



Master's degree thesis

LOG950 Logistics

**Efficiency, Digitization, Sustainability and Innovation
in Public Procurement: Cluster Analysis of Norwegian
Public Organizations**

Daniel Hosana

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PREFACE AND ACKNOWLEDGEMENT

This master thesis is the culmination of my master study in MSC Logistic Program with a specialization in Logistics Analytics at Molde University College from Aug 2021 to May 2023. It represents my biggest achievement in my academic journey. My motivation to write a master thesis about public procurement is to better understand the different strategic approaches used by public organizations. By identifying patterns or best practices, I wish to contribute to organizational performance and effectiveness in this area.

I would like to begin by expressing my gratitude to all those who have contributed to the success of this master thesis and moreover this master study. I am thankful for the opportunity to acknowledge the existence of the Almighty and be guided by God throughout this journey, as well as to express my sincere appreciation to Him.

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May 2023

Daniel Hosana

ABSTRACT

Public procurement has changed to become more strategic bodies than organizational servant. However, public organizations have different roles and preferences. This master thesis examines to what extent do public organizations differ in their strategic focus, and how can these variations be classified and analyzed to gain insights into public procurement practices. This study focuses on the level of procurement strategy, procurement expertise, and the contributions of digital tools in public procurement process. This study aims to understand the diverse strategic approaches employed by public organizations as well as identifying potential patterns.

Twostep cluster analysis employed to reveal distinct segments of public organizations according to the procurement strategies implemented. Data analysis and findings are based on secondary data to the primary research which survey was conducted to procurement managers working in various public sector organizations in Norway.

The findings reveal three distinct segments: Advanced clusters, Intermediate clusters, and Selective clusters. Advanced clusters belong to public organizations applying all four strategies. Intermediate clusters are public organizations who implement procurement strategy efficiency, digitization of procurement process, climate and environment but not innovation. Selective clusters are public organizations having a combination of two or three procurement strategies as well as only one procurement strategy with relatively low membership compared to the other two groups.

The statistical test was performed to identify patterns and see significant differences in variables procurement expertise and contribution of digital tools. The results of this study imply that the more sophisticated public organizations in terms of procurement strategy implemented, the higher the level competency owned. Although the level of competency is higher, the findings show that there is no significant difference in the benefits of implementing digital tools in procurement process with the public organizations who owned the lower level of competency.

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1.0 INTRODUCTION

1.1 Background

Public procurement represents around 13% to 20% of global GDP. In 2018 the spending of countries globally was around 9.5 trillion US dollars (The World Bank, 2020) and in the same year Norwegian public sector amounted 564 billion NOK or around 53 billion euros (Kløvfjell & Chivers, 2020). Referring to the huge amount of money, efficient procurement mechanisms therefore need to be well planned as it is critical for the allocation of numerous goods and services (Lewis & Bajari, 2011).

Prior to digitization, several web-based technologies such as electronic procurement, e-commerce, and enterprise resource planning (ERP) were being adopted for all procurement processes, such as tendering or bidding and progress monitoring (Yevu et al., 2021). According to the EU view of digital procurement, it believes as one of the key drivers to reduce administrative burdens in public administration (European Commission, 2022). Through the implementation of electronic public procurement, new digital technologies provide excellent opportunities to streamline and simplify the procurement process (European Commission, 2017a).

To measure whether public organizations meet public needs in terms of goods and services or not, more over because of the source of the financing of public procurement is national budget funds, digital tools in public procurement operations is an important part as it increase the effectiveness in the process (Egorova et al., 2021).

Utilization of digital tools in public procurement contribute to the efficiency and streamlining in several area of process such as reduced time spent in the process, reduced waiting time due to process time become faster, better budget control due to better management, enhanced communication with suppliers, decrement number of errors, increasing number of suppliers per tender competitions and better decision making to support management. Bobowski and Gola (2018) in the “E-Procurement in the European Union” explain that the implementation of digital tools in procurement process expect to enhance the transparency, effectiveness, optimized and more market-oriented.

Competency in digitization of procurement is essential when implementing procurement with digital technology tools such as electronic procurement, e-commerce, and enterprise resource planning. The expertise level of the organization determines how optimal the digital tools efficiently utilized in the process. Expertise in using digital tools may vary between the organization depends on the scale of the organization or number of manpower or proficiency of manpower for using digital tools or digital tools being used.

Norway is well-known for their digitize public sector, even before COVID-19 hit, automation, digital collaboration tools and the use of cloud services and platforms has been used (Norwegian Ministry of Local Government and Modernisation, 2021). Due to big amount spend at Norway public procurement new technologies promoted to have better security, more efficient services, economic growth and lower emissions (Norwegian Ministry of Local Government and Modernisation, 2021). Generally, Norway's electronic procurement and information system classified as advance with several information portal operated (MAPS, 2018).

Besides digitization in public procurement process, climate and environment has become a priority focus on government activity. Therefore, expertise of the government entities in implementing the activity related to any sustainability topics become the concern. Not to put climate and environment less important than digitization, in some way, one of digitization goals is to create sustainable system as well as the triggers to sustainability (Bobowski & Gola, 2018).

It is interesting to examine the expertise level of public organizations in relation to the procurement strategies implemented in the planning. As digitization plays an important role in public procurement process nowadays, then contribution of digital tools in procurement process will be investigated, how far contribution of digital tools perceived by public organizations when implementing it in the procurement process.

In Norway, topics of efficiency, digitization of the procurement process, climate and environment or innovation are hot topics discussed in recent years especially as a sustainable strategy and key performance indicator (KPI). Digital tools presented in public procurement to be helpful for and contribute to addressing areas like efficiency (Bobowski & Gola, 2018),

environmental (Egorova et al., 2021), innovation (Pekolj et al., 2019), and of course digitization of procurement process itself.

This study focuses on the level of procurement strategy, procurement expertise, and the contributions of digital tools in public procurement process. The problem statement of this study will then be: To what extent do public organizations differ in their strategic focus, and how can these variations be classified and analyzed to gain insights into public procurement practices? This question addresses the classification of public organizations based on their strategic focus, which can provide valuable insights into how different organizations prioritize and align their strategies. Exploring this topic can contribute to understanding the variations in strategic approaches among public organizations and potentially identify patterns or best practices that can enhance organizational performance and effectiveness.

1.2 Research Questions

For this study we divided the research problem to two parts by asking three research questions, which are:

1. What distinct segments of procurement strategy can be identified regarding the topics described in the procurement strategy of public organizations?
2. What are the characteristics of segments related to expertise and resources and what is the tendency of the public organizations that have sufficient level of expertise and resources?
3. What are the characteristics of segments related to the contributions of digital tools?

To answer the research questions, we ask survey questions to organizations in Norway involved in public procurement. We limit the analysis to 381 public organizations.

1.3 Structure of The Thesis

The master thesis structured as follows:

Chapter 1: Introduction of the study, background, statement of research questions

Chapter 2: Literature review from relevant literature (Contributions of Digital Tools in Public Procurement, Procurement Expertise, Public organizations' Procurement Strategy and Productivity in Procurement)

Chapter 3: Presentation of case description in detail

Chapter 4: Detail of data and methods of data analysis

Chapter 5: Findings from the analysis

Chapter 6: Discussion of the research questions

Chapter 7: Conclusions, research summary, implications, limitations of the study and suggestions for further research.

2.0 LITERATURE REVIEW

The aim of this chapter is to review relevant literature about topics that will be discussed in this study. The literature review will focus on three main topics from research problem, digital tools contributions in public procurement, procurement expertise and procurement strategy.

2.1 Contributions of Digital Tools in Public Procurement

Digital public procurement is more than public procurement activities that shift to use digital tools in the process, it is the transformation which lead and stimulate economic development (Pekolj et al., 2019). Digital tools involve in various phases of the procurement process, the goal of digital transformation of public procurement is to simplify the whole process for business to participate and public sector to manage, besides, it allows integration data based at various stages (European Commision, 2023a). Ilhan and Rahim (2020) mention that digital procurement as a representation of a concept that involves automation of procurement processes using e-procurement systems.

The 2014 public procurement directive brought new mandatory as a continuation of 2004 public procurement package and 2005 EU ministers advice regarding public procurement which makes the use of electronic procurement is mandatory (Pekolj et al., 2019). The transition to digital public procurement (e-procurement) in EU was the background of EU rules, public procurement package in 2014 (Sanchez-Graells, 2019). It is expected that within 2023 e-forms will be mandatory in use. EU legislative target the fully implementation of electronic forms (e-forms) as it is capable to support better analytic data for more transparent procurement (Egorova et al., 2021).

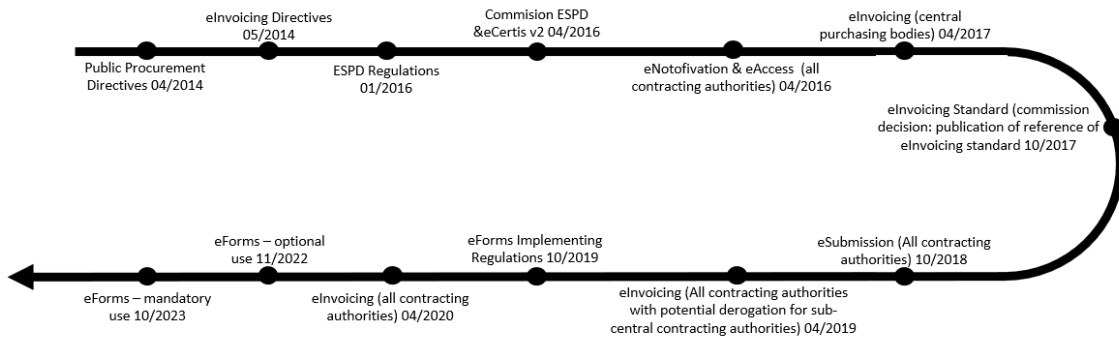


Figure 1. E-procurement timeline (European Commission, 2023)

In EU, it has been found that digitization of public procurement is an important trigger of the sustainable, socially-inclusive growth based on innovation, due to improvement in efficiency and transparency of the public spending, while streamlining and better targeting such procedures and contracts (Bobowski & Gola, 2018). One of the reasons of digitization of procurement system improve in efficiency assume due to simplification of procedures of public contracting (Bobowski & Gola, 2018). In EU the reform of public procurement is to simplify the procedures of procurement by reducing the bureaucracy and increase efficiency by providing more flexibility (Bobowski & Gola, 2018).

