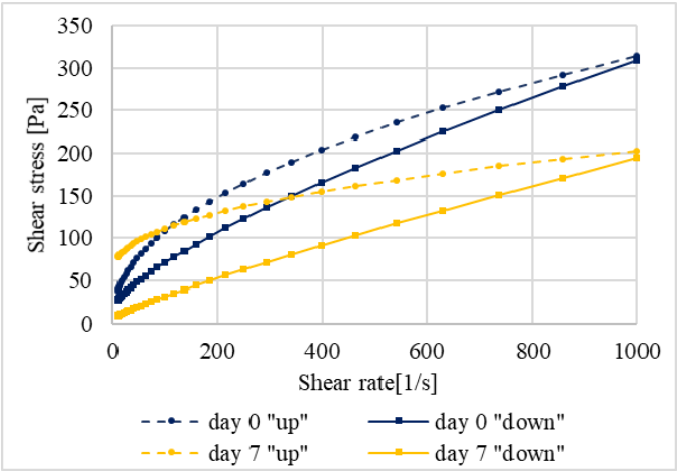

Figure 1. Examples for the hysteresis of lemon curd samples at 20°C (control sample (day 0) and the sample made of liquid egg yolk frozen for 7 days and thawed fast (2 hours, 35°C)

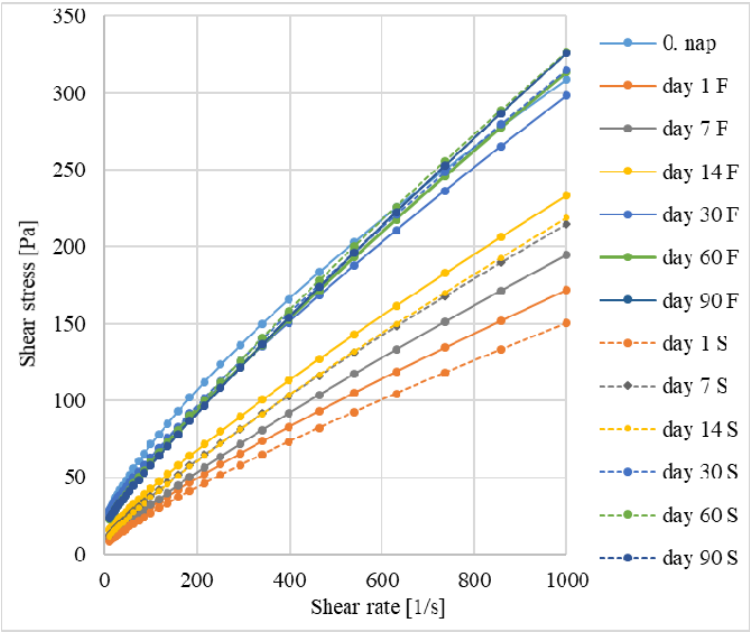

Figure 2. Effect of length of frozen storage (-18°C) and thawing methods (F-2 h, 35°C, S-24 h, 5°C) of the egg yolk on the shear stress-shear rate relationship (flow curve) of lemon curd at 20°C

Figure 2. shows the accelerating phase of the flow curves of the examined lemon curd samples. The diagram shows that there is a large difference in the shape of the curves from the first day to day 14 compared to the control sample. From the first month on, the curves of the prepared lemon curds are much more similar to the control sample. Table 1 shows the constants of the Herschel-Bulkley model fitted to the flow curves.

The values of yield point are between 5 and 23 Pa. These values are smaller than the yield point values in the studies of Yan and his co-workers (2010), Meeten (2005) and Meeten (2007). All of these studies examined Tesco value lemon curds, not self-made samples. In addition, their values are relatively different in the range of 77-135. It can be seen that the yield point of samples of days 30 to 90 are very similar to the yield point of the control sample. In contrast, the tendency for the consistency coefficient changed during the experiment and the flow behaviour index was higher than that of the control sample in each case. A big difference in these parameters can be seen in comparison to the above-mentioned studies.

Table 1. Rheological parameters (yield stress, τ_0; consistency coefficient, K and flow behaviour index, n) of unfrozen and cryogenic frozen-thawed LEW after modelling flow curves with the model Herschel-Bulkley

Storage time	Thawing method	τ0 [Pa]		K [Pa·sn]		n		R2	
[days]		mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
0	2 h, 35°C	17,65	0,11	1,84	0,13	0,73	7,4E-03	1,000	1,7E-06
1	2 h, 35°C	7,77	1,97	0,47	0,02	0,85	1,7E-02	1,000	1,4E-05
7	2 h, 35°C	5,94	0,12	0,51	0,02	0,86	9,4E-04	1,000	5,7E-05
14	2 h, 35°C	11,41	2,18	0,63	0,03	0,85	1,0E-02	1,000	1,4E-04
30	2 h, 35°C	22,04	4,49	0,92	0,22	0,83	3,4E-02	0,999	5,8E-04
60	2 h, 35°C	16,85	2,11	0,85	0,13	0,85	1,4E-02	0,999	4,7E-04
90	2 h, 35°C	18,33	5,07	0,66	0,03	0,89	9,9E-03	1,000	6,2E-05
0	24 h, 5°C	17,65	0,11	1,84	0,13	0,73	7,4E-03	1,000	1,7E-06
1	24 h, 5°C	5,02	0,43	0,51	0,02	0,82	8,9E-03	1,000	1,5E-05
7	24 h, 5°C	8,27	0,03	0,60	0,06	0,84	1,8E-03	1,000	8,7E-05
14	24 h, 5°C	7,70	0,71	0,56	0,01	0,86	2,7E-03	1,000	6,8E-05
30	24 h, 5°C	18,76	0,74	0,92	0,03	0,84	1,9E-03	1,000	8,5E-05
60	24 h, 5°C	19,45	2,08	0,94	0,06	0,83	4,6E-03	0,999	2,0E-04
90	24 h, 5°C	18,33	5,07	0,66	0,03	0,89	1,0E-02	1,000	6,2E-05

The method of thawing of the LEY samples had no significant effect on the rheological properties of lemon curd samples ($\tau_{0,TH}$ ($F(4.916;1)=0.762$; $p=0.390$), K_{TH} ($F(0.006;1)=0.696$; $p=0.411$, n_{TH} ($F(3.39E-04;1)=2.228$; $p=0.147$)). The combined effect of thawing method and storage time was not significant in neither case, so in the following we examined the effect of the storage time. The storage time had significant effect on each rheological parameter (($\tau_{0,T}$

($F(1291.849;6)=33.385$; $p<0.001$), K_T ($F(0.006;6)=164.905$; $p<0.001$, n_T ($F(3.39E-04;6)=91.622$; $p<0.001$)). Multiple comparison was performed by Games-Howell test in case of τ_0, Tukey test was used in case of K and n. Results of the post hoc test are shown in Table 2.

Table 2. Time dependency of rheological parameters (yield stress, τ_0; consistency coefficient, K and flow behaviour index, n) of lemon curd samples made with frozen and thawed liquid egg yolk

Storage time	τ_0 [Pa]		K [Pa·s^n]		n	
[days]	mean	S.D.	mean	S.D.	mean	S.D.
0	17,65^b	0,09	1,84^d	0,12	0,73^a	0,01
1	6,39^a	1,98	0,49^a	0,03	0,83^b	0,02
7	7,11^a	1,28	0,56^{ab}	0,06	0,85^b	0,01
14	9,55^a	2,49	0,59^b	0,04	0,85^b	0,01
30	20,92^b	3,25	0,92^c	0,14	0,83^b	0,02
60	16,56^b	1,53	0,90^c	0,10	0,84^b	0,01
90	18,33^b	4,54	0,66^b	0,02	0,89^c	0,01

$^{a, b, c}$ means with different letter in a column are significantly different ($P<0.05$)

Yield stress values formed two groups based on the results of two-way ANOVA. The value of τ_0 at day 1, day 14 and day 30 was less than that of the control sample, but it was similar to the control sample at 2 and 3 months of storage. The K values are the largest in the control sample, followed by a significant decrease and then increase under storage, but values do not reach the control sample. For n, we can see that the control sample is significantly different from the frozen and then thawed samples.

Conclusions

In this study, we investigated the extent to which the rheological properties of homemade lemon curd are altered when made from frozen egg yolk rather than raw egg yolk. In addition, two types of thawing methods were applied, one of which was slower (2 hours, 35°C) and one was faster (24 hours, 5°C). It was found that the rheological properties of lemon curd can be described by the Herschel-Bulkley equation. In addition, the method of thawing did not affect the rheological characteristics of the creams. However, freezing and frozen storage caused changes in all three rheological parameters. The change decreased to some extent during frozen storage.

In our next experiment, we use LEY, which is frozen by adding sugar, so less sugar is needed to make a lemon curd. It is based on the fact that sugar, as a cryoprotectant, prevents the structural transformation and gelling of egg yolk.

Nomenclature

K	consistency coefficient	$Pa \cdot s^n$
n	flow behaviour index	-
R^2	correlation coefficient	

Greek letters

τ	shear stress	Pa
τ_0	yield stress	Pa
γ	shear rate	1/s

Subscripts

T	time
TH	thawing

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Use of plant monitoring for crop prediction in hydroponic longterm tomato cultivation

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Abstract

In greenhouse tomato cultivation it is increasingly important to estimate the yield and to get an accurate understanding of the plant's processes. Using plant monitoring and climate computer data and accurate yield measurement, there are countless new opportunities for growers to maintain crop yields and plant condition through to the end of the growing season. It is necessary to emphasise the importance of plant monitoring measurements and to conduct further examinations. Acquired data can provide help for identifying technology failures and forecasting crop yields, which can greatly assist sales.

Keywords

tomato, plant monitoring, hydroponic, measuring, production

1. Introduction

In the Central European region, modern, soilless, hydroponic vegetable forcing technology is an increasingly focused and developing sector. Significant investments have been made in this sector in both Hungary and in the neighboring countries over the last 5 years. The development of several hectares of horticultural farms requires such an investment that the owners try to eliminate any technological mistakes and minimize the risks. An excellent way to do this is to continuously monitor plant development, which is also an indirect method for controlling technology. For more than 10 years, Alicja Szőriné Zielinska, represented by Grodan, has been using method for plant monitoring (crop registration), which is beneficial in many ways. It is possible to predict the expected weekly harvest, and the growth parameters will also guide the consultant to respond to possible negative effects.

There are different three tomato varieties were cultivated in the examined greenhouse farm in 2018. During the cultivation, monitoring measurements were carried out on 14 plants of all three varieties from January to November. Measurements began before tomato flowering began and continued until the end of cultivation. The monitoring data also recorded the weight of the harvested crop, which correlates with the changes of the plant parameters and their effect on the yields. Economy considerations, and the quantity/quality demands of the market, force the introduction of crop monitoring in other, even smaller horticultures, with fewer parameters at first.

2. Literature review

The aim of greenhouse climate control is to achieve the most favourable impacts on the development, yield and quality of plants by regulating climate elements (i.e. irradiation, air temperature, humidity, carbon dioxide level). Climate of greenhouses is enhanced as compared to outside conditions by ventilation, heating, shading and, as a most recent advancement, supplementary lights (Terbe – Slezák, 2008).

Climate control can now be automatized. The centre of the control is a climate regulating computer that automatically adjusts, monitors and controls the ventilation, heating, lighting, humidity and CO2 content within the greenhouse. This automatized climate control can facilitate the optimal development of crops, because the optimal combination of light, air and water is of key importance as regards of both quality and quantity. Nevertheless, producers can avoid excessive energy and water consumption by effectively forecasting the changes of climatic conditions in- and outside the greenhouse. This process can improve the efficiency of production (Kovács et al, 2005; Rodríguez et al, 2015).

By using data recorded by these climate computers certain researchers (Trigui et al, 2001) elaborated such algorithms that can optimise net profit by predicting yields. In this case net profit means the value of crop yield deducted by the production cost (i.e. heating, vaporisation, adding CO2 etc.). This algorithm is able to calculate the yield by using the selected inner climatic parameters. It is also possible to estimate the energy costs (heating and vaporisation) based on the expected climatic conditions (solar irradiation, temperature, wind speed and relative humidity).