Digitization of the public procurement as expected brings more benefits to the effectiveness of the process compared to traditional public procurement. One of the reason a government implement electronic procurement in procurement role is to increase the efficiency and effectiveness of the procurement system in the middle of increasing fund spent on goods, works and services to meet public needs (Egorova et al., 2021). As what e-procurement system capable for, it makes e-procurement play a strong role in the process of effective public procurement (Egorova et al., 2021).

Bobowski et al. (2018) point out what could be the benefits of digitalizing the public procurement:

- Improvement of access to public procurement markets for enterprises, with special regard to small and medium enterprises,

- Increased transparency,
- Simplification and acceleration of procedures,
- Reduction of costs of participation in the procedure for all parties,
- Reduction in administrative burden and red tape,
- Encouraging innovation.

The organizational structure is often forgotten whereas in order to effectively manage the procurement it is essential (Chapelle & Bayona, 2021). As stated by Babica et al. (2019) that digital procurement able to bring successful transformation but strict monitoring need to be performed to prevent the innovations to subjectivity results. By these, we can deduce that Organizational development of the procurement needs to be balanced with the digital transformations if organizations would like to optimize the advantage of performing digital tools in public procurement processes.

According to Capgemini Consulting Report in 2007 which quoted by Bobowski and Gola (2018) in their research, e-Invoicing able to benefits 40 billion euros annually in business to businesses field in EU. Bobowski and Gola (2018) mention at least four advantages of applying e-invoicing:

- Reduction of printing, postage, and storage costs,
- Speed-up of the financial settlement with the customer,
- More efficient data administration due to transfer of the content of electronic invoice directly to enterprise's payment and accounting systems,
- Reduction of training and system development costs,

What study often mention is the impact or advantage and disadvantage of electronic procurement to the public or bidders or suppliers, we will in this study discuss also about contributions perceived by public organizations regarding implementations of digital tools in public procurement processes. What could be the contributions of digital tools in public procurement as follow:

- Reduced time spent (per task),
- Reduced waiting time (wait for someone to do something),

- Better decision support to management,
- Increased control of the use of allocated budget funds,
- Reduced number of errors,
- Enhance supplier relation management.

2.1.1 Contribution in Reducing Time Spent

Several activities in public procurement process done manually sees as an inefficient procedure which results in invisible cost such as time required for preparing, printing and scanning of documents (Pekolj et al., 2019). Administrative work counts as work cost of the manpower, longer time spent on process means higher cost to the process.

The reason behind reducing time spent to complete task is to save money from the long processing time activities in the procurement process. The procurement process carried out traditionally usually end up with unproper management to the tender of public procurement (Babica et al., 2019).

As mentioned earlier, one of the roles of e-procurement on the procurement process to provide system which able to reduce the time to complete the task (Egorova et al., 2021). It gives advantage in time saving to all buyer, bidder and awarded supplier of public and private organizations involved in the procurement process (Bobowski & Gola, 2018). Digitization in public procurement emerged to save time by streamline the process and able to increase the capability in managing the competition (Tayler & Wright, 2018).

Time spent at any stages of procurement process can be reduced as a result of simplification documentation and procedures by digitization implementation (Bobowski & Gola, 2018).

It also claimed by supplier that the use of e-procurement systems result in time saving (Ilhan & Rahim, 2020). Bobowski and Gola (2018), Egorova et al. (2021) and Pekolj et al. (2019) stating that one of the reasons behind electronic procurement being implemented is to speed up the process of procurement by eliminating administrative burden in public procurement process.

The use of electronic resources is projected to minimize administrative load and gain time savings, from the benefit of time saving, hence, procurement officers' time is freed up, which allowing them to devote more of their time to professional development (Pekolj et al., 2019). It can be the reason for digital expertise development of both public organizations and bidders or awarded suppliers.

Besides efficiency and cost saving, e-procurement brings benefit in terms of process time, time saved per transaction and faster evaluation in stages of activity (Babica et al., 2019). In the case of tender stage, the reduced time gives opportunities for buyer to perform double check on the specifications of the product as they save time on previous task (Babica et al., 2019). McCue and Roman (2012) point that electronic procurement tools such as e-signature, e-notice, or e-bids able to reduce processing time greatly due to the simplification of bureaucracy but he mentioned that this would result in security issues.

Reducing process time does not only mean getting task or activity completed faster or ensuring all the process done on schedule, but it also creates another opportunity which paves the way to other benefits and innovation.

2.1.2 Contribution in Reduced Waiting Time

In relation to process time, waiting time is associated with high queue and long process time in previous tasks which leads to idle situation on upcoming station. As task in the procurement process done traditionally, it makes process take longer time to complete which results in employee wait for someone before they can do something. Prior to digitization, as already wrote in the previous part, the working time may exceed the schedule or take a long time to complete.

In terms of efficiency, Patrucco et al. (2021) interpret minimized waiting times as a part of it. From 2018, e-procurement has been declared as a mandatory for all forms of public procurement, one of the expectation of the implementation is to improve the efficiency of the procedure (Babica et al., 2019). The digitalization brings good impact on how working time manage, it also means that it organized how task organized (Llave, 2021). Digitized

public procurement results in workflow automation which act as the key role on reducing inefficient process in the procedure (Desuivit, 2023)

One of the main barriers in public procurement overcome by digitization is the shortage of capacity of procurers (Babica et al., 2019). The result of the solution is that the task becomes well organized. Reported by Pekolj et al. (2019) without involvement of e-procurement the contract authority is not capable to handle a lot of bids coming. When a section or department is incapable of handling a certain number of tasks, it will end up with the other section waiting for the task from another section. Digitization claims to overcome the problem explained above.

The digitization claims to support the streamlining of administrative process with 80 percent of process time improvement (Tayler & Wright, 2018).

2.1.3 Contribution in Better Decision Support to Management

Traditionally management as decision maker rely on the basis of experience they built and patterns and relationship they have observed (McAfee et al., 2012). Prior to digitization on public procurement, data are scarce, expensive to obtain and of course not available digitally, such situation make the needs of expertise and outsiders to process the data which make it high in cost (McAfee et al., 2012).

According to Egorova et al. (2021), electronic procurement technology play an important role in decision making in tender awarding. Transformation from traditional system to implementation of digitalization will improve the quality of decision taken by management as they emerged utilization of big data analytics to support decision making processes (Babica et al., 2019). Digital tools in public procurement able to provide information sharing system, databases, benchmarks and networks that help public organizations to have better understanding about the market that can contribute to decision making in procurement process (Pekolj et al., 2019). Technologies such as artificial intelligence, machine learning and advanced data analytics and data-driven emerged as linkage between the business stakeholders which support strategic decision (Chapelle & Bayona, 2021). Electronic

procurement can provide valuable decision to support the management, somehow through some manual operations such as manual data collection and analysis, regular procurement reviews support can still be provided to management without but the consequences of following that way are accuracy due to human error and long process time due to manual process.

Digitization in public procurement enables advanced data analytics from data generated automatically from electronic procurement to support decision making (Sanchez-Graells, 2019). When the data made available, it pave way wide range of opportunities to enhance performance of procurement strategy and shape future strategic decisions (Sanchez-Graells, 2019). In Russia, procurement information system which handle data processing and analytical function impact to enhanced strategical decision on business such as an increase in the sales market and business geography, saving time and money, legal protection of the parties, access to government orders, process transparency, convenient statistics and analysis of sales dynamics (Egorova et al., 2021). The utilization of electronic forms targets high quality and accessibility data for the purpose of transparency to support better management decision (Egorova et al., 2021).

Ilhan and Rahim (2020) found that improved data quality is one of the factors of management decision to streamline procurement process. According to (Prier et al., 2018) open data from Tenders Electronic Daily data helps to enhance economic decision-making. What highlight by McAfee et al. (2012) is that digitization in public procurement helps organizations or authorities make better predictions and smarter decision without erase the need for vision or human insight.

2.1.4 Contribution in Increasing Control of The Use of Allocated Budget Funds

In their recommendations, OECD (2008) said that information and communication technologies is mandatory to ensure transparency of public tenders, increasing competition quality, contract management, cost savings and public finance management report. One of

the purposes public organizations implementing digital tools in public procurement is to obtain an improvement accountability of the process (Babica et al., 2019). The improvement proved to have impact on reducing the corruption which makes clearer budget control, it also prove by several studies that public bodies use digital instruments as a tools of anti-corruptions (Babica et al., 2019). Collusive public procurement agreements diminish public expenditures and ultimately harm the public interest (Pekolj et al., 2019).

Mohagheghi and Jørgensen (2017) reported that successful digitization on public sector system followed by the success of budget control and project efficiency. Electronic procurement has become one of the tools to reduce maverick-buying in organizations (Babica et al., 2019), as the nature of digital tools is to provide a structured and controlled purchasing environment which at the end prevent unauthorized or unnecessary purchases. Pekolj et al. (2019) noted that dynamic purchasing system in the electronic public procurement process may become an enhanced standard for contracting authorities to improve their spending, forecasting, and allocating their budgets.

Electronic procurement reported able to benefits for three public sector, national, central government, and local government, with electronic procurement benefits the organization in reduced corruption, reduced cost of operation, increased efficiency and enhanced accountability (Ilhan & Rahim, 2020). In the context of strategic procurement initiative of five large hospitals in Kenya, survey results reported that an electronic procurement contributed in improving in financial performance (Ilhan & Rahim, 2020).

Digitization in public procurement has become an important driver for the innovation as it solves the problems of efficiency and transparency which improves the use of public funds and spending control (Egorova et al., 2021). The use of electronic procurement solves accountability problem, it benefits the organization in more cost-effective in public purchase, the technologies also improve procurement management between purchasing and vendor organization which results in more efficient of budget management (Nandankar & Sachan, 2020).

2.1.5 Contribution in Reduced Number of Errors

Speaking about traditional public procurement, administrative burden is one of the sources of human errors in tender process due to numerous of human intervention in the process. Prior to the implementation of information communication technologies on public procurement, intervention of human and human errors frequently occurred. We can see in the study done by many researchers; they describe that one of the benefits of implementing digitalization in public procurement is eliminating human error. As stated by Kramer (2016) that paper-based procedure of public procurement brings many negative impacts, one of them is that this procedure bring numerous of source of errors.

Digital tools play a role as a procedure standardized that streamlines the process to become more efficient and effective. Implementing electronic procurement results in more efficient operations in public procurement as they document several positive results in minimizing the errors in following areas:

- Supplying the goods and services,
- Billing process,
- Payment procedures,
- Bureaucratic procedures.

The improvement made by electronic procurement demolished the error caused by traditional or regular public procurement.

Communication in traditional public procurement makes data entry in either procurer or supplier have a risk of error to happen when input process performed. Ilhan and Rahim (2020) mention about integrating procurer-supplier business system with electronic data interchange (EDI) to minimize errors in data entry. The linkage between two systems is able to support the beginning of the critical business process, avoiding errors in data entry which without its errors in data entry means errors from the beginning to the end of the supply chain process (Ilhan & Rahim, 2020).

Electronic procurement is one of information and communication technologies tools that attempt to reform the government public procurement, implementation of electronic

procurement results in many benefits which one of them is reducing human errors in purchasing decision (Neupane, 2014).

Therefore, public procurement after digitization is more profitable due to the increase in efficiency. Because the problem cause by errors can be minimized by the digitization so that the process is significantly improve, Kramer (2016) mentioned several improvement caused by digitization in public procurement that reduce the chance of errors in the process, there are:

- Reduced paperwork through the automation of the procurement process,
- Transform the entire process almost paperless,
- Decreased redundancy and less bureaucracy,
- Standardization of the procurement process across all levels of government,
- Standardization of documentation; ensured compliance with procurement laws and regulations,
- Easier access to information (such as background information on new potential suppliers, related tenders, and purchases of the same nature)

Implementation of digital tools is not solely reducing the number of errors happen in the process or stages of public procurement activity. It also gives an impact in increasing capacity of public organizations to handle procurement activity as time and source for handle the errors could shift to manage the process due to the process is become more effective and efficient. The public organizations will also receive benefits in becoming more transparent as the human error and human interference is greatly eliminated (Kramer, 2016).

2.1.6 Contribution in Enhancing Supplier Relation Management

Communication between procurer and potential suppliers prior to competitive tendering is works like potential suppliers prepare and offer the product or expertise and procurer has the power to make decision (Alhola et al., 2017). OECD (2008) in their recommendations said that communication should be effective in a way that potential suppliers having a better understanding about the procurer needs with effective tender specifications and by better

understanding market capabilities. It describes using electronic procurement systems such as online catalogue and online order tracking which makes supplier and buyer easily and correctly informed without wordy communication, and the communication is real-time. Electronic procurement also makes procurers able to monitor supplier performance by system without any direct interactions. Communication in procurement process sometimes poor specifically when suppliers are not anticipating the signal of the demand (Alhola et al., 2017). In EU area, legislative framework of electronic procurement in fully electronic communication including bid submission has been applied by the purchasing organizations since April 2017 (Bobowski & Gola, 2018).

Electronic procurement can enhance communication with suppliers by facilitating real-time communication, increased collaboration, and access to information. In electronic public procurement, communications between procurers and suppliers are highly digitize through information technology systems and infrastructure, Ilhan and Rahim (2020) emphasize the use web based portal for communication in transaction process can reduce unnecessary communication and miscommunication. For instance, the role of digital tools is as a liaison between the procurer and the supplier, the system capable in transferring a very clear information related to the transaction quickly, it means that the use of digital tools in public procurement can help to eliminate delay in communication and reduce the risk of communication. OECD emphasize that electronic procurement system could benefits all stakeholders in reducing the direct interaction (Babica et al., 2019).

Electronic procurement automate communication through web-based procurement between supply chain partners (Nandankar & Sachan, 2020). According to (OECD, 2022) advantages of reducing buyer-supplier direct communication is related to a tender process, such as reducing the risk of bid-rigging and collusion, increasing competition, improving quality of bids, facilitating innovation and enhancing transparency and accountability.

Electronic procurement able to contributes in procurer-supplier communication in purchasing process, it works in a smart system way that transmitted the purchase order to the supplier when goods quantity below certain stock level without any necessary human involvement in the communication (Ilhan & Rahim, 2020). It makes traditional public procurement become an advance procurement system. Babica et al. (2019) in their study

conclude that lack of direct interactions between supply chain parties in electronic procurement process may lead to purchasing innovation.

Neupane (2014) in his research defines the contribution of implementing electronic procurement in public procurement process:

- Helps to reduce human errors,
- Convenient to acquire information,
- Provides a better relationship between government and bidders,
- Brings an increase in transmission of timely public information in contract awards on price, volume, and execution time,
- Increases the availability of public information on bids,
- Increase accuracy of orders.

Alhola et al. (2017) argues although technical dialogue use for procurer-supplier communication, so far it mostly represents one-way communication instead of two-way interactions. It looks like the procurer is the initiator and supplier or potential supplier are the informants. This shows that communication is mainly instruction without any feedback from the information receiver which can trigger an innovation.

One of the reasons for less suppliers in competition in public procurement is because small and medium enterprises find it challenging for them to access cross-border due to several limitations such as administrative burdens and lack of information (Pekolj et al., 2019). Contracting Authorities are expected not only to obtain the needed commodities, works, or services and meet their fundamental demands, but also seek to maximize the competition (Pekolj et al., 2019). A relation between state or contracting authorities may lead to violations of competitions and regulations (Egorova et al., 2021).

With enhanced technological solutions on management it helps the organizations in organizing competitions which will lead to more suppliers accessing the competitions (Nandankar & Sachan, 2020). Digitization makes public procurement able to increase the capability in managing the competition (Tayler & Wright, 2018), especially the participation of small and medium enterprises as it reduces the cause of not participating. Babica et al.

(2019) argues that award criteria should be embedded to e-procurement system to make evaluation of bids more objective.

The application of tenders, auctions, request for quotation in procurement procedures conducted by electronic form have increase the quality of transparency of public procurement (Egorova et al., 2021). Dynamic purchasing system is a technique for electronic procurement that designed to improve competition and accelerating opportunities by simplification and reducing administrative burdens for all stakeholders, it available where broad competition is present (Pekolj et al., 2019).

Improvement of competition management achieved by information system enhancement and reduction of administrative burdens (Pekolj et al., 2019). Transparency which can avoid collusive arrangements to happen and increase the participation of suppliers to the competition which without the involvement of digital tools it's hard to make all the process transparent (Pekolj et al., 2019). The untransparent environment leads to low level of competition and less participation (Nandankar & Sachan, 2020). Prier et al. (2018) argues that transparency may lead to collusion instead of reducing it.

Electronic procurement has the potential to expand the number of suppliers participating in competition, furthermore it is resulting in competitive pricing, better products and better outcomes for enterprises and governments (Pekolj et al., 2019).

E-procurement improves market access, resulting in enhanced efficiency, increased competitiveness, and decreased administrative load (Egorova et al., 2021). Babica et al. (2019) argues that although digitization capable to makes the competition level increase and reach more suppliers accessing the tender, it also makes bid-rotation easier to occur.

However, supplier relation management performance in public procurement is affected by the performance of the suppliers themselves, not only the performance of public organizations. It will be unclear whether the contribution of digital tools operated by public organizations is already optimal or not as there are possibilities of the drawbacks on supplier side not on public organizations side.

2.1.7 Public Procurement and Digital Tools in Norway

In this part we would like to have an overview on a situation in Norway about contribution of the digitization in their public procurement. The review will be taken from three source, MAPS (2018), MAPS (2020) and anskaffelser.no.

Norway public spending considered high, constitutes 16% of Norway's GDP (Gross domestic product), compared to the average of OECD (Organization for Economic Cooperation and Development) which is 12% of GDP. In 2015 Norway's central government spending is building, construction and real estate in the first place. Professional services were the second largest. The third was ICT (information and communication technologies) (MAPS, 2018).

Norway is required to implement EU law on public procurement due to EEA (European Economic Area) membership and the agreement on EEA. Norway's public procurement rules is also based on EU rules especially the 2014 EU Directives (2014/23/EU, 2014/24/EU and 2014/25/EU) (MAPS, 2018). In terms of the level of corruption, Norway categorized as low in a level of corruption, it's proven by the Transparency International's Perceptions of Corruption Index and the Global Corruption Barometer that Norway ranked 6th in transparency out of 176 countries. (MAPS, 2018)

Norway uses procurement platform Doffin (doffin.no, national public procurement notices database) to announced open tender contract nation-widely (MAPS, 2018). The national threshold is set at NOK 1.3 million for goods and services procured at central level (DFØ, 2022). Public procurement in Norway is under Directorate for Administration and Financial Management (DFØ), the main aim of the organization is to reach good financial management of government through good governance, organisation, management and decision-making support (DFØ, 2023).

Norway public procurement system categorized as decentralized means that contracting authorities located at all government levels (MAPS, 2018). MAPS (2018) found that Norway's public procurement operational main challenges is on decentralization and public procurement data collection as contracting authorities irrespective of their governmental

level, are not obliged to submit data to the central level, which electronic systems might not be aligned.