During the past years researchers elaborated numerous systems related to yield simulation, as H.Li et al., 2017 summarise. Tomato growing theories study primarily the growth period, environmental factors and the attributes of growing equipment. Some of these models are FAST, TOMSIM, TOMGRO, TOMPOUSSE and CROPGRO-Tomato. The most frequently used parameters within these models are temperature, leaf area index (LAI), dry matter content weight, CO2 level, growth rate, yield weight, leaf number, photosynthesis, air exchange, leaf weight and irradiation level.

3. Methods and material

Use of monitoring measurements is not widespread in hydroponic cultivation. There are only a few production units that spend time on implementing measures. Usually consultants ask for these data in order to draw conclusions on the adequate development of plants as well as to establish a yield estimate. The processed data have been collected in a croatian greenhouse. Beef tomato was used. Data have been assessed in 2018. Tomatoes were planted in the beginning of December using 1.9 plant/m2 stand density. Stands were later extended up to 3.8 plants/m2. Measurements started at the beginning of January and were conducted weekly.

Parameters involved in the examination were as follows:
- weekly growth
- leaf data (length, width, number of leaves, lai area)
- stem diameter
- distance head
- flowering and set truss
- plant load
- harvesting data (fruit weight, ripening fruit)

Source of the figures was, on the one hand, data set by and stored in the climate computer. On the other hand, data recorded by the unit managers using manual measurements also provided results. Data were categorised into one of the following three groups:
- climate data: temperature, irradiation, water used for irrigation per week
- plant data: weekly growth, stem diameter, leaf length
- harvesting data: number of flowering, calculated and harvested weekly yields

During the assessment climate date could primarily be compared to plant and harvesting data.

4. Results and assessment

Main climatic data were compared by using a correlation function. We looked for potential connections among certain climate parameters and measured plant parameters by using purely statistical methods.

Based on data correlation, the weekly growth shows strong correlation with several factors such as irradiation, humidity, irrigated water, EC and pH values and, in this context, drainage water. The amount of CO2 added shows a strong correlation with leaf width and plant load. No other strong correlation with the statistical method can be detected in this case.

The following figure (Fig.1.) shows the change over time of the the leaf area (LAI) and distance of flowering truss from the top of the plant during the growing year.

Table 1. Correlation values of the main climate and plant monitoring data, 2014 to 2017

	Weekly growth, cm	*Leaf Length, cm*	*Leaf Width*	*Number of Leaves, pc*	*LAI area/m2*	*Stem Diameter, mm*	*Distance Head, cm*	*Flowering Truss growth, pc*	*Set Truss growth, pc*	*Plant Load, pc*	*Fruit Weight*	*Ripening fruit growth*	*Estimated weight, kg/m²*	*Real weight, kg/m²*
Radiation, J/day	0,6623	0,2296	0,3544	0,0557	0,4033	0,3943	0,4755	0,2810	0,3182	0,4172	0,2874	0,3363	0,0937	0,1294
Temp 24 hour, (°C)	0,1639	0,1799	0,0320	0,0218	0,1097	0,0669	0,1032	0,0219	0,0813	0,1275	0,0975	0,1422	0,0577	0,0914
Temp DAY, (°C)	0,6912	0,1781	0,1396	0,3244	0,4954	0,2275	0,2248	0,2089	0,1974	0,0243	0,2733	0,2546	0,0062	0,0472
Temp NIGHT, (°C)	0,1442	0,1708	0,0145	0,0349	0,1032	0,0565	0,0825	0,0130	0,0677	0,0955	0,0753	0,1369	0,0536	0,0894
HUMIDITY, %	0,5306	0,0989	0,3085	0,1264	0,3990	0,2671	0,4538	0,2192	0,2763	0,2867	0,0129	0,3597	0,1356	0,1948
Irrigation (liter/m2/day)	0,7413	0,2849	0,3042	0,1918	0,5066	0,2926	0,4845	0,2956	0,3311	0,3435	0,2781	0,3781	0,1191	0,1688
irrigation EC	-0,5591	-0,0942	0,2858	-0,4926	-0,3835	0,1353	0,0419	-0,2067	-0,3181	0,1978	-0,5010	-0,4426	-0,1152	-0,2017
irrigation pH	0,5646	0,3803	0,5288	0,2492	0,6484	0,2203	0,6294	0,1718	0,1109	0,1517	-0,0944	0,2656	0,0514	0,1202
Drain (liter/m2/day)	0,6781	0,2552	0,1339	0,2290	0,4754	0,0933	0,3572	0,3229	0,3468	0,1963	0,2290	0,3948	0,1766	0,2276
Drain (%)	0,2571	-0,0280	-0,2867	0,2665	0,1788	-0,2620	-0,0679	0,2139	0,2435	-0,1469	0,0474	0,2488	0,2187	0,2428
Drain (ml/ Joule)	-0,0349	0,1525	-0,0675	0,4109	0,2222	-0,3005	0,0121	-0,1250	-0,2119	-0,3103	-0,3716	-0,0161	-0,0254	0,0395
CO2 (ppm)	-0,0565	0,1159	0,5638	-0,4822	-0,0727	0,3194	0,3551	-0,1035	-0,0868	0,5800	-0,1752	-0,1399	-0,0476	-0,0798

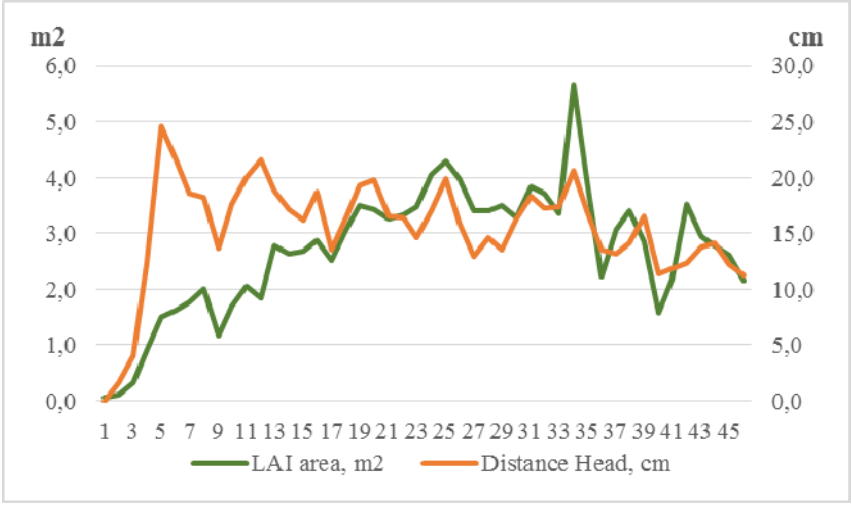

Figure 1. Lai area and Distance Head, 2018

It can be seen that in the early period the distance of the flowering truss from the top of the plant increases intensely in low light, and then moves from April to a relatively narrow band until the end of the growing season. The leaf area also grows intensively by the 13th week, and then the growth rate slows down, because the harvest begins and with it the period of intensive leaf picking begins in cultivation. The outstanding value of week 35 is the result of lagging plant work, which quickly returns to around 4 m2 and it decreases evenly and halves at the end of cultivation.

Measured increase of stem diameter at the shoot tip is one of the best "indicator" parameters showing whether a plant is in the state of vegetative-generative balance, whether it is able to intake enough medium for growing trusses and ripening berries. Weekly changes in stem diameters of the 2018 growing year regarding with the changes in leaf area are shown in the following figure.

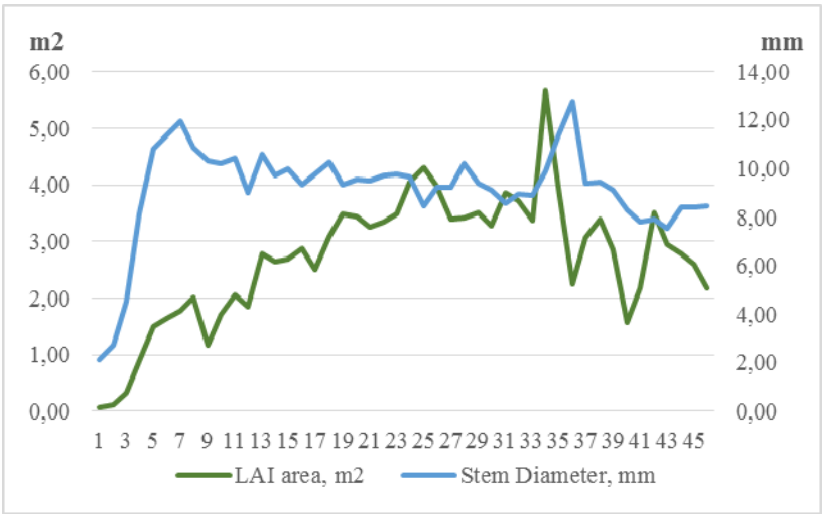

Figure 2. Lai area and Stem Diameter, 2018

In terms of stem diameter, the stem did not become thinner during the growing season, and cultivation conditions were ideal throughout the growing season. The ideal values of around 10 mm were maintained throughout the year, once the stem diameter was thicker due to the large leaf surface, but returned to the ideal range within 2 weeks.

Irradiation is one of the most important parameters in hydroponic cultivation, and in the figure below the irradiation data are compared with the weekly harvesting data.

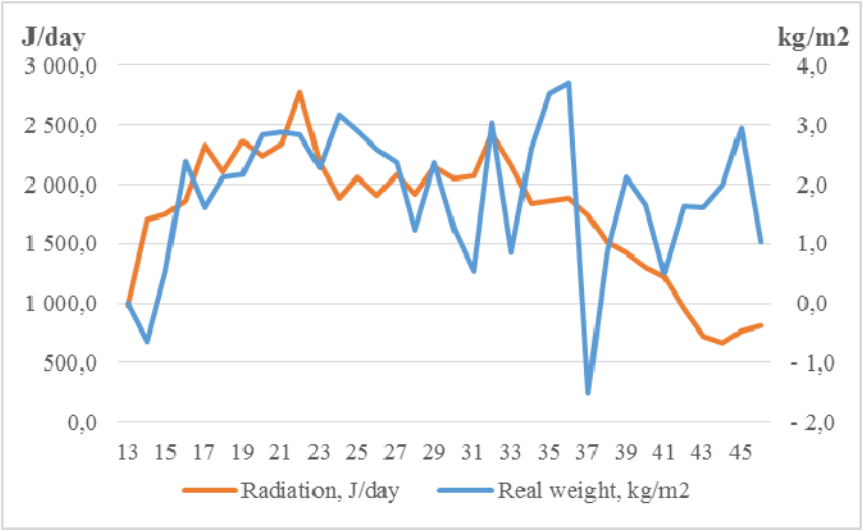

Figure 3. Radiation and weekly real weights, 2018

The amount harvested was kept at around 2 kg/m2 for most of the growing period, and even at the end of the growing year the reduction in light due to irradiation did not fully affect the quantities, although they decreased. The outstanding value of peak thickening shown in the previous figure coincides with the large decrease in picking at 37 weeks, where the plant is likely to have responded with tip thickening to the increasing load.