The use of electronic procurement and digitalization level in Norway is considerably advanced, Doffin has registered around 3,300 buyers (MAPS, 2018). It is implemented by all levels of government with regards to the capacity level, higher use at larger public organizations and lower use at smaller public organizations and decentral authorities (MAPS, 2018). In addition, decentral units are seen as having less competence to use electronic procurement compared to central agencies (MAPS, 2018).

As Norway is high in level of digitalization, it makes implementation of electronic means in all procurement cycle possible to be done. E-submission and e-invoicing are considered as the highest practice of electronic procurement (MAPS, 2018). The use of digital tools is claimed to be helpful for public organizations to monitor outcomes, results and performance due to well transmitted information (MAPS, 2018). Digital tools, anskaffelser.no, also facilitate the publication of any opportunities as well as keeping it up to date to all parties easily (MAPS, 2018).

Develop electronic, data driven systems that can support contracting authorities in the follow up. Further develop the e-procurement system to allow gathering on statistics around sustainable public procurement (i.e., highlighting procurements which consider “green” or social dimensions) and providing greater granularity of statistics while at the same time allowing for insights at the systems-level. The use of electronic procurement in Norway is promising to support sustainability in public procurement (MAPS, 2020). As digitalization usage is increasing, invoicing process is being automated and streamlined, as a result it is the most on time process or stages compared to other stages of public procurement (MAPS, 2020).

2.2 Procurement Expertise

2.2.1 Expertise in Digitization of Procurement

In order to fulfill complete digital procurement transformation, it is important to have a complete understanding of competencies needed. Typically, in a public procurement organization, expertise is focused on the procurement process, and the necessary expertise on the functionalities and technologies of the procurement object is lacking (Vilpponen, 2021). In line with Thai and Piga (2007), Vilpponen (2021) emphasize that public procurement also need to deal with issue of utilizing new technology to enhance procurement efficiency including electronic procurement.

EU consider people to have at least basic digital skills up to 80% in 2030, without it, public organizations unlikely able to achieve the goal of digitalization in economic growth and circular economy (Vilpponen, 2021). Lack of digital skills as well as low knowledge about ability of digital service may hinders the processing of technology (Vilpponen, 2021), Pekolj et al. (2019) call it as minimizing the use of digital tools in practice and therefore significantly diminished the usefulness of digital tools. The lack of competency in digital procurement can lead to challenges in increasing manpower and hinder innovation (Danielsen, 2021). Survey by KPMG shows the same, that the biggest obstacle to optimally digitalize is lack of expertise in digital skills (Norwegian Ministry of Local Government and Modernisation, 2021).

The World Bank (2020) highlight key lessons addressing the digital gap in public procurement system:

- Gradual implementation with the support of government plan,
- Leadership and political will in establishing digital procurement system,
- Capacity, institutions, and legal building should be in the first place before leapfrogging,
- Digital transformation in public procurement as it proved to eliminate any negative impact caused by traditional procurement.

OECD emphasize several government's supports that can help public organizations to make educated decisions and enhance their understanding about the markets, through guidelines, training and counselling, as well as information sharing systems, databases, benchmarks and networks (Pekolj et al., 2019). As reported by MAPS about different digital competency between contracting authorities in different public organizations level, Ilhan and Rahim (2020) pointed out that training, capacity building and sufficiency of information and communication technologies framework found to influence benefits of electronic procurement system. The same point also mention by Pekolj et al. (2019) who said that skill development and professionalization are mandatory to obtain potential benefits of public procurement instead of only adopting legislative rules without any capacity and capability development. Pekolj et al. (2019) describe digitalization and professionalization or expertise as two sides of coin, both are strongly related which both need to be well planned to achieve the goals. Professionalization of procurement officers is one of the key determinants to achieve efficiency of digital public procurement, therefore it is critical for public organizations to have the right competence or plan a skill development for the people (Pekolj et al., 2019).

The expertise of public organizations or procurement manpower prove to have an important role in digitalization implementation besides legal arrangement. Countries that already in advance level of digitalization have realized significant benefits in economic growth and increase the functioning of their public sector (Pekolj et al., 2019). Training and education of public procurement staff as well as the supplier claimed to have an impact on the success of electronic procurement system (Ilhan & Rahim, 2020).

2.2.2 Expertise in Climate and Environment

There was a consensus of beliefs that the lack of professional expertise and the existence of competency gaps in the Green Public Procurement domain are seen as barriers to its adoption (Akenroye et al., 2013). Most of the departments related to Green Public Procurement hired staff with a lack of environmental management and/or green economics, while some others concern more about how and where to implement Green Public Procurement (Akenroye et

al., 2013). Public procurement staff in most developing countries and at the municipal government level are often not equipped to assess the greenness of any product or service, therefore it is important to use multiple indicators (Zhu et al., 2013).

According to a survey conducted by OECD in an investigation of the implementation of Green public procurement in National Environmental Policies, found that one of the biggest obstacle is the lack of training for the manpower as well as insufficient information about how beneficial it is to protect nature (Testa et al., 2012). In addition, lack of cooperation between department and lack of management support are two main barriers to the success of green public procurement implementation (European Commission). There are guidelines published by some countries to clarify, product/service groups, and a set of minimum environmental requirements about how green criteria can be synchronized as a part of public tender stages (Testa et al., 2012; Zhu et al., 2013). These tools give a better understanding of how to apply green criteria in public tenders, it could avoid the mistake due to less information in the process (Testa et al., 2012). However, understanding detailed regulatory requirements is also play an important role when green public procurement is adopting and implementing (Zhu et al., 2013).

The success of building the expertise in climate and environment in public procurement is supported by sufficient training to procurement staff, good cooperation between departments, good management support and clear regulation socialization.

2.3 Public Organization's Procurement Strategy

Public procurement in its journey has become more strategic, for instance in 1990 outsourcing contract is preferred rather than direct employment in terms of delivering service to customer (Moe & Päivärinta, 2011). Strategy is important for the organizations to acquire both direct and substantial goals. Procurement activity and organizations grow as they focus on the core competencies and outsource tasks to their business partners (Moe & Päivärinta, 2011).

Public organizations in designing the procurement procedures are not only expecting purchase the desired goods, works or services and satisfy primary needs but also wish to obtain a larger goal of a strategic procurement such as maximize the competition, get the best value for money, minimize corruption, more sustainable procurement, regulation enforcement, innovation, environment sustainability and accessibility maximization (Pekolj et al., 2019). This situation has make public procurement transform from “organizational servants to having a strategic function” (Patrucco et al., 2017).

Strategic action in public procurement often seen from two perspectives, short term by applying superior power in bargaining which results in dramatic cost reduction and long term by planning a good supply chain management (Murray, 2009). Procurement strategies as a driver of public procurement activities play a very significant role. The size of the role of organizations is highly correlated with the objective and responsibility, the higher the role the higher the complexity of the responsibility and the goal (Patrucco et al., 2017).

Public procurement nowadays has dramatically move to more strategic role in achieving government and politician objective (Patrucco et al., 2017). Government currently urge by challenges to acquire the most value for money towards taxpayer money, strategic decision in public procurement bring up more contribution to horizontal policy objectives and social values (Pekolj et al., 2019). However, achieving a large goal is not only through policy that will pathway a good result, but also through good collaboration between stakeholders, other departments and suppliers (Patrucco et al., 2017). Moreover, procurement strategies supposed to aligned with government economic goal and local economic strategy (Murray, 2009).

Strategy implementation vary depending on the organization type and level, one could prioritizing innovation and transparency while the others could highlight efficiency and regional development (Glas et al., 2017). Good public procurement strategy should include wide range of aspects, considering not only one category but multiple category to achieve strategic goals define by government (Patrucco et al., 2017).

Procurement strategy pathway economic development in many countries as significant portion owned by this activity (Reis & Cabral, 2015). In this part we would like to review

topics that are described in the procurement strategies. Four procurement strategies will be reviewed respectively, efficiency (cost savings), digitization of procurement process, climate and environment as well as innovation.

2.3.1 Efficiency (cost savings)

Public procurement in the operation put concern on efficiency as well as quality assurance, supplier relationship, procurement ethics and green procurement (Choi, 2010) unlike the private procurement who prioritize profit maximization above all. Efficiency comes first in public procurement, as the government tries to optimize taxpayer money when purchasing goods, works or services. To improve the effectiveness of the public procurement process, some core principles must be followed, such as the value for money, economy, transparency, quality of products and services, and fair competition, without which the procurement process's efficiency would indeed be criticized (Ali et al., 2021).

There are factors that influence efficiency in public procurement, unnecessary bureaucracy and high transaction costs (Grega et al., 2019). Efficiency is a key factor of implementation digitalization in public procurement. The process has been influenced by technological tools usage, for instance the implementation of electronic procurement has help to increase efficiency as process become streamlined and unnecessary procedures is eliminated (OECD., 2019).

The efficiency of public procurement is significantly important as country spend 15% to 20% of their GDP and approximately contributes to 1% of spending efficiency, as a results of the efficiency country could allocate the savings to the important sector such as health, education, municipal services (Ali et al., 2021). Good public procurement regulations may help governments decrease the pressure on public finances, achieve value for money, and give greater prospects for private investment (Ali et al., 2021).

Efficiency is measured through economy and transparency (Ali et al., 2021). Therefore, the efficient on process such as reduced process time, reduced waiting time or increase handling

capacity need to be measured by the economic impact to the stakeholders, and in the case of public procurement, public organizations who should feel the benefit.

On the case of sourcing, single sourcing collaborative in the long term will be detrimental to public organizations as it narrow the available option and support reduced choice and quality which will result in inefficient (Murray, 2009). Despite efficient operation, single sourcing could end up creating inefficient action. Procurement strategy should take precedence over the temporary short-term plan in order to create a highly efficient procurement process.

2.3.2 Digitization of The Procurement Process

Digitizing public procurement process aims to obtain more benefits which regular public procurement is unable to give. The use of electronic procurement in the EU is by EU directive in public procurement. Digitizing all the process is beyond electronically transform, it rather involving digital tools in various phase of the process and minimizing human intervention (Neupane, 2014). Kramer (2016) mention that paper-based procedure of public procurement brings many negative impacts, one of them is that this procedure brings numerous of source of errors. Government decision of digitize the public procurement process backgrounded by lack of optimum results by the regular procurement.

As explained in a previous part that expertise is an essential tool to implement this strategy besides the legal arrangement. Therefore having manpower with right competence and skill development in organizations is crucial (Pekolj et al., 2019).

As reviewed in previous section that digitizing procurement process could benefits public organizations in many aspects, reduced waiting time (wait for someone to do something), better decision support to management, increased control of the use of allocated budget funds, reduced number of errors and enhance supplier relation management. It expected that Time spent at any stages of procurement process can be reduced as a result of simplification documentation and procedures by digitization implementation (Bobowski & Gola, 2018). The digitization claims to support the streamlining of administrative process with 80 percent of process time improvement (Tayler & Wright, 2018). Digitization make public

procurement able to increase the capability in managing the competition (Tayler & Wright, 2018), especially the participation of small and medium enterprises as it reduce the cause of the not participating, this procurement strategy aim at holistic country's economic growth. The use of analytical tools in public procurement enables advanced data analytics from data generated automatically from electronic procurement to support decision making (Sanchez-Graells, 2019). Digitization in public procurement has become an important driver for the innovation as it solves the problems of efficiency and transparency which improves the use of public funds and spending control (Egorova et al., 2021). Electronic procurement can enhance communication with suppliers by facilitating real-time communication, increased collaboration, and access to information. It is obvious that digitally process will reduce the number of errors as it minimize human intervention, such as what mention by Ilhan and Rahim (2020) about integrating procurer-supplier business system with electronic data interchange (EDI) to minimize errors in data entry.

Technological tools being used by countries to digitizing their procurement process, such as AI (Artificial Intelligent) for product management, Chatbot for procurement information provider and big data for open contracting data standard transformation and analytics, blockchain to enable supplier registration information (European Commision, 2019). Digital technologies are playing an increasingly essential role, the purpose of digitizing public services is to create public value in numerous ways, such as better services, better usage of public resources, and more openness (Mikalsen & Farshchian, 2020).

2.3.3 Climate and Environment

According to the 2015 Paris Agreement about international treaty on climate change it is legally binding, agreed on overarching goal. However, The UN Environment Program (UNEP) has actively approach sustainable public procurement at global, national and regional levels since 2005 (UNEP, 2023). Designing strategies which are greener and more sustainable is backgrounded by these agreements and direction.

European Commission define three procurement initiative to achieve goal at environmental friendly procurement. European Commision (2023b) define green public procurement (GPP)

as public procurement for a better environment, process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured. The main purpose of this program is less environmental impact on procurement process. While sustainable public procurement (SPP) define as process by which public authorities seek to achieve the appropriate balance between the three pillars of sustainable development - economic, social and environmental - when procuring goods, services or works at all stages of the project (European Commision, 2023b). The European Commision (2017b) defines circular public procurement as “the process by which public authorities purchase works, goods or services that seek to contribute to closed energy and material loops within supply chains, whilst minimising, and in the best case avoiding, negative environmental impacts and waste creation across their whole life-cycle. The three types of procurement have similarities that impact to the more environmental friendly, compared to tendering and procuring scenarios based on purchase at the lowest up-front price (Sönnichsen & Clement, 2019).

Unlike traditional procurement, electronic procurement adoption on green procurement consider the impact on environment when procuring the products, it consider also the production on supplier side with the aim on minimizing impact to the environment (Shatta et al., 2020). Regarding this, the government can lead the way in stimulating sustainable procurement management in markets, by demanding environmentally and socially responsible products and services of suppliers, who in turn are likely to offer them to other customers in the market (Walker & Brammer, 2012). Strengthen the statement above, the Norwegian Government wishes consumption and production in Norway to be as sustainable as possible and the public sector, lead the way and set an example through its own procurement processes (Norwegian Ministry of The Environment et al., 2007).

OECD (2023) emphasize the three benefits of implementing green public procurement, first is it can be a major driver for innovation to achieve environmentally friendly works, services, and goods. Second is it may provide financial benefits for public organizations when full life-cycle cost is considered (OECD, 2023). Third is it able to face environmental challenges such as greenhouse gas emissions or moving to further circular economy (OECD, 2023).

Talking about digitization for sustainable public procurement, in EU it has been found that digitization of public procurement is an important trigger of the sustainable, socially-inclusive growth based on innovation, due to improvement in efficiency of public spending, while streamlining and better targeting such procedures and contracts (Bobowski & Gola, 2018).

It is currently more than just a green procurement in the condition of procurement activity with concern on environment sustainability, it is going towards circular economy where it emerged innovation of technologies for public procurement (Sönnichsen & Clement, 2020).

2.3.4 Innovation

Public procurement is the place with a lot of organization and societal transformation, many of the transformation from government initiative implemented in public procurement such as use of internet, and today more innovation emerged such as solution to climate change and global societal challenge (Mikalsen & Farshchian, 2020). The reason of innovation in public procurement is the need of making a strategic contribution on societal values and the best value for public money (Pekolj et al., 2019). As it account for enormous amount of country's GDP, it has the potential to emerged innovations (Alhola et al., 2017). Therefore, innovation is essential for economic growth that will benefits to procurement stakeholders as well as citizens (Pekolj et al., 2019). Public procurement as a government function in fulfilling the needs of country or citizen often find what to be improved to optimize procurement operations in a more efficient way therefore innovation often define as a relation of government and citizens (Mikalsen & Farshchian, 2020). Alhola et al. (2017) argued that innovation is triggered by interaction between procurer and supplier.

Innovation in public sector may occur on a various model such as networked governance, collaborative innovation, open innovation, and new public governance, this concept of innovation emerged digital transformation which cause the impact of the technologies to the individuals, organizations and society (Mikalsen & Farshchian, 2020). Pekolj et al. (2019) emphasize that the professionalization and digitalization make it much easier to obtain innovative public procurement. Based on political construction, in order to provide

breakthrough in innovation, government can create new market segment as a strategic decision or incentivize suppliers to innovate (Mikalsen & Farshchian, 2020).

Digital technologies are playing an increasingly essential role in innovation and are seen as a critical component in addressing our societal concerns, the purpose of digitizing public services is to create public value in numerous ways, such as quality service, better usage of public resources, and more openness (Mikalsen & Farshchian, 2020). Pekolj et al. (2019) note that to increase the economic growth it is important that procurement system not only comply with the law but also make strategic innovative decisions. The objective of innovation in public sector is to increase public services, more effective public administration, transparency and improve government trust (Mikalsen & Farshchian, 2020).

2.4 Productivity

In general, the idea of productivity does not change over time and across situations, where productivity is the relationship between output and input. Therefore, the use and availability of resources are important, so there is no decrease in productivity when resources are not used optimally and keep focus to ensure that all activities and resources can add value to the process and final product (Tangen, 2002). The relationship between input and output will result in a productivity improvement Tangen (2002) describes it in 5 possibility correlation: “(1) Output and input increase, but the increase in input is proportionally less than the increase in output, (2) Output increases while input stays the same, (3) Output increases while input is reduced, (4) The output stays the same while the input decreases, (5) Output decreases while input decreases even more”.

Nowadays the improvement of productivity is also influenced by technology. Understanding the influence of technology is an important issue in order to fully understand the productivity growth (Zhen et al., 2021). Thus, it is important to determine which direction to choose in technological progress to be able to achieve optimal development (Zhen et al., 2021). In private sector, competition may also encourage higher productivity growth with greater incentives to innovate in creating new products and services and win market competition

(Simpson, 2009). Moreover, in the public sector, especially in public procurement, the responsibility to maintain development and cooperation to support is supposed to be one of the criteria to increase productivity to give additional value for competitiveness (Mäki, 2012). However, the measurement of productivity in the private sector is easy to quantify, unlike the measurement in the public sector. The output of the public sector is service; therefore, it is more difficult to calculate.

Productivity growth is the result of using smarter and more efficient methods when doing work by maximizing new production technology and techniques owned or has been prepared by the organization (Brynjolfsson & Hitt, 1998). Nevertheless, some experts believe that the evidence of digitalization impacting productivity is questionable due to several effects. These effects include business readiness for widespread adoption, expenses related to management's attention and efforts toward digital transformation, and the costs and revenue losses experienced by established organizations during the transition (Remes et al., 2018). The famous economist, Robert M. Solow wrote "You can see the computer age everywhere but in the productivity statistics" and it initiate the discussion of technology's impact on productivity and later on, known as the "productivity paradox" phenomenon (Polák, 2017). In other words, the productivity paradox can be described as, "the discrepancy between measures of investment in information technology and measures of output at the national level" (Polák, 2017).

In the field of procurement, like in most organizations, information and communications technology (ICT) has been employed as the primary driving force for innovation in recent times (Lim et al., 2008). For instance, at the beginning of the 20th, assembly lines were promising significant increases in productivity in many industries, however, it is also shown that if an early adopter like General Motor in 1999 were too quick implementing e-procurement technology which results waste of resources (Ageshin, 2001). The current version of the Solow paradox is more intricate than it was in the 1980s, primarily due to the diverse range of technologies in use, specifically, the introduction of intelligent automation yields distinct outcomes in comparison to the adoption of advanced digital technologies (Capello et al., 2022).

Robert M. Solow mentioned four theories that might be the cause of the productivity paradox, there are productivity gains, but there are inadequate or inappropriate methods of measuring it; instances where gains made by some individuals or companies are offset by losses experienced by others; there are time lags in the realization of productivity gains; and the challenge of managing technology effectively (Palmer, 2015). The new research about the Solow paradox derives a policy reflection, investing in technology diffusion to enhance productivity is a valid approach for the most productive sectors and can also prove beneficial for less innovative sectors, as long as there is sufficient time and level of adoption given (Capello et al., 2022).