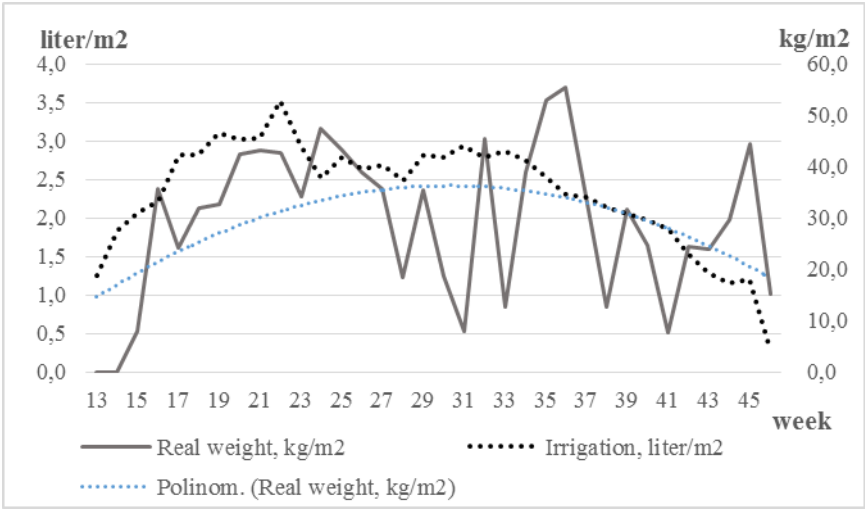

Figure 4. Irrigation and real weights, 2018

Irradiation and the amount of irrigated water shows high correlation (correlation coefficient: 0,9728). Thus, it can be stated that irrigation was applied based on the irradiaton figures in the growing units. This option is a basic feature in every up-to-date irrigation computer. Irradiation-based irrigation takes actual irradiation level into consideration. In practice it is recommended to check the validity of the calculations, since after 8 to 10 years of use sensors may malfunction and, as a result, under- or overirrigation occurs.

The irrigation values compared with the weekly picking data (see figure above) show that when plotted on a trend line, the picked amount also shows a high degree of similarity to the amount of water irrigated. The quantity picked is never perfectly matched to the needs of the plant, so these excursion are also due to fluctuations in purchase orders.

In this plant monitoring system, the program calculates a theoretical weekly amount of picking, that we compared to the actual harvesting results.

Figure 5 clearly shows that there is less than 10% of the difference between the actul harvested crop amount and the amount calculated by the program in 50% of cases, but there is also a 30% difference. In the future, working closely with the grower will provide an answer to what extent is due to these fluctuations in customer demand.

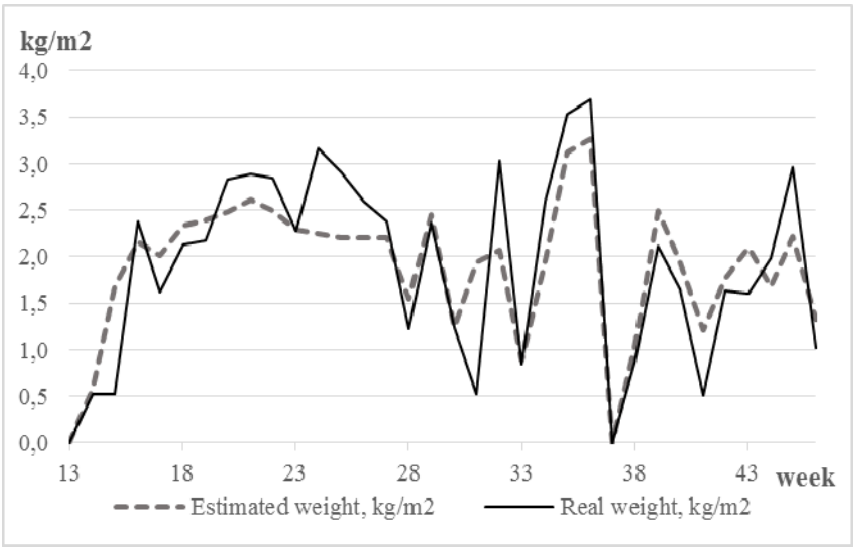

Figure 5. Differences between estimated and real weight of yield, 2018

Conclusions

Plant monitoring can reveal important data in long-term tomato cultures regarding the development and yield prediction of plants. In the examined years the well-established irrigation strategy shows considerable correlation with irradiation, thus following this method is of key importance for producers. The even thicknesses of the stems show that it is possible all year to grow a strong plant in a good greenhouse with good climate control. Plant monitoring already gives an accurate picture of the expected yield results.

Summary

Up-to-date, large space growing units become more and more popular in long-term tomato cultures. Climate computers used in these units can also record all measured climatic parameters. Plant monitoring processes are usually automatized in modern European horticulture. Such algorithms are currently under development that push these processes toward creating autonomous greenhouses.

There are no such development initiatives in Hungary, since the area of up-to-date growing surface is quite small (130 to 140 ha). Plant monitoring based on manual data collection is applied in some Hungarian greenhouses, but it is not a widespread practice. It is necessary to emphasise the importance of plant monitoring measurements and to conduct further examinations. Acquired data can provide help for identifying technology failures and forecasting crop yields, which can greatly assist sales.

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Vibration control as smart tool for quality work in agriculture

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Abstract

With the spread of precision agriculture and the digitalisation next to the power machines the attached equipment is becoming smarter and smarter. Through permanent technological and IT development, it became possible to thoroughly monitor and analyse operating functions and parameters not only for the most important power machines such as tractors, combines and other, but also there are existing solutions for measurement - and related to that a collection and an analyse of data - of specific utilisation parameters for other attached equipment. All of these processed data are essential for making well-considered actions related to the production technology and the machine operating. They help us to gain information about the quality of machine operations of the technology, the environmental factors, or even about the state of attached working equipment and machines.

In this work, the vibration control system as smart solutions on the fail movers will be presented which are effective tools for the utilization of machines, for the precision machine work as well as for prolonging the machine life cycle.

Keywords

smart machines, fail movers, GPS, data analysing, Vibration Control

1. Introduction

Precision Farming did become a popular research field since the 1980s. Technologies have been developed all over the world to help the farmers raise crop yields and make agricultural production processes more efficient. This new developments steadily contribute to a higher productivity and show that this technology is very important. Electronic assistance systems, such as autonomous track guidance or section control are state of the art when investing in new machines on crop farms. (Bauerdick, et al. 2017) This technologies are efficient tools to improve sustainability and productivity in farming. Precision Agriculture technologies offer solutions to produce more with less. It is one of

the biggest revolution in agriculture (Crookston 2006). Practically, Precision Agriculture technologies provide farmers with extra sensors which give them more information on how to manage natural variations. (Dryancour 2017) It is technical, environmental and management innovation that has come out of the strategic product and technology innovation phase, while the whole management system is sharacterized by continuous renewal and new, higher added value added. (Takácsné 2018)

The aim of precision, or site specific agriculture is to handle within field variability (Auernhammer et al. 2001) with input materials to achieve the highest and sustainable profit. The approach mainly benefits from the development of technologies like GPS, GIS, computer technology, automatic control, remote sensing and advanced information processing (Gibbons 2000).

2. Material and method

Smart Farming in Agriculture 4.0.

"Smart Agriculture" and "Digital Farming" are based on the emergence of smart technology in agriculture. These technologies are using smart devices which consist of sensors, actuators and communication technology (Kovács and Husti 2018).

Digital systems, sensor techniques and technologies, remote sensing on different platforms, artificial intelligence including machine learning and deep learning, and in particular unmanned or quasi unmanned production systems are developing fast, and these are the tool for dynamic sustainability. In the future there will be the integration of these common players into smart transport, smart organisation, and smart landscape management by smart policy making. (Lundström and Lindblom 2016, Urso et al. 2017, Kempenaar et al. 2016, Neményi 2018)

The term Agriculture 4.0 should be logical upgrading of Smart and Digital Farming. There is some possibility about how will Agriculture 4.0 impact the supply chain by better using of IT:

- Optimize the inputs (Precision Farming).
- Manage mechanization more efficiently & use of energy resources.
- Enhance crop storage techniques & reduce crop losses.
- Provide better information about market demand & seasonal fluctuation.
- Improve transport & logistics services.
- Optimize retailer stocking & storage (less waste). (Adam 2017)

Automated data mining and -interpretation is becoming a critical element of agricultural industrial research. (Horstmann 2016) Developments in agriculture which mine data and act almost autonomously on basis of these data can be summarized by the term "Agriculture 4.0" (Clasen 2016).

Some Precision Agriculture diagnostic technologies are already highly affordable and thus available to smaller farms thanks to smart phones or tablets

and their applications, like in our presented study. Such applications can directly signal a problem on the field or connect to an online service for further probing. (Dryancour 2017)

Devices for Precision Farming in grassland
In comparison to its widespread implementation on arable farms, Precision Farming in grassland is used rarely in practical farming. There was some efforts to measure the quantity of harvested grass to, amongst other things generate yield maps. Demmel et al. in 2002 examined a weighing system in a conveyor belt, mounted at the rear part of a mower. Kumhála et al. (2007) used methods to measure forage yield known from choppers or harvesters. They equipped a drum mower with a torque sensor and a curved impact plate (behind a mower conditioner) which was hit by the mowed grass.

Some small smart applications already found their way into practice like a torque sensor for warning the driver if the rotation of the mower and the rotation of tractors power take off (PTO) distinguish too much to give him assistance for an optimum velocity and motor speed.

he Company INO Brežice d.o.o.
A Slovenian company INO Brežice produces a variety of mulching machines, vibrating subsoilers, fertilizer spreaders. Among the company's innovative products are so-called "Smart Solutions" which ensure a safe and efficient operating of their basic products:

- flail mowers by means of continuous measuring vibrations and detecting the outstanding ones,
- fertilizer spreaders and vibrating subsoilers by efficient specific electronic control of operating. (Šubic 2017)

3. Results

Basic description
The Vibration Control System is a smart solution based on IoT principal, which consists of INO flail mower, sensor, (Figure 1.) smart mobile device and web application. (Figure 2.).

It offers to the user an online information about working conditions for professional agricultural and communal machines. The main purpose for using INO Vibration Control is to control vibrations on the machine that means flail mower, arm mower or similar (Figure 3.). The sensor is measuring the level of vibrations which are sent to the mobile device. The mobile device stores GPS coordinates, a time stamp and x, y, z axe vibration levels and temperature through all working process for each second.

Figure 1. The sensor of the vibrations (Source: INO)

Figure 2. INO Vibration Control System (Source: INO)

Figure 3. The position of the vibration sensors on the working machines, actually on the flail mower machine (Source: INO)

Innovation character

The goal of this system is to control the level of vibrations on flail mowers and consequently also on other machines, used for public utilities and for agricultural land cultivation, where the level of vibration in allowed area is one of the key features for correct, safe and long-lasting operation. Data compilation, collection of information is continued also in the direction of other telemetric information for the purpose of work control on cultivated land, data import from the phone, drawing-up of the surface in online graphic folders and keeping track of various attributes on an individual cultivation area, e.g. number of mowing, amounts of yield, fertilization, quantity, working temperature, speed of movement, location, etc.

Usability and advantages of system are globally as follows:

- control of machine operation,
- control of the operator's work,
- measuring productivity,
- communication between sensor and mobile device without vendor lock limitations

– online vibrations control level to enable safe, long-lasting operation and to decrease the maintenance costs
– mobile application for Android and iOS system
– telemetric data for determination of productivity level of the end user (tractor operator)
– simple Enterprise Resource Planning web based application
– useful analytical synthesis data for the extension of the warranty
– independence from different payable systems,
– saving measured data,

The program package is developed for different users:

a) operators-tractor drivers
– alert if the engine hits something
– alert if too high vibrations are on the engine (see Figure 4.)
– alert when low battery

b) supervisors at the desk:
– too high vibrations are on the engine
– engine is working in wrong time and/or on wrong area
– the exact place where the engine is working in the exact time

c) analysts-reporters:
– full report and analyse of working productivity including of working time and stops, working area, vibrations and alerts for each engine, details of surface covering, tracking and so on
– Application with program package without use the sensor, adapted to the buyer's needs (possible all up-mentioned data except vibrations) (Vučinić 2018)

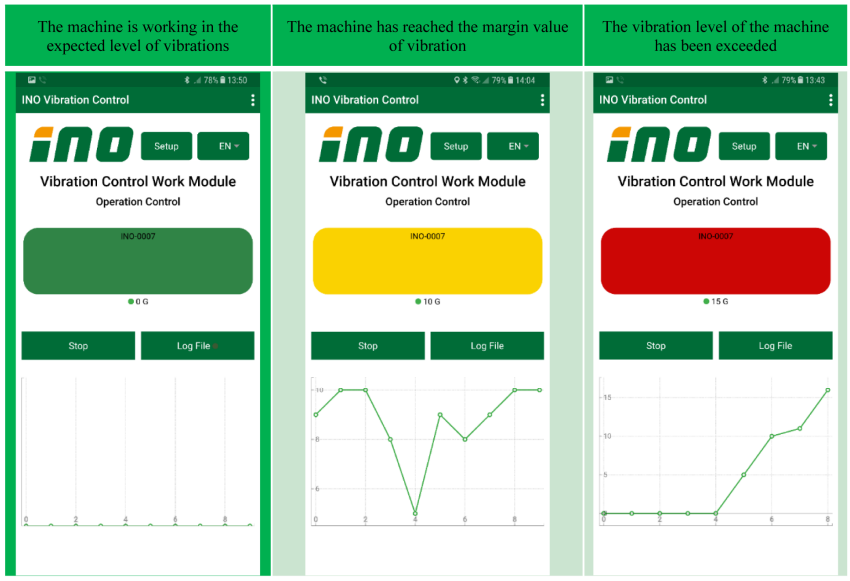

Figure 4. Three level of vibrations, normal, marginal, and excessive, showing on the mobile phone (Source: INO)

The mobile application could provide the user with the next information:

- Emergency SMS service (send SMS with current location to selected contact)
- Send SMS for detection of machine stop (to selected contact)
- Send SMS for excessive vibrations (to selected contact)
- Option for use only as GPS tracking (no INO sensors needed)
- Show on Map for Log Files (with vibration data markers) (Vučinić 2018)

The measured sensor data can be stored to the mobile device. The user can read stored data for each second of recording: GPS coordinates, vibration levels by X, Y, and Z axis, temperature and exact time. Stored data can be exported to another device or computer and later analysed in one of the required applications (for example: MS Excel), or can be viewed directly on a mobile device. (Figure 5., 6.)