2.5 Theoretical Framework

Strategy in public procurement is usually top-down direction from management as well as political vision (Mikalsen & Farshchian, 2020) which have influence in the decisions at planning, policy, contracting stages (Neupane, 2014) and budgetary control (Patrucco et al., 2017). Similarly, Alhola et al. (2017) said that procurement strategy is government's platform for innovation and market growth. Procurement strategy implemented by public organizations have significant contribution to value creation and competitive advantage to improve organizational performance (Patrucco et al., 2017).

The economic and strategic benefits of digitizing procurement are real, but the proliferation of competing technologies has made it difficult for companies to figure out where to start (Radell & Schannon, 2019). Digital procurement solutions not only create an opportunity to improve efficiency; they also pave the way for procurement teams to play a strategic role in accelerating innovation. (Radell & Schannon, 2019). Digitization create powerful insight leads public organizations to new solutions and accelerating innovations (Radell & Schannon, 2019), therefore will helps public organizations in implement the strategy.

Public procurement digitization begin overdue due to bad start and unclear return on investment calculation (Radell & Schannon, 2019). However , the wave of digitization prove

to have an impact on government service, led to new services such as internet information, electronic commerce and productivity improvements (Katz, 2017).

Competence define as knowledge and behavior required to perform such operation (Vilpponen, 2021). When designing the strategy, public organizations may face several challenges, therefore, procurement maturity, competency and skills has become a key role to define the components, contents and process of action plan in the strategy (Patrucco et al., 2017). Competency in digital procurement is the key role to successfully execute procurement strategy with the support of digital technologies (Pekolj et al., 2019), digital expertise embrace both procurement strategy and the use of digital tools.

In summary, in the context of public procurement, the relation between digital expertise, digital tools and procurement strategy is that digital expertise enables public organizations to optimally utilize digital tools to facilitate implementation of procurement strategy in the procurement process and further the benefits (Pekolj et al., 2019).

This study is focuses on the relation between procurement strategy and digital public procurement, however, the main aim is to find the level of expertise of public organizations and how digital tools contribute to their procurement process in Norway regarding their characteristics in terms of procurement strategy, therefore research questions begin with RQ1: What distinct segments of procurement strategy can be identified regarding the topics described in the procurement strategy of public organizations? Segmentation is widely used to demonstrate the behavior and demographic of the things being analyzed (Tkaczynski, 2017). The variable included in segmentation is all the procurement strategy, then characteristics analyzed is what will be asked in the next questions.

In Brundtland sustainability diagram, procurement strategies are based on one or more sustainability elements (Ayarkwa et al., 2020). It is important to note that not all procurement strategies primarily consider environmental impact, in many cases procurement organizations may prioritize economic over environment.

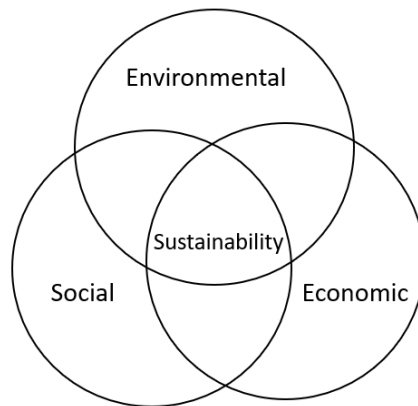


Figure 2. Brundtland elements of sustainability. Adapted from (Porras et al., 2017)

As groups defined, the next research question asks RQ2: What are the characteristics of segments related to expertise and resources and what is the tendency of the public organizations that have sufficient level of expertise and resources? The next leap towards the evolution of procurement is the digitalization of procurement processes therefore it demands that organizations should be digitally savvy (Motaung & Sifolo, 2023). This is required because of the huge amount of information flow that must be captured, analyzed, and interpreted to support real-time business decisions by procurement organizations (Burnson, 2018). Digital skills as well as low knowledge about ability of digital service are necessary to the processing of technology (Vilpponen, 2021). Thus, it is important to understand at what level digital expertise of the public organizations to successfully implement the procurement strategy. Besides, digitization in public procurement process, climate and environment has become a priority focus on government activity. Therefore, expertise of the government entities in implementing the activity related to any sustainability topics become the concern. Not to put climate and environment less important than digitization, in some way, one of digitization goals is to create sustainable system as well as the triggers to sustainability (Bobowski & Gola, 2018).

Furthermore, the third research question is RQ3: What are the characteristics of segments related to the contributions of digital tools? There are multiple digital tools and information technologies which are used to support the process of purchasing and companies' overall procurement (Radell & Schannon, 2019). Many digital technologies such as cloud

computing, socially enabled business services, mobile services for customer engagement, cyber tracking & security, data mining and analytics give contribution in the development of public procurement, it able to enhance quality of process throughout procurement stages (Venkatesh & Sagar, 2019). General agreed on digital tools in contributing to the streamline of the process when it implemented in procurement operations.

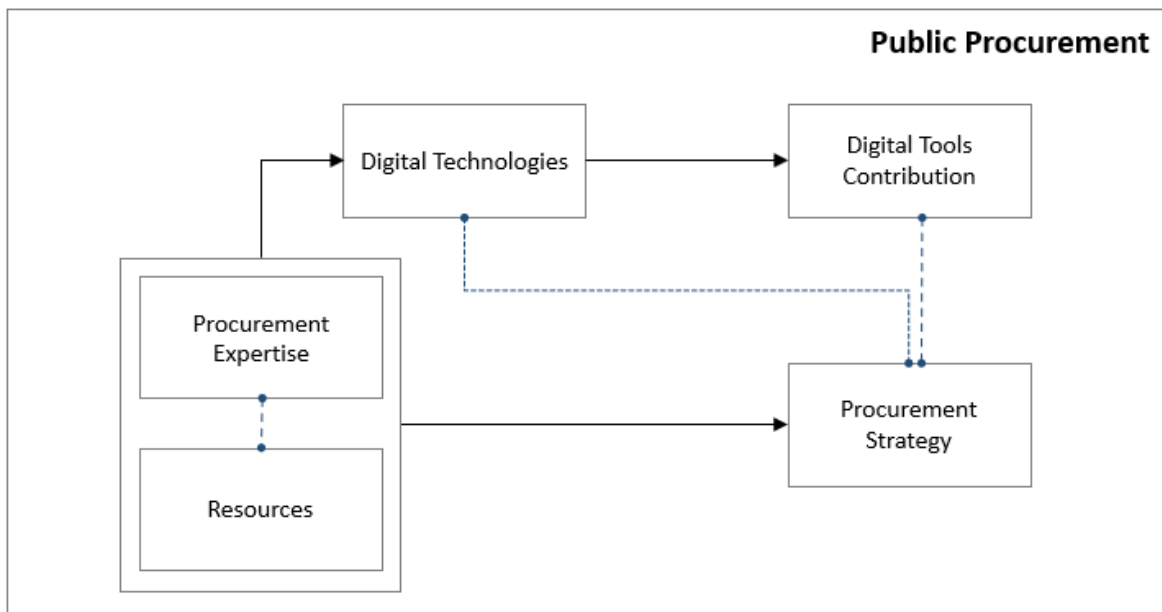


Figure 3. Digital public procurement concept emanated from the study (own illustration)

Figure 3 above shows that sufficient procurement expertise and resources of procurement authorities are obligatory to perform certain procurement strategies. The use of digital tools in public procurement will support procurement authorities in streamlining the procurement process which is described as digital tools contribution. The use of digital technologies will also have an impact on procurement strategies implemented by public organizations.

In conclusion, this chapter has provided a comprehensive understanding about the procurement strategy, procurement expertise and digital tools contribution on procurement process, exploring its principle, process, and challenges. Understanding has been gained as this review brings valuable insights into the world of public procurement. In the next chapter,

we will delve into methods and data. We will explore research approach, methods and purpose utilized as well as explain data collection and uncover how data analysis enabling valuable outcomes for public procurement.

3.0 METHODS AND DATA

In this chapter we will dive into the realm of public procurement, focusing on the key concepts explained in the previous chapter. This chapter explores the tools, techniques, and analytical approaches that enable procurement professionals to make informed choices and valuable outcomes. From data analysis, statistical methods, and research methodologies, valuable insights about procurement operations can be gained.

The chapter begins by exploring research approaches and methods that are suitable for this study. Discussing qualitative and quantitative research as well as various kinds of research methods. The following sub-chapter discusses various types of research purposes, exploratory, descriptive, and explanatory, acting as a guide of selection of appropriate methods and analysis techniques.

The next sub-chapter highlighting the importance of data collection and how data gathered for this study. Next, the chapter delves into data analysis. It introduces techniques and provide analysis to answer research questions as well as data visualization.

3.1 Research Approach and Method

While conducting research, the researchers can choose which approach is most suitable. There are two basic approaches that are commonly used, they are qualitative and quantitative research. Qualitative research deals with qualitative phenomena, that is, phenomena relating to or involving a quality or kind (Kothari, 2004). On the other hand, quantitative research is research based on quantity or quantity measurements, this research is usually suitable for phenomena that can be expressed in quantity (Kothari, 2004). This approach can be further sub-classified into inferential, experimental and simulation approaches. *Inferential approach* is when researcher need to form a data base from which to infer characteristics or relationships of population, usually it came in a form of survey. *Experimental approach* is when the research environment characterised by much greater control over, and some variables are manipulated. *Simulation approach* involves the construction of an artificial

environment, to observe dynamic behaviour under controlled conditions. For our research question, we are trying to analyse secondary data from previous research survey. Therefore, according to previous explanation, we believe that quantitative research with inferential approach is most suitable.

Furthermore, Research methods are the basis of scientific research that describes how to build systematic knowledge (Patten, 2017). Regardless of the method chosen, social science research methods are designed so that research can be carried out in a systematic manner and minimizes bias (Patten, 2017). There are five most used research methods, experiments, surveys, archival analyses (secondary data), histories, and case studies. Yin (2009) states that each strategy has its own strengths and weaknesses depending on these several condition; type of research question, the extent of control and researcher has over actual behavioral events, and the degree focus on contemporary as opposed to historical events.

Following the condition mentioning above, it is clear that our research question is trying to find what the segmentation of public organizations based on procurement strategy in Norway and identifying the characteristics in the procurement expertise and contributions of digital tools. Our research required no control of behavioral events and not focus on contemporary events. Thus, we can conclude that archival analysis is a suitable method for this research.

3.2 Research Purpose

The research design serves to produce the collection of relevant evidence with minimal expenditure of effort, time and money, but this can be achieved depends on the research purpose (Kothari, 2004). There are three different groups of research purpose, exploratory, descriptive, and explanatory. *Exploratory research* often focuses on generating hypotheses rather than testing them and has a tendency to use qualitative data (examples: brainstorming sessions, interviews, short survey) (Sue & Ritter, 2007). This research is suitable when it is difficult to define the research problem and there is uncertainty in what models to use (Parida & Parida, 2005).

Very often *descriptive research* aim is to describe characteristics of populations based on data collected from samples, it often requires the use of a probability sampling technique, such as simple random sampling (Sue & Ritter, 2007). Once the generalization of characteristic begin to appear, it can lead to theory development (Parida & Parida, 2005). Descriptive research is focused and designed only to explain the distribution of existing variables, and ignores causation or other hypotheses (Grimes & Schulz, 2002).

The main purpose of *explanatory research* is to provide an explanation of why a phenomenon occurs and to provide a predictor of future events. Most of the time this research using quantitative data and almost always demand statistical test to ensure the validity of the relationships (Sue & Ritter, 2007). In addition, explanatory research outcome should be abstract analogies the researcher believed had been generated from observation, instead of summaries of statistical relationship (Kalleberg et al., 2004).

Cluster analysis and statistical test to 381 observations gathered from the same number of public organizations will be performed in this research to answer the research questions mentioned above. Based on that reason, our research purpose is most compatible with explanatory research.

3.3 Data Collection

Data or collection of information may be collected during a study, or as a result of an experiment, or during an observation, or through census or survey (Mazhar et al., 2021). Data may be of two types, primary and secondary data. Primary data are data collected for the specific research problem, it is originally data for specific research goal (Hox & Boeije, 2005). While secondary data is data which include the data that have previously been collected by someone else and have already undergone the statistical process (Mazhar et al., 2021). As researchers around the world collect large amounts of data, the practicality of using existing data for research is becoming more prevalent (Johnston, 2014). Social scientists who intend to study particular theoretical problem or specific policy issue have choice to collect their own data or to use relevant existing data (Hox & Boeije, 2005). When

the relevant information on the research topic is accessible, the data will be the answer of new research question, smooth the initial stage of a project, or provide the researcher with a wider sample base for testing interpretation at far less cost and less time consuming (Hox & Boeije, 2005). Therefore, our master thesis will be based on secondary data on primary research “Maturity in Public Procurement”.

In the spring of 2020, a survey was conducted to gather data for the primary study, Maturity in Public Procurement. The data collection was carried out by Directorate for Administration and Financial Management (DFØ) with assistance from the consultancy firm Rambøll Management Consulting, via a digital questionnaire, the participants were public procurement managers working in various public sector organizations, including municipalities, counties, state agencies, and state-owned enterprises. The main objective of the survey was to collect relevant information to enhance public procurement practices. The questionnaire covered a wide range of topics, such as human resource competence, control and leadership, digitalization, climate and environmental concerns, and innovation. The selection of respondents was carefully considered to ensure suitability. The participating managers possessed a diverse range of knowledge pertaining to the questionnaire's subject matter and had access to the necessary information required to answer the questions accurately. A total of 769 organizations were provided with the questionnaire, out of which 403 responses were received, resulting in a response rate of 52 percent. In order to maintain data quality, responses with excessive missing values related to the target variables were excluded. As a result, the final sample consisted of 381 observations.

Besides the benefit derived from using secondary data, the most common limitation to the secondary data analysis method approach is “inherent in its nature” in that the data were collected. The specific information that needed by the researcher would like to have may not have been collected; or there will be problems with geographic region of interest, time, or the specific population that are the focus of the research. However, ensuring a match between the research questions and the existing data and carrying out a careful reflective check and critical evaluation of the data, can avoid most of the limitations of secondary data analysis (Johnston, 2014).

Following the steps for choosing the technique of data collection in a particular type of study is important in order to make sure the data chosen is accurate and answer research question. These are four steps to follow for choosing data collection type: consider the time required; calculate the number of interviews require; time to carry out the interviews; determine the available time for study. Secondary data are data originally collected for a different purpose and reused for another research question (Hox & Boeije, 2005). While secondary data has many advantages, it can also have limitations such as incomplete or inconsistent data. To address these limitations, we will carefully evaluate the quality and reliability of the data and make any necessary adjustments to ensure its suitability for our research.

The survey questions and results we use are gathered from the same number of participants, 381 public organizations. They are:

Table 1. Survey questions and response options

	Questions	Response Options
A	<p>What topics are described in the procurement strategy?</p> <ol style="list-style-type: none"> 1. Efficiency (cost savings) 2. Digitization of the procurement process 3. climate and environment 4. Innovation 	<p>0 - Not selected</p> <p>1 - Selected</p>
B	<p>To what extent do you feel that the business has sufficient expertise in the following areas when implementing procurement:</p> <ol style="list-style-type: none"> 1. Digitization of procurement 	<p>1 - To a very small extent</p> <p>2 - To a small degree</p> <p>3 - To some degree</p>

	2. Climate and environment	4 - Largely 5 - To a very large extent 99 - Do not know
C	We have enough time and resources to clarify needs and prepare competitions in a good way	1 - Completely disagree 2 - Disagree 3 - Neither agree nor disagree 4 - Agree 5 - Totally agree 99 - Do not know
D	To what extent do digital tools contribute to efficiency in the following areas: 1. Reduced time spent (per task) 2. Reduced waiting time (wait for someone to do something) 3. Better decision support to management 4. Increased control of the use of allocated budget funds 5. Reduced number of errors	1 - To a very small extent 2 - To a small degree 3 - To some degree 4 - Largely 5 - To a very large extent 99 - Do not know

Respondents could choose one option for each question in Table 1. Respondents need to respond to all four detail questions under scope “topics described in the procurement

strategy” and seven questions under scope “To what extent do digital tools contribute to efficiency in the following areas”, means totally twelve questions need to be answered.

Table 2. Responses of procurement strategy

Variable – Procurement Strategy	Total	
	N	%
<u>One option chosen</u>		
Climate & environment	18	4.7%
Digitization of the procurement process	4	1.0%
Efficiency	6	1.6%
<u>Combination of two</u>		
Climate & environment, Innovation	6	1.6%
Digitization of the procurement process, Innovation	1	0.3%
Efficiency, Climate & environment	6	1.6%
Efficiency, Innovation	1	0.3%
Efficiency, Digitization of the procurement process	14	3.7%
Digitization of the procurement process, Climate & environment	15	3.9%

<u>Combination of three</u>		
Digitization of the procurement process, Climate & environment, Innovation	9	2.7%
Efficiency, Digitization of the procurement process, Innovation	2	0.5%
Efficiency, Climate and environment, Innovation	18	4.7%
Efficiency, Digitization of the procurement process, Climate & environment	30	7.9%
<u>Combination of four</u>		
Efficiency, Digitization of the procurement process, Climate & environment, Innovation	78	20.5%
<u>Not choosing at all</u>		
Not select	173	45.4%

Question about procurement strategy allow respondent to choose more and less than one procurement strategy, as a result there will be a combination up to four of chosen procurement strategy per public organization as well as only one procurement strategy and not choosing at all.

Table 3. Response of procurement expertise

Variable – Procurement Expertise	Total	
	N	%
Digitization of Procurement		
1 - To a very small extent	13	3.4%
2 - To a small degree	39	10.2%
3 - To some degree	119	31.2%
4 - Largely	138	36.2%
5 - To a very large extent	66	17.3%
99 - Do not know	6	1.6%
Climate and Environment		
1 - To a very small extent	18	4.7%
2 - To a small degree	74	19.4%
3 - To some degree	157	41.2%
4 - Largely	98	25.7%
5 - To a very large extent	28	7.3%
99 - Do not know	6	1.6%

Table 4. Response of Resource and time availability

Variable – Have Enough Resources and Time	Total	
	N	%
1 - Completely disagree	24	6.3%
2 - Disagree	126	33.1%
3 - Neither agree nor disagree	113	29.7%
4 - Agree	102	26.8%
5 - Totally agree	13	3.4%
99 - Do not know	3	0.8%

Table 5. Response of digital tools contribution on efficiency in procurement process

Variable – Digital Tools Contribution	1 –		2 –		3 –		4 –		5 –		99 –	
	To a very		To a small		To some		Largely		To a very		Do not	
	N	%	N	%	N	%	N	%	N	%	N	%
Reduced time spent (per task)	62	11.1%	16	7.8%	15	4.8%	107	15.7%	120	18.8%	61	22.4%
Reduced waiting time (wait for someone to do something)	79	14.1%	29	14.1%	52	16.7%	103	15.1%	81	12.7%	37	13.6%
Better decision support to management	85	15.2%	41	19.9%	74	23.8%	82	12.0%	76	11.9%	23	8.5%

Increased control of the use of allocated budget funds	91	16.3%	57	27.7%	76	24.4%	93	13.6%	47	7.4%	17	6.3%
Reduced number of errors	73	13.1%	16	7.8%	23	7.4%	103	15.1%	115	18.1%	51	18.8%

Scalable answers are used for survey responses to questions about procurement expertise in digitization and climate and environment, enough resources and time, and to what extent do digital tools contribute to efficiency of procurement process.

3.4 Data Analysis

As mentioned above, in this research we will analyze the secondary data. We believe that the data is appropriate for my research because it was collected using rigorous methods and has been widely used in previous studies.