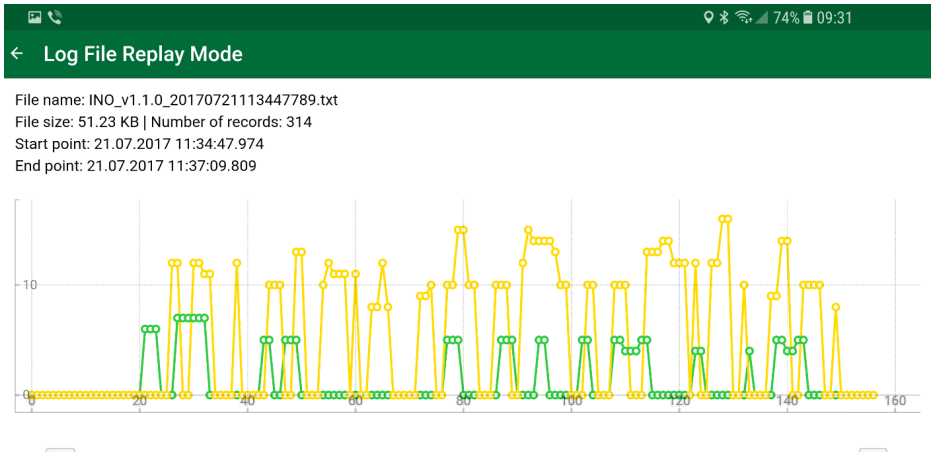

Figure 5. The history of the measured data on the Mobile Phone Screen (Source: INO)

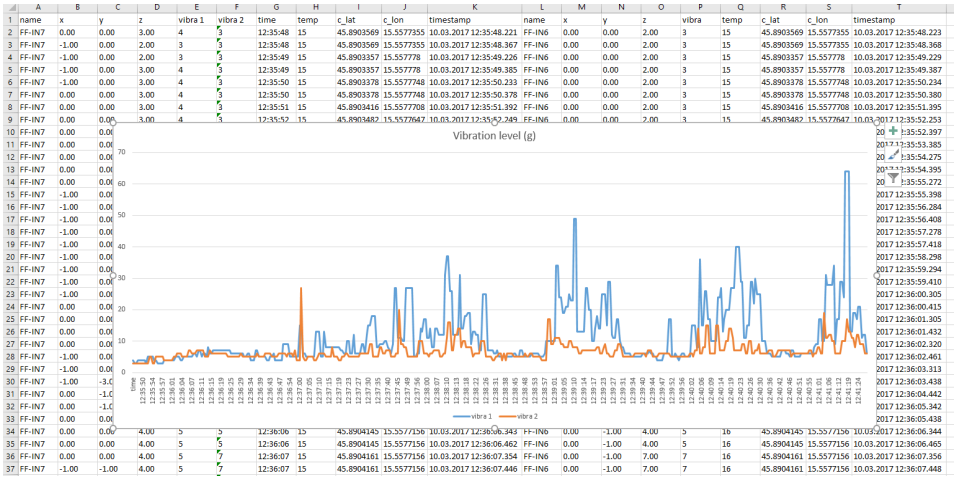

Figure 6. The history of the measured data on the Computer Screen (Source: INO)

Conclusions

For small, medium-sized, and for the large-scale farm machinery too, the introduced control systrem prove to be beneficial for efficient work, professional utilization of machines.

A common feature of systems described in this article is that they can be operated independently from the tractor's ISOBUS system. Both, the controller as well as the data collecting interface can be operated autonomously using their own system by means of a mobile phone or tablet device that can be controlled via wide spread accessible mobile application.

It is very important to mention that there are some advantages of IT, but some problems as well. Most significant are those related to putting systems into the operation and fighting with malfunctions. One of specific problem is coupling the tractors and implements by using different stages of ISOBUS. That means, full commercial maturity of compatibility of ISOBUS is still in front of us. (Bosch J. 2018)

The design of these electrical systems can also be realized by an individual, innovative medium-sized machine manufacturing company, as it is shown in the presented work.

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Smart agricultural equipment from innovative manufacturer of agricultural machines

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Abstract

Precision Agriculture technologies are efficient tools to improve sustainability and productivity in farming. These technologies offer solutions to produce more with less.

Nowadays the increasing of the efficiency of agricultural production and the increasing of crop yields cannot be achieved without modern digital technology and smart machines that are a part of it. Next to the power machines the attached equipment is becoming smarter and smarter.

In this work, without completeness, we present smart solutions from medium-sized innovative manufacturer of agricultural machines which are independent from the size of the machine and which are effective tools for the utilization of machines, for the precision machine work.

Keywords

smart machines, Precision Agriculture, GPS, spreading, variable rate fertilizing

1. Introduction

Many authors have reached to the conclusion that development of digital technology and applications are regarded as an important factor in their economic growth and development in the agricultural production. The improvement of mechanization of field work, machinery and equipment is a continuous process. We are witnessing the spread and agricultural use of the more and more modern equipment, which reflects to the technical and technological level of the area (Kovács and Husti 2018).

Precision Agriculture is just a hypernym and can be divided into three major topics Auernhammer (2002),: "Precision Pasturing", "Precision Lifestock Farming" and "Precision (Crop) Farming". While Precision Pasturing focuses on methods for e.g. managing feed supply and stocking rates on pastures (Schellberg, et al. 2008), Precision Lifestock Farming addresses all kind of systems which correspond with animals in husbandry. The last topic, Precision Farming, is defined as technology-supported cultivation of agriculturally used areas (Doluschitz, et al. 2011). (Bauerdick, et al. 2017)

The aim of precision, or site specific agriculture is to handle within field variability (Auernhammer et al. 2001) with input materials to achieve the highest and sustainable profit. The approach mainly benefits from the development of technologies like GPS, GIS, computer technology, automatic control, remote sensing and advanced information processing (Gibbons 2000) Farm field under conventional management receive uniform applications of these inputs like fertilizers, herbicides, seed or irrigation. (Mulla 2013) (Bűdi et al. 2018)

The most popular precision agricultural technologies are the grid soil sampling, the variable rate fertilizer applications, the global positioning systems and yield mapping and the variable rate seeding (Daberkow and McBride 1999, Mackay 1997, Taylor and Whelan 2010, Bullock et al. 1998, Clark and McGuckin 1996, Nafziger 2012).

The biggest problem with the precision farming technology is that the possible advantages and disadvantages of the technology highly depend on the professional knowledge and attitude of the farmers or of the manager and the stuff of the agricultural company. The appearance of a new technology in generally of great interest, the so co-called 'new technology fun' farmers try the application, invest in the new equipment – and very often without the proper knowledge, skill – they implement it into their farming. After the first experiments – if they have not got good yield and economic result – many of them give the new technology up, or did not continue the introduction and extension of the new item. The excessive expectation does not match with the reality. After the interest peak, there is almost temporary disillusionment. After the refinement of the technology, its applicability improves, instead of the risks, the benefits come to the fore, leading to its spread in production. (Takácsné 2018)

2. Material and method

2.1. Smart Farming

"Smart Agriculture" and "Digital Farming" are based on the emergence of smart technology in agriculture. These technologies are using smart devices which consist of sensors, actuators and communication technology (Kovács and Husti 2018).

Digital systems, sensor techniques and technologies, remote sensing on different platforms, artificial intelligence including machine learning and deep learning, and in particular unmanned or quasi unmanned production systems are developing fast, and these are the tool for dynamic sustainability. In the future there will be the integration of these common players into smart transport, smart organisation, and smart landscape management by smart policy making. (Lundström and Lindblom 2016, Urso et al. 2017, Kempenaar et al. 2016, Neményi 2018)

The Smart Logistic System, integrated with the ERP (Enterprise Resource Planning), enables application of 4.0 industry approach. Its intention is to enable

same application to agricultural machinery, e.g. for logging the seeding and fertilizing process (lot, operator, date, quantity) and remote diagnostic by using IoT ready systems. The advantages of own production applied utilization of digital information to trace the different materials and automate their handling, are listed following objectives:

- to reduce the material handling;
- to reduce the inventory failures;
- to implement flexibility with discipline;
- to find one place for everything and everything in its place;
- to set a FIFO (First In First Out) rule;
- to implement the material traceability. (Martinov et al. 2018)

2.2. The Company INO Brežice d.o.o.

A Slovenian company INO Brežice produces a variety of mulching machines, vibrating subsoilers, fertilizer spreaders. Among the company's innovative products are so-called "Smart Solutions" which ensure a safe and efficient operating of their basic products:

- flail mowers by means of continuous measuring vibrations and detecting the outstanding ones,
- fertilizer spreaders and vibrating subsoilers by efficient specific electronic control of operating. (Šubic 2017)

3. Results

3.1. INO Smart Flow

INO Smart Flow ensures the quality work of the FERTI-2 type double-disc mounted fertilizer spreader (Figure 1.) and the VVP 115 vibrational subsoiler with deep fertilizer spreader (Figure 2.). It is well known regarding versatility and an ease of use. Nowadays, site-specific nutrient application comes to the fore. Thus, accurate determination of the amount of fertilizer applied and precise dosing is essential. With this system cost savings can be achieved through efficient production and avoidance of excess nutrients.

INO Smart Flow electronic regulation of fertilizer flow on Ferti-2 is the system, which automatically regulates the position of both shutters on the bottom of the hopper. It is completely developed and designed in INO Electronic Department.

The machine ensures equal spreading density (kg/ha) across the spreading area, regardless of the working speed. At faster speed, the shutters must be more open than at lower speed. The optimal position of the shutters is calculated in the electronic box, based on the spreading width, speed of the tractor and fertilizer calibration.

For a proper operation the system needs to get the speed of the tractor. This information is provided by ISO 11786 connector of the tractor or GPS speed sensor. Fertilizer calibration is the procedure, which has to be done just once for

specific fertilizer (NPK, Urea, KAN...) ant it takes only ca. 10 min. After this procedure is done, all necessary data are permanently stored in the electronic box and the work can begin.

Figure 1. Double-disc mounted fertiliser spreader FERTI-2 (Source: INO)

Figure 2. VVP 115 vibrational subsoiler with deep fertilizer device (Source: INO)

The interface to the user is INO SmartAssist terminal (Figure 3) placed in the cabin of the tractor, which provides all necessary data on the graphic display. User can also change all necessary parameters from tractor cab.

Before work, the user just selects the fertilizer, which is actually in the hopper and desired spread density (kg/ha). When the user starts driving, the shutters are automatically open to the correct position. If the work speed changes, the shutter position also changes to meet requirements (kg/ha). When the tractor stops, the shutter closes automatically. The user can also additionally increase or decrease the quantity of fertilizer on the area directly by pressing button on the terminal without changing basic parameters stored.

Figure 3. Innovations from INO's Electronic Development Laboratory - INO SmartAssist for FERTI-2 Fertilizer Spreader and for VVP 115 Vibrational Subsoiler with deep fertilizer device (Source: INO)

Additionally, the system provides simulation of the fertilizer quantity in the hopper (weight data in kg). To use this feature, the user must enter the quantity of the fertilizer, which is added to the hopper before work. The real quantity of the fertilizer is measured by a TRUE Weighing System attached on the spreader (optionally) and connected with INO SmartAssist.

The side limiter (option) is also electrically driven, so the operator just presses the button and the limiter is placed onto the working position-on and back-off. (Žniderščič 2018)

The system also provides some other useful data:

1. Battery voltage
2. RPM of the discs
3. Hectares done
4. Residual hectares
5. Working hours
6. Recommendation for greasing every 8h
7. Working speed

Using this equipment, the farmer receives necessary information about production technology and about the safe operation of the machine, such as the amount of fertilizer dispensed, the amount of fertilizer in the tank, the speed of work, the size of the cultivated area, the amount of fertilizer that can be used in the tank, the number of hours worked, the battery charge level and the alerts for the machine maintenance.

3.2. Winter Smart Flow

Winter PK Smart is a spreader for salt and sand with electronics Winter Smart Flow and terminal SmartAssist. (Figure 4.)

The construction of the spreader consist of plastic hopper, rigid frame, stainless components for regulation, dosing and spreading, stainless deflector consisted of changeable flaps, gearbox with slower rotations and the electronic control SMART package.

The SMART package includes:

- built in three electric actuators, used for:
  - Opening-closing of a dosing flap
  - Adjusting of the spreading width left (flaps on deflectors)
  - Adjusting of the spreading width right (flaps on deflector)
- electronic system Winter Smart Flow together with a terminal SmartAssist for operating control with the following functions:
  - Adjustment of the spreading width on the right and on the left side with lifting flaps on deflector
  - Precise adjustment of the spreading density in g/m2,
  - Automatic adjustment of dosing flap according to the working speed
  - Closing the dosing flap when stopped
  - Measuring the distance travelled
  - Showing the remaining weight of the product in the hopper - virtual weight,
  - Availability for storing 10 different sorts of the spreading product (calibration),

Intelligent calibration of the spreading product

Figure 4. Winter PK Smart is a spreader for salt and sand with electronics Winter Smart Flow and terminal SmartAssist (Source: INO)

Electronics receives data regarding the tractor's speed via ISO 11786 (7-pin socket on the tractor) or GPS antenna or from the sensor on the wheel. (Žnideršič 2019)

3.3. INO SMART HOPPER on the flail mower Boxer

Figure 5. Flail mower INO Smart Hopper (Source: INO)

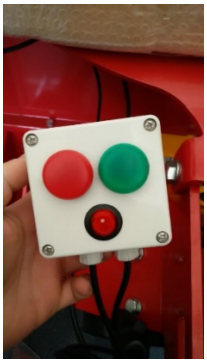

Figure 6. Control panel of INO Smart Hopper (Source: INO)

Further, the company has proven INO Smart Hopper as a powerful tool for BOXER type collector containers. The device warns the user with sound and light signal when a container is fool. The control panel is easy to use. (Figure 5., 6.)

Conclusions

Precision Agriculture technologies have been developed all over the world to help the farmers increasing their crop yields and make agricultural production more profitable. This new developments resulted higher productivity and proved that this technology is very effective. Some of assistance systems, like autonomous track guidance, distribution control or side limiter are standard when investing in new agricultural machines, e. g. fertiliser spreader.

For small, medium-sized, and for the large-scale farm machinery too, the above-mentioned Smart Solutions prove to be beneficial for efficient work, professional utilization of machines and for minimizing the production and mechanization costs.

A common feature of systems described in this article is that they can be operated with or without from the tractor's ISOBUS system. The controller can be operated autonomously, using their own system, by the control panel (assistant) which is specially designed for this purpose.

The design of these electrical systems can also be well realized by an individual, innovative medium-sized machine manufacturing company, as it is shown in the presented work.

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Development of a digital database for supporting precision technologies

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Abstract

Among other determining circumstances and input factors, reliable database is needed for supporting the production not only in the agriculture, but in the other value-added sectors of the economy. The application of the precision technologies in the agriculture, can not be realised without up-to-date information technology, and a wide and complex range of information regarding to all the essential producing factors (machine, place of production, human resource, excipients, input and output materials, etc.). Efficient big data analysis could result valuable information for successful farm management, that is in the concept of the smart farming. Well-structured database creation is one of the targets in our research work supporting precision field machine operation.

Keywords

Information and communication technology, Agro informatics, BigData, Precision technologies, Smart farming

1. Introduction

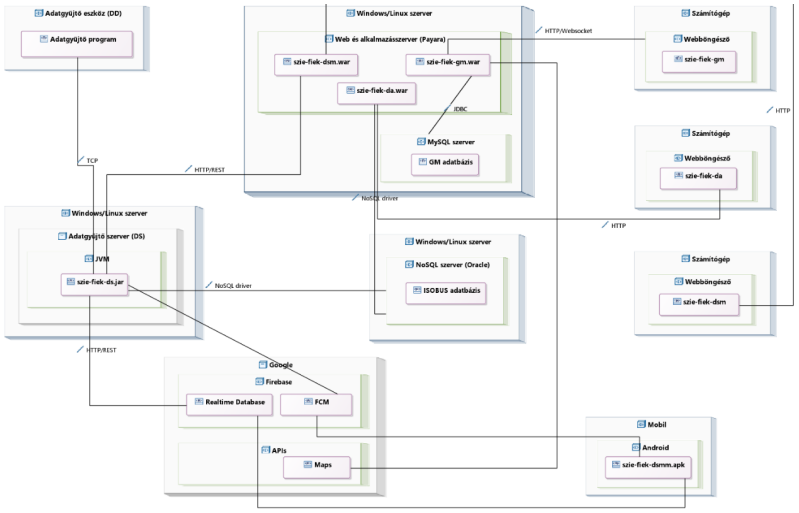

Figure 1. The system installation diagram

The proposed database system is able to receive ISOBUS communication data from agricultural machines, it can receive data from ISOBUS independent data acquisition systems, while storing any other data from existing machines with same structure like a book library (see Fig. 1.).

2. Applied materials and method

DS Data Acquisition Server (TCP Server) is a desktop application (szie-fiek-ds)
This application can receive Base85 encoded data from ISOBUS TCP clients, what is able to interpret and store received data in a database for the transmission of interpreted data to monitor (web and mobile) applications. Currently, it is capable parallel handling of any number of TCP clients (depending on memory and CPU capacity) (data acquisition, in the following "DD"), that means it is able to establish connections and receive / log byte sequences sent by clients. This system makes possible to interpret raw data, that means it decomposes received byte sequences into messages and interprets messages (defines property-value pairs encoded in messages, so the SPN - Suspect Parameter Number data)

```
SEVERE: sendMessageToMonitor: DeviceMessage[
        type = DATA
        head = 00 0F EF 38
        rawData = 88 B6 5F 6F 99 89 8B 29
        receivedTime = 1539609875254
        timestamp = 1539609568000
        errorType = NO_ERROR
        parameters = [Parameter{pgn=65267, spn=584, spnLength=32, value=19.36533
589999999, name=Latitude, enumName=null, unit=deg}, Parameter{pgn=65267, spn=585
, spnLength=32, value=47.592810499999985, name=Longitude, enumName=null, unit=de
g}]
]
```

Figure 2. Sent and interpreted message for monitoring

The program is ready to store parsed messages in predefined structure / type (NoSQL) database. Capable for transmitting connection status and raw / parsed data to monitor (szie-fiek-dsm, szie-fiek-gm web and szie-fiek-dsmm for Android) applications by:

- web services to web applications,
- brecording in a Realtime database for mobile applications.

Used for the above: The data is stored in the Oracle NoSQL-type database, which, like other NoSQL-type databases, supports the efficient storage and retrieval of large amounts of data. The (short-lived) data displayed by the sie-fiek-dsmm mobile application is stored using the Google Firebase Realtime Database (GFRD). GFRD enables real-time access to data on a mobile and even a web interface.

DD Data Acquisition Tool (TCP Client) Desktop Application (szie-fiek-testdevice)
The task of the device is to send test data to the data acquisition server (DS) and so ready to connect to DS and send random byte sequence (corresponding to

base85 encoding) to DS, send measurement log data to DS, either by unencrypted byte sequence or by (base85) decoded byte sequence.

DSM Data Acquisition Server Monitor Web Application (szie-fiek-dsm)
The task of the device is to display DS connections and received data in a web interface, and provide a web service endpoint for other applications. This ready to display connections and raw data provided by DS and display of interpreted data.

DSMM Data Acquisition Server Monitor is a mobile application (szie-fiek-dsmm)
The function of this program is to display the connections and data received by DS in a mobile application. This is ready to send instant (FCM) notification to your mobile device when DD is connected to DS, and ready to display connections and messages provided by DS (data display is automatically updated by using Google Firebase Realtime Database).

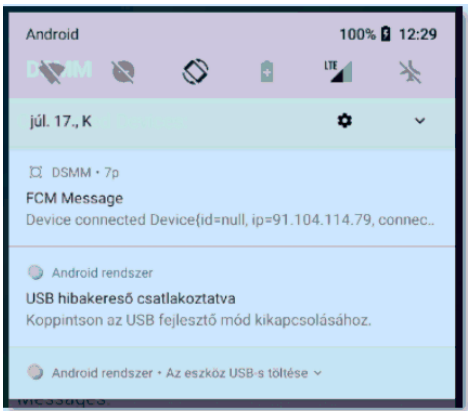

Figure 3. FCM message on Android screen

Figure 4. Connected tools and interpreted messages

DA Data Analyzing (szie-fiek-da)

The task is to analyze the data collected by DS. This is capable of displaying data provided by DD and stored in NoSQL database by device, date / SPN and / or SPN / date. After selecting the device and date, the user can view data for each SPN and time / value diagram for the measured feature. It can seen in Fig. 5.

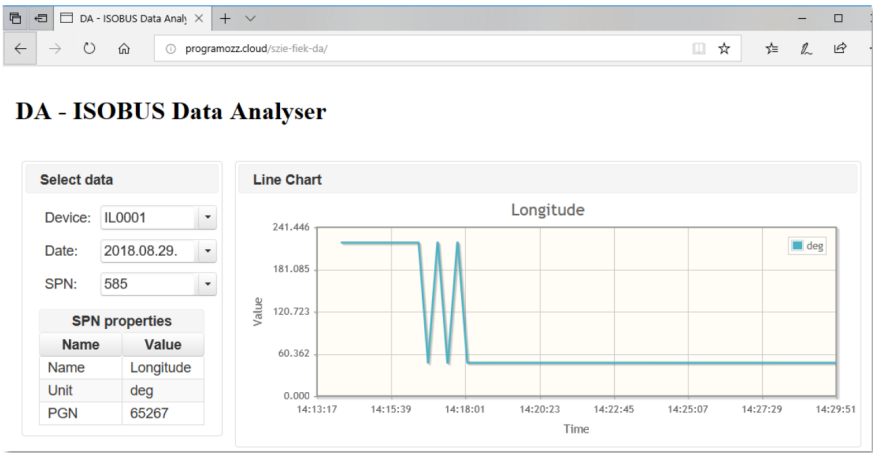

Figure 5. An line diagram from analyzer

GM Farmer Monitor (szie-fiek-gm)

Its task is to provide real-time and statistical information what is useful to farmers based on the collected by DS. It can display data for the selected tractor and implement based on the screen layout outlined in the UI implementation. [9]

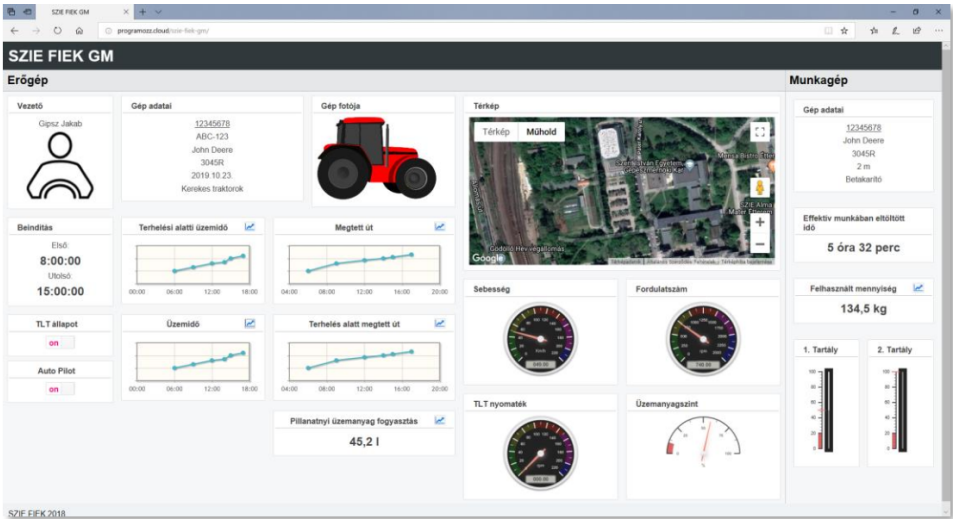

Figure 6. Current / daily status of a selected tractor unit and implement

In the background can find the entity-connection table with the fields, records and keys.

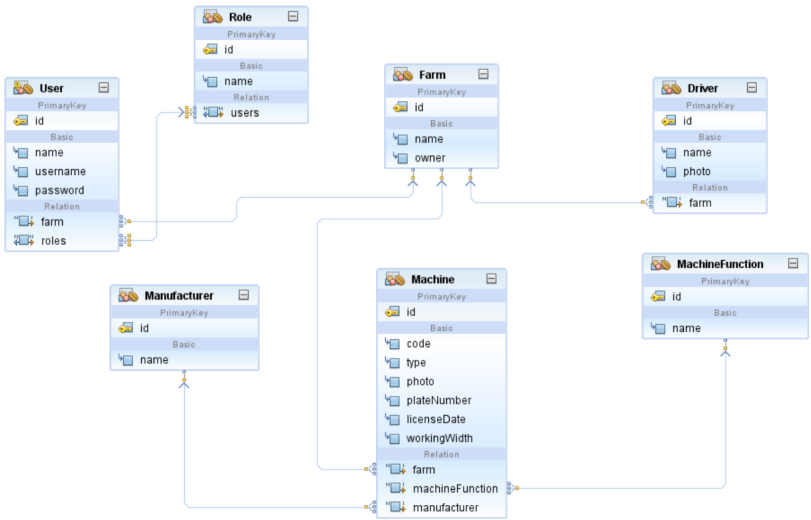

Figure 7. JPA entity relationship diagram

The programming environment use Java EE (EJB, JPA, JSF, PrimeFaces), CSS Canvas Gauges JavaScript/CSS. The database use Oracle NoSQL, MySQL, Google Firebase Realtime Database.

GEPSZIN Agricultural machine search web application and database (szie-fiek-gepszin)

The purpose of this interface is to enable farmers to search for agricultural machines on the web based parameters (manufacturer, performance, function, classification, type) what was pre-recorded in the database.

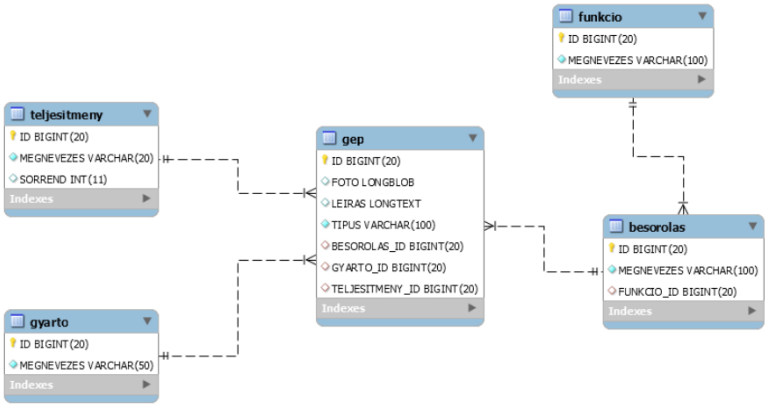

Figure 8. The database entity connection diagram

The project has an administrative interface for machine-related master data (manufacturer, performance, function, rating). An other administrative interface has been created to record machine data. The user authentication and search interface has been created and also the multi-criteria search has been programmed. A responsive interface (supporting multiple resolutions) has been created as well.

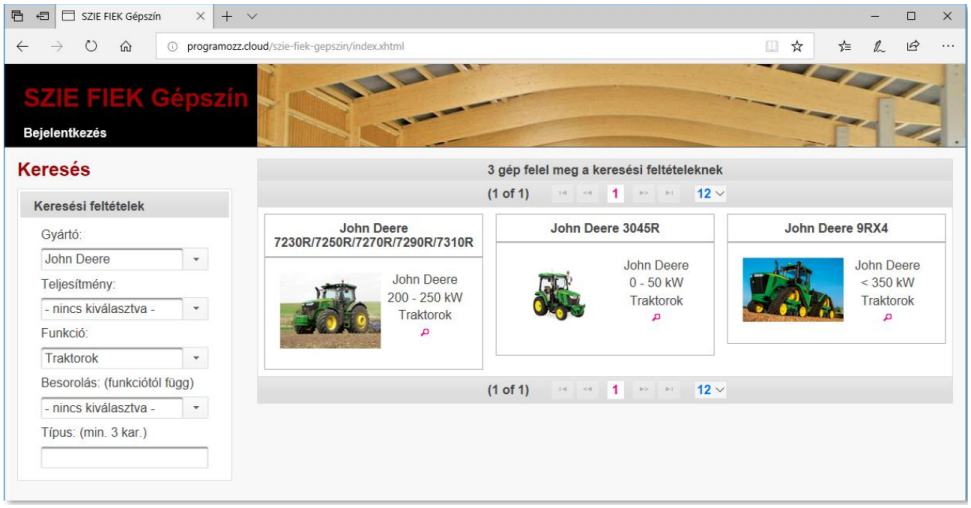

Figure 9. The user interface to web application and database

Conclusions

At this stage of the development, we have succeeded in laying the foundations of a system which:

- allows receiving, interpreting, and storing data provided by Data Collection Devices (DD) transmitted via TCP protocol by the szie-fiek-ds (DS) server application,
- allows monitoring of connected devices and communication between devices and server using szie-fiek-dsm (web) and szie-fiek-dsmm (mobile - Android) applications,
- allows to display (near) real-time data from each device on a graphical interface (supported by charts, maps) by the szie-fiek-gm web application,
- allows to display the data stored in the database in a statistical manner supported by the szie-fiek-da application.

Acknowledgements

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specialization in the themes of water management, hydroculture, precision mechanical engineering, alternative crop production, and was sponsored by FIEK_16-1-2016-0008 project too.

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The programming environment used Java EE (EJB, JPA, JSF, PrimeFaces), CSS Canvas Gauges JavaScript/CSS. The database used Oracle NoSQL, MySQL, Google Firebase Realtime Database.

Application of DFT analysis on experimental data

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Abstract

In this paper, we are dealing with the analysis of discrete-time series of experimental data measured in the real duty of agricultural off-road machines. The time series was recorded with the sensor of acceleration which was mounted in a defined location. For analysis of dataset we were used the PTC Mathcad Prime software and used the discrete Fourier transformation (DFT). The frequency and the magnitude of the peaks were obtained.

Keywords

numerical methods, signal processing, time series

1. Introduction:

The goal of this paper is the application of Discrete Fourier transformation on the experimental data. Finding the relevant frequencies and eliminate the unwanted values of signals, which arise when recording the acceleration signal was realized with low-pass filter and FFT techniques. One of the most common signal processing techniques is the Fast Fourier Transform (FFT) which generates the frequency spectrum of a continuous signal. The FFT is a variant of the Discrete Fourier Transform (DFT), but it is equipped with clever algorithms to perform the same function as the DFT in considerably less time. The FFT converts a continuous time signal x(t) from the time domain into its frequency domain representation according to the following expression as defined by [3]:

$$S_x(\omega) = \int_{-\infty}^{\infty} x(t).e^{-i.\pi.\omega.t} d(t) \qquad (01)$$

where:
- $S_x(f)$, is the frequency domain representation of the signal,
- $x(t)$, is the time domain representation of the signal,

– $i = \sqrt{-1}$.

Time-series approaches was investigated by [4,5,9]. The DFT analysis was processed by [7]. The low-pass filtering techniques and its application was investigated with [1,2]. Application of Butterworth maximally flat magnitude filter on experimental data was realized by [6]. The application of data filtering techniques in the Matlab software environment was investigated by [8].

2. Material and methods

The purpose of realization of experimental measurement was to obtain a technical exciting function of vibration of mounted operating tool of agricultural off-road vehicle. To the determination of tool vibrations and its behavior to the agricultural machine the measurement devices was mounted. The used tool was a plough and its technical properties are listed in the table 1. The visualization of this plough is on the figure 1. The Sensor was located on the rear part of the plough. The dimensions of location are not important for this paper, but the location of measurement device is depicted in the figure 2. The type of the sensor of acceleration was Eval - ADXL 345Z-DB and is depicted in the figure 3. The recorded data are stored in the micro-SD card in text format. The board measured accelerations in the XYZ axes. The off-road vehicle was used tractor Fendt 930 Vario.

Table1 Parameters of plough

Parameter	Value	Unit
Manufacturer	Pottinger	
Type	Servo 65 Plus	
Mass (m_P)	3085	kg
Distance between bodies	1	m
Bodies	7	m
Beam ($a \times a \times t$)	0,16x0,16x0,005	m

Figure 1. Plough Pottinger

Figure 2. Detail of sensor location

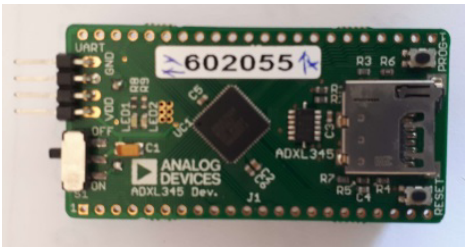

Figure 3. Sensor Eval - ADXL 345Z-DB

The measured raw data are depicted in the figure 4. From the measured data set we extract the time series about 30 second. The part of machine start and stop was cut off. The main frame of the plough are rotated after the finishing the ploughing on one side and then the plough frame rotating. The mounted sensor also rotated with plough frame. For this reason we were also transforming the measured negative accelerations to the positive quadrant of coordinate system. The main step of measurement was $\Delta t = 0.25s$. For the Mathcad solving procedure we were defining $N = 3000, T = 0.25, n = 0..N-1, s = n.T, f = \frac{1}{T}$

where:

- N, is count of measured data,
- T, time ,
- n, number of data points,
- s, distance between samples,
- f, sampling frequency.

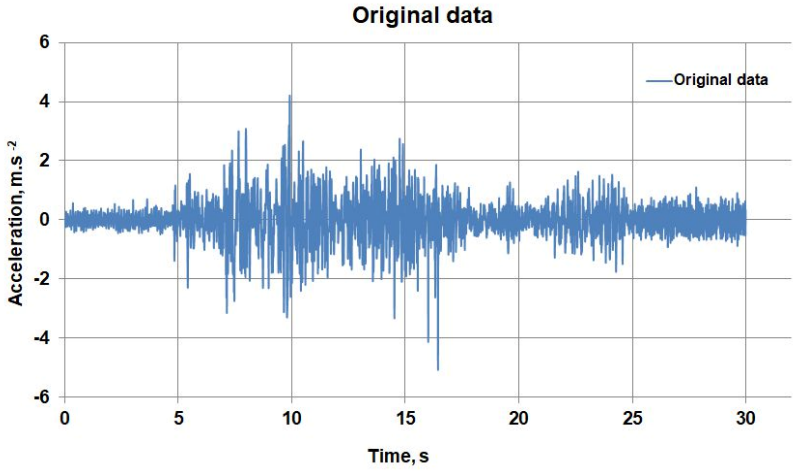

Figure 4. Raw data

The solving algorithm for data filtering and frequency analysis was created in the PTC Mathcad Prime software. The software is licensing with academic license at Faculty of Engineering SUA Nitra.

3. Results and discussion

To filtering of the experimental data we had to load the data from excel sheet. This action was realized by command *READEXCEL*. After loading data we were define the variable filter and used command *lowpass* as follows :

$$filter := \text{lowpass}(0.25, 15, 4) \tag{02}$$

To display the filtered data we defined variable *flt* and used the command *response* as follows:

$$flt := \text{response}(ff1, filter, 3000) \tag{03}$$

where variable *ff1* is the original dataset. The filtered data is depicted in the figure 5. To calculate the discrete Fourier transform of filtered dataset we were created the variable *X1* and used the function *dft* as follows:

$$X1 := \text{dft}(flt) \tag{04}$$

The result of Fourier transform is the complex vector array and is depicted in the figure 6. To show the result of DFT in chart we had to convert the complex array to real number and for this purpose we were define the variable *XX1* and used the operator $|\ |$ as follows:

$$XX1_n := |X1_n| \tag{05}$$

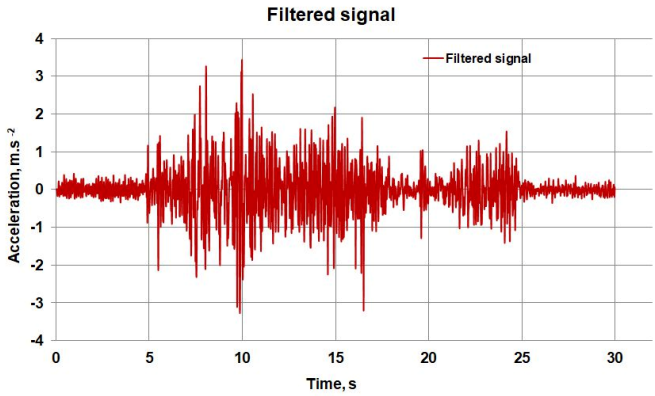

Figure 5. Filtered data

$$X1 = \begin{bmatrix} -21.094 \\ 10.476 - 3.061i \\ -5.137 + 9.829i \\ 2.894 - 21.225i \\ -12.147 + 15.663i \\ 4.106 - 14.269i \\ 9.065 + 7.448i \\ 4.352 - 22.898i \\ -2.88 - 1.326i \\ -18.767 - 9.964i \\ 17.758 + 19.631i \\ -3.482 - 15.395i \\ \vdots \end{bmatrix}$$

Figure 6. Complex array

The obtained frequencies are depicted in the figure 7.

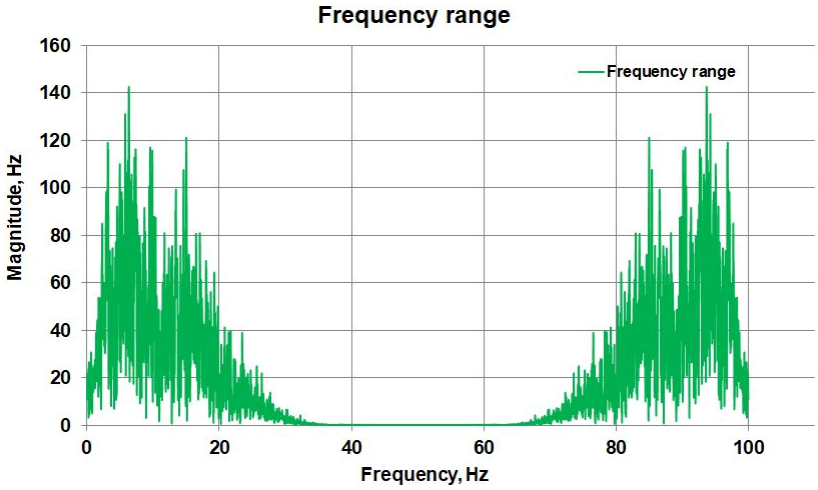

Figure 7. Magnitudes and frequencies

To find the peak values we were used the commands *max* and *match.*

Conclusions

The necessary review of literature was created. The experimental data was recorded with defined sensor of acceleration. Form the measured dataset was the parts of start and end (braking) of agricultural technological operation, neglected. The methodology of time series signals processing was designed. The

designed methodology of data processing was realized in the PTC Mathcad Prime software. For this purpose were used the build-in functions and commands. The processed data was exported to the MS Excel sheets. The dataset was filtered with low-pass filter. Filtered data was processed with DFT analysis. The peak values of magnitudes and frequencies were founded. To find the maximum value of magnitude we were used the command *max*. Maximal peak value was 142,361 and occurrence in dataset was funded with command *match*=191 and 2809 positions at 6.367 Hz and 93.633 Hz.

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Force measuring methods of milling and turning for experimental use – A brief review

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Abstract

In this review, solutions and methods are presented for measuring the cutting forces applied by researchers so far in the case of milling and turning in experimental use. This research does not cover all solutions, but the most commonly used techniques will be presented and evaluated without detailed technical data. The advantages and disadvantages of each method are explained in the conclusion. The goal is to determine which cutting force measurement methods can be used for further research.

Keywords

cutting forces, milling, turning, force measuring

1. Introduction

Nowadays, with the advancement of additive technologies, machining is still very important in industry, especially if the goal is to achieve high precision. The two most frequently used machining methods are milling and turning. Most finished products made by machining go through either the milling or turning process, or both. Therefore, these two processes are constantly being researched to obtain more and more accurate information. Cutting processes depend, among other things, on the used cutting parameters. Forces are constantly changing in the function of time during the cutting process, so numerical calculation is not always applicable. Cutting force measurement is the key to control the machining operations. [Albrecht *et al* 2004] Knowing the cutting forces can increase the chip removal rate, reduce production time and cost. Optimization of parameters avoids unwanted effects such as high vibration, overload, tool breakage or excessive tool wear. In addition, the cutting forces influence the generated temperature and the surface roughness of the machined surface, and thus the machining accuracy. [Yaldiz, Ünsacar, 2005]
It is clear from the above that the measurement of cutting forces is an important task in the field of mechanical engineering.

This review describes some methods used to measuring the cutting forces which are found in the literature.

2. Basics of milling and turning

In milling (Figure 1 left side), generally the tool performs the main movement (rotary movement) and the workpiece performs the secondary movement (movements in X, Y and Z direction).

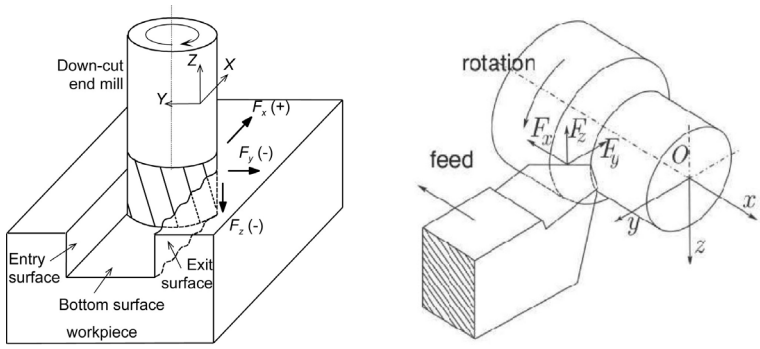


Figure 1. Force components of milling [Luo *et al* 2007] and turning (http://inspirehep.net/record/1246074/plots)

Turning is mainly done on cylindrical workpieces. Then the workpiece makes the main movement (rotary movement) and the tool performs the secondary movement. Right side of Figure 1 shows the theoretical picture of the turning process.

In the following, examples are given from the literature where the cutting force was measured in various ways for milling and turning.

3. Cutting force measuring methods in turning

When measuring the cutting force in turning, two main types are distinguished. One is when the displacement of a material with a known matrix is measured by a sensor such as an inductive transducer. The other type is the measurement of the deformation of a material with a known elasticity factor using strain gauges.

3.1 Force measurement with inductive transmitter [Kári-Horváth, 2009]

In this work a special holder was made to hold the transmitter under the tool shank. The holder and the tool were fixed together into the tool holder. TR102 type inductive transmitter was used to measure the displacement of the tool shank in only one (vertical) dimension.

This solution is easy to implement, but inaccurate because it can only measure the cutting force in one direction.

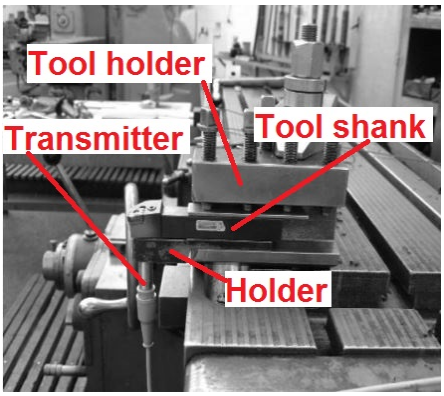


Figure 2. Force measuring with inductive transmitter [Kári-Horváth 2009]

3.2 Force measurement with strain gauges

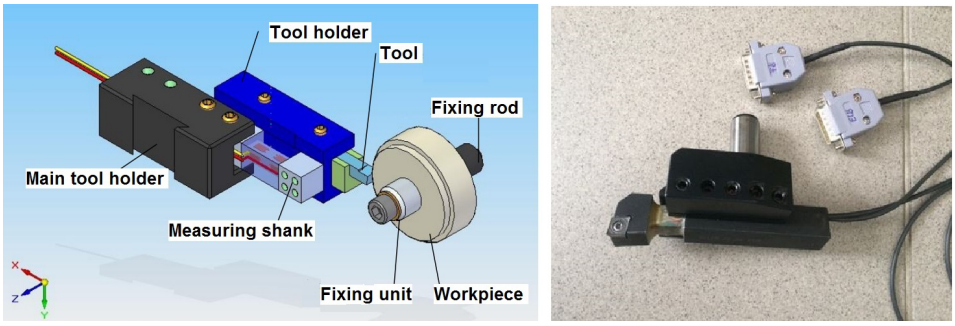


Figure 3. Force measuring units with strain gauges (Designed and created by Róbert Keresztes) [Dobrocsi 2011, Kovács 2016]

Figure 3 shows two solutions for cutting force measuring with strain gauges. With these measuring methods the feed force (in the Z direction) and the main cutting force (in the Y direction) can be measured. *Dobrocsi* put the strain gauges on a measuring shank what was connected to a tool holder (left side of Figure 3). The advantage of this system is the more accurate measurement and tool interchangeability. However, due to the added elements the actual cutting edge is too far from the main tool holder, which can make the measurements unstability. *Dobrocsi* used polymer workpieces, therefore this setup was suitable for measuring the cutting forces and a comparison between these.

Similar solution for force measuring. In this case the strain gauges took place on the tool shank (right side of Figure 3). The cutting edge was closer to the fixing, however with this method, only that type of turning inserts can be use, which are compatible with the given tool shank. The measurements were done on a CNC lathe machine.

3.3 Cutting force measurement with Kistler dynamometer in turning [Dömötör 2013]

Dömötör used Kistler dynamometer to measure the cutting forces during the turning process in Z direction. Type Kistler 9129A dynamometer (Figure 4) is suitable for measuring three components of forces. The tool in interchangeable with this device. This method is more expensive compared to the previous solutions.

Figure 4. Kistler dynamometer for cutting force measuring

3.4 Special cutting force measuring devices

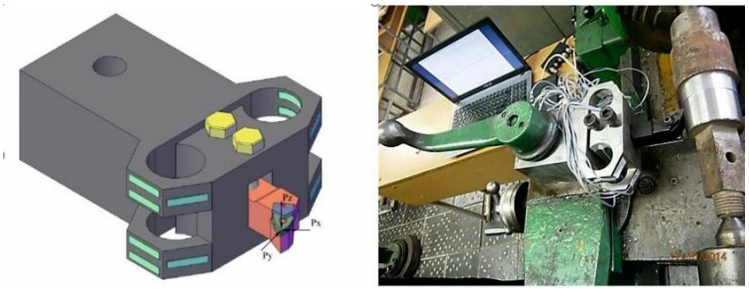


Figure 5. Special force measuring unit [Zablotskyi et al 2017]

Zablotskyi et al used a special force measuring device for separating and analysing cutting forces (Figure 5). It consists four elastic elements which allow the deformation of the cutting force component to be absorbed through the nodes of the elastic elements. The device is designed as a special mechanism, that can

be mounted to the tool holder. The fixed tool is attached to a strong nest in the form of four elastic semi-circular holders.

The article of *G. Totis et al* shows an accurate and reliable solution (Figure 6).

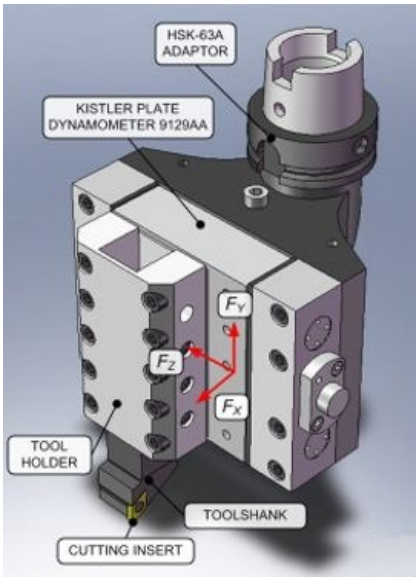


Figure 6. Triaxial holder

In this work, the authors present an innovative dynamometer for measuring the triaxial cutting force, specifically for use on a milling-turning CNC machine with a turning head. The device is based on a piezoelectric power ring and its modular design allows for easy replacement of the cutting insert without changing the preload of the sensor. The prototype device was designed and experimentally tested with static calibration and dynamic identification, which showed good static and dynamic characteristics. Finally, the sensor was tested by machining a test piece under operating conditions.

4. Cutting force measuring methods in milling

There are two commonly used methods to measure cutting forces in milling. The most common method is to attach the measuring device directly to the workpiece. Another method is when the measuring unit is connected to the milling tool or the spindle near to the tool.

4.1 Measuring cutting forces in milling using capacitive sensors

In milling, researchers also use these types of sensors to measure the cutting forces during machining. *Albrecht et al* installed a capacitance type displacement

sensor on the main spindle of a three-axis CNC vertical machining center. The sensor was attached externally to the front of the spindle system using a bracket, which was clamped around the spindle housing (left side of Figure 7). They measured the force only in X direction in an example case.

Kim et al used CCDS (Cylindrical Capacitive Displacement Sensor) to measure the cutting forces (right side of Figure 7). They measured the forces in X and Y directions also.

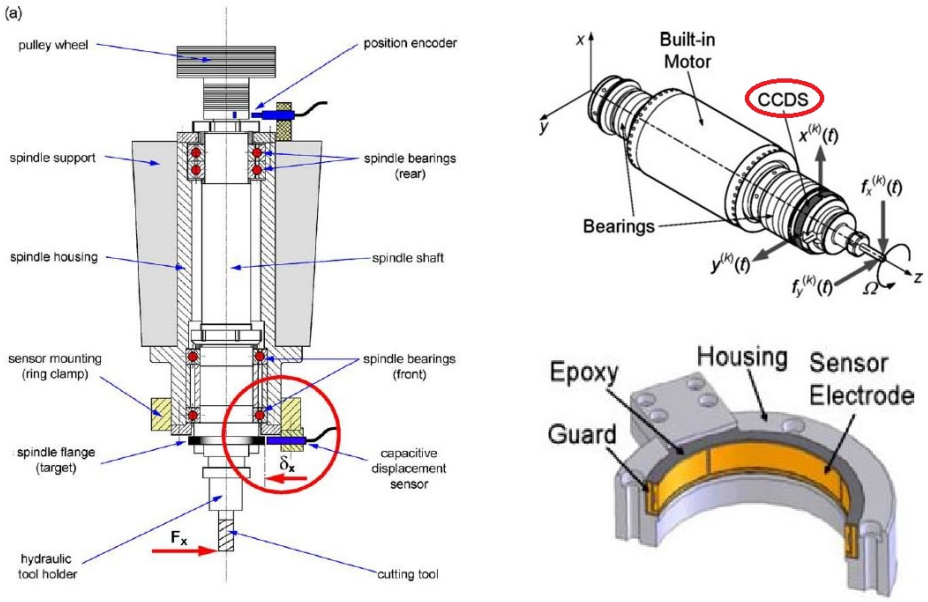


Figure 7. Force measuring with capacitive displacement sensors [Albrecht *et al* 2004, Kim *et al* 2005]

4.2 Cutting force measuring in three dimensions with combined sensors

Altintas and Park measured the cutting forces in three dimensions in their milling experiment. The spindle of a vertical machining center was retrofitted with three pairs of piezo-electric sensors. The cutting force was transmitted to the sensors, located at the stationary housing from the cutter and rotary spindle shaft through bearings. Two pairs of shear sensors (Kistler 9145) were used to measure lateral forces in the feed (x-axis) and normal (y-axis), and a pair of compression sensors (Kistler 9135) were used to measure the axial (z-axis) forces in milling. The preloaded sensors were arranged to be opposite to each other to compensate the unequal deformation and to improve the sensitivity of the force measurements. The signals from each sensor were added and passed through an anti-aliasing filter. The signals were then amplified by the charge amplifiers. Figure 8 shows their setup.

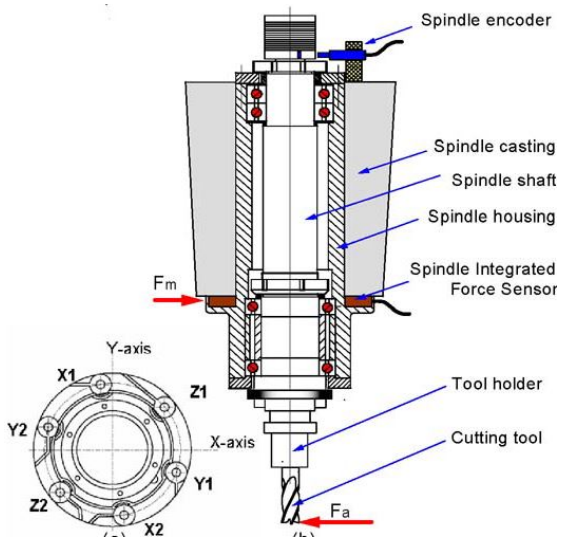


Figure 8. Force measuring method with combined sensors [Altintas *et al* 2004]

4.3 Cutting force measuring with rotating cutting force dynamometer

Kaya et al used a rotating force dynamometer (Kistler 9123C1111 type) for the dynamic and quasistatic measurement of the three force components (F_x, F_y, F_z) as well as of the drive moment M_z on a rotating tool (Figure 9). The output from the cutting dynamometer is transferred with a non-contact Radio Frequency protocol to charge amplifier (Kistler Corporation, Model 5223B).

Figure 9. Experimental setup using a rotation force dynamometer [Kaya *et al* 2011]

The rotating cutting force type dynamometer (RCD) has advantages over fixed dynamometers, such as the cutting forces can be measured on the rotating

tool independently of the size of workpiece and measurement can be performed on any spatial position (four or five axis milling).

4.4 Force measuring with multicomponent dynamometer

Phokobye et al used multicomponent dynamometer (Kistler 9255C type) for measuring the cutting forces during milling. In their research a solid rectangular work piece of MS 200 TS was clamped to the dynamometer using two holes and the dynamometer was clamped directly to the machine table (Figure 10). Milling operations were thereafter performed for dry cutting using different cutting parameters of cutting speed, feed rate and depth of cut.

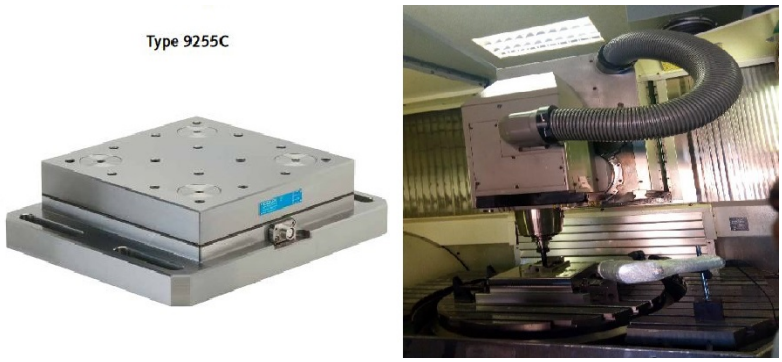
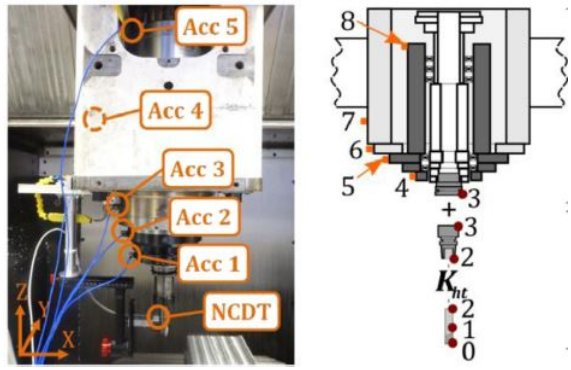


Figure 10. Force measuring with multicomponent dynamometer [kistler.com, Phokobye *et al* 2019]

4.5 Cutting force measuring with spindle mounted vibration sensors [Postel et al 2019]



7. Figure Force measuring with accelerometers [Postel *et al* 2019]

In this article the spindle of a 5 axis CNC machining centre is instrumented with 5 accelerometers mounted on the non-rotating housing (Figure 11). The

objective was to estimate the cutting forces and vibrations at the tool tip from the accelerometers attached to the housing during machining.

5. Discussion

Two tables were made to compare the methods. One for compare the force measuring methods in case of turning, another for force measuring in milling. We used numbers to evaluate aspects. 1 means expensive, too complicated, not accurate, 2 means moderate, 3 means cheap, easy to implement, easy to use, robust, high accurate. In the tables the methods were signed with the first author's name.

Table 1. Comparison of the cutting force measuring methods in case of turning

Aspects	Kári-Horváth	Dobrocsi	Kovács	Dömötör	Zablotskyi	Totis
Accuracy	1	2	2	3	3	3
Tool interchangeability	2	3	1	3	2	3
Simplicity	3	2	2	3	1	1
Easy to use	1	3	3	1	1	1
Direction(s)	1	2	2	3	3	3
Machine compatibility	2	3	3	2	3	3
Cost	2	2	2	1	1	1
Total	12	17	15	16	14	15

Table 2. Comparison of the cutting force measuring methods in case of milling

Aspects	Albrecht	Kim	Altinas	Kaya	Phokobye	Postel
Accuracy	1	2	3	3	3	3
Simplicity	3	3	2	3	3	1
Easy to use	3	2	2	3	3	1
Direction(s)	1	2	3	3	3	3
Cost	3	3	2	1	1	3
Total	11	12	12	13	13	11

Conclusion

All the above methods have their own advantages and disadvantages. Special units are more accurate than simpler units, but also have more expensive. In case of turning the method presented by Dobrocsi was best suited to those aspects. In milling two methods were equally appropriate. The rotating dynamometer also measures the torque of the spindle. It is an extra information for our work. The more information we get on a given measurement, the better we can get to know a process.

We must always keep in mind which aspects are important. Of course, if any of the aspects in the table are particularly important, or vice versa, the result may change. This article provides a comprehensive overview of some of the previously used cutting force measurement methods. Based on these, researchers can choose the appropriate method for future research.

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