To answer research question one, cluster analysis is conducted on topics described in the procurement strategy of public organizations to obtain the segmentation. In this research, segmentation on public procurement strategy aims to have a better understanding about the characteristics in digitization of procurement process and procurement expertise.

Cluster analysis is very common to create a segmentation from survey responses, it is often used by researchers to identify the homogenous group (Halpern et al., 2021). Two-step cluster analysis will be used to obtain the segmentation in this research. Two-step cluster analysis used because it can process categorical variables (Rundle-Thiele et al., 2015) which what we have in this study, it capable to process input with more than three categories (Tevdovski, 2009). This cluster analysis method proved to be better than the traditional one (Tkaczynski, 2017), it is the reason why we decide to use two-step cluster analysis to get the

segmentation. The two-step cluster analysis will be performed using the statistical package available in SPSS. It is a two-stage process cluster that includes pre-clustered process and refining the initial group. As SPSS will be used in this research, so that data transformation before data analysis is not required (Rundle-Thiele et al., 2015).

As the first step, initial data is pre-clustered (Rundle-Thiele et al., 2015). Tkaczynski (2017) state that the aim of this step “is to reduce the size of the matrix that contains distances between all possible pairs of cases. The algorithm selects a subset of the data to create the initial small clusters (Tevdovski, 2009). As the categorical variable used in this analysis then log-likelihood distance measure will be employed (Tkaczynski, 2017). In this step, the algorithm allow maximum number of cluster to be specified at the beginning (Tevdovski, 2009).

The second step is the clustering step or process of merging, re-calculation, re-merging and refining and finally grouped into determined number of cluster (Tevdovski, 2009). In this step, the subclusters are merged into the best clusters already produced or new based on the Schwarz’s Bayesian information criterion (BIC) (Rundle-Thiele et al., 2015). Schwarz’s Bayesian information criterion (BIC) used because it can helps researchers to prevent the algorithms from creating arbitrary clusters which usually happen if traditional method employed (Rundle-Thiele et al., 2015).

Silhouette measure of cohesion and separation needed to assess the quality cluster produced, it need to be above required level 0.0 so that cluster quality can be finalized (Rundle-Thiele et al., 2015). As can be seen in the Silhouette measure of cohesion and separation graph, when it is above 0.2 the quality of clusters produced is fair and moreover it needs to be above 0.5 to be rated as good quality of clusters. Another aspect is predictor importance, it determine the importance of the input used for cluster analysis, considering the importance level of the variable is necessary to define the final solution, least important variable might be excluded in order to obtain better quality of the clusters (Tkaczynski, 2017).

Regarding research question two, independent t-test employed to see the significant difference between variables tested. The first t-test is performed between clusters against expertise and resources variable, the aim of the test is to see how significantly different each

variable between clusters is. The second t-test is to test variable of procurement strategy to the related resources and expertise. The aim of the test is to see how characteristics of public organizations significantly different regarding their resources or expertise are between who apply certain procurement strategy and who are not. From the test, it is expected that characteristics related to their expertise and resources of the clusters can be explained.

Regarding research question three, it goes similarly like what will be done in research question two, independent t-test employed to see the significant difference between variables tested. The t-test ran to see the significant difference between clusters and the contributions of digital tools in their procurement operations. The test is expected to bring the conclusion about how different the clusters in terms of benefits from digital tools perceived. Both t-test in research question two and three are performed in SPSS.

The observations related to procurement strategy (four variables) which responded as “not selected” will be treated as a missing value and eliminated. Public organizations which do not select any procurement strategy are probably implementing other strategies so that it is incorrect to imputing the missing value. Observation with answer “Do not know” at all the scalable required answers will also be treated as missing value that will be eliminated. In the case of many potential eliminated rows due to missing value, imputing missing value with mean value will be done as deleting certain number of observations will results to the quality of data analysis because it may not be enough to represent the characteristics of the original data set.

4.0 FINDINGS

In this section the findings from data analysis are presented.

4.1 Cluster Analysis

Four inputs (variables) are used for cluster analysis. They are all variables related to procurement strategy, Efficiency (cost savings), Digitization of the procurement process, Climate and environment and Innovation. Prior to cluster analysis process, 173 observations were found to be missing value as they answered all procurement strategy options with “not selected”. As a result, 173 observations are eliminated, and the cluster analysis continues using 208 observations with proper value. All the inputs used are treated as categorical variables in this cluster analysis. As mentioned above, Schwarz’s Bayesian Criterion (BIC) and log-likelihood are used.

SPSS computes fourteen clusters. According to the lowest Schwarz's Bayesian Criterion (BIC) coefficient, the best number of clusters is nine (Table 6). However, according to the largest ratio of distance computed in SPSS, the optimal number of clusters is eight. The cluster distribution is shown in Table 7.

Table 6. Auto-clustering from SPSS

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change ^a	Ratio of BIC Changes ^b	Ratio of Distance Measures ^c
1	948.114			
2	686.340	-261.774	1.000	1.662
3	537.290	-149.050	0.569	1.264
4	423.831	-113.458	0.433	1.510
5	355.902	-67.929	0.259	1.476
6	316.751	-39.151	0.150	1.125

7	284.332	-32.419	0.124	1.182
8	260.207	-24.124	0.092	1.828
9	256.681	-3.526	0.013	1.232
10	257.841	1.160	-0.004	1.079
11	260.485	2.644	-0.010	1.124
12	265.199	4.715	-0.018	3.213
13	281.371	16.172	-0.062	1.356
14	298.902	17.531	-0.067	. ^d

^a. The changes are from the previous number of clusters in the table.

^b. The ratios of changes are relative to the change for the two-cluster solution.

^c. The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

^d. Since the distance at the current number of clusters is zero, auto-clustering will not continue.

Table 7. Cluster Distribution from SPSS

Cluster	N	% of Combined	% of Total
1	19	9.1%	9.1%
2	78	37.5%	37.5%
3	15	7.2%	7.2%
4	21	10.1%	10.1%
5	15	7.2%	7.2%
6	18	8.7%	8.7%
7	12	5.8%	5.8%
8	30	14.4%	14.4%
Combined	208	100.0%	100.0%
Total	208	-	100.0%

Table 8. Cluster distribution with variable details

Cluster	1	2	3	4	5	6	7	8
N	19	78	15	21	15	18	12	30
Efficiency	•	•		•			•	•
Digitization of the procurement process		•	•	•	•			•
Climate and environment	•	•	•		•	•	•	•
Innovation	•	•	•	•				

Distribution of cluster with detail of variable can be seen in Table 8. The number of members of cluster 2 is significantly higher compared to the other seven clusters, it is 78 or 37.5%. Second highest is cluster 8 with 30 population. Cluster 4 situated third with 21 population. Fourth is cluster 1 with 19 members. Fifth is cluster six with 18 members. Sixth and seventh are clusters 3 and 5 with the same number of members, 15. Eighth is cluster 7 with 12 members in the cluster.

The quality of cluster produced is good, it is above minimum expectations to be measured as good, 0.5. The algorithm produces cluster with silhouette measure of cohesion and separation value of 0.9 (see Figure 4).

All the inputs are shown to be an important variable for this cluster creation. All the inputs score more than 0.8 in predictor importance (see Figure 6). Innovation is the most important variable, digitization of procurement process situated second position, the third is efficiency and the last is climate and environment.

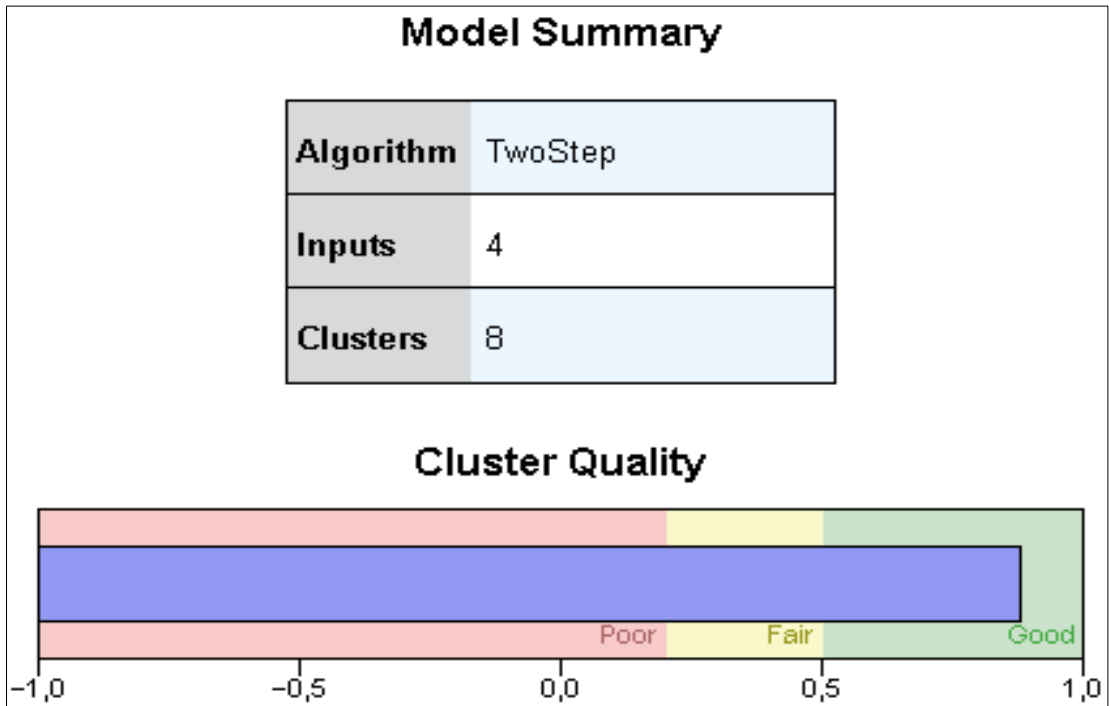


Figure 4. Silhouette measure of cohesion and separation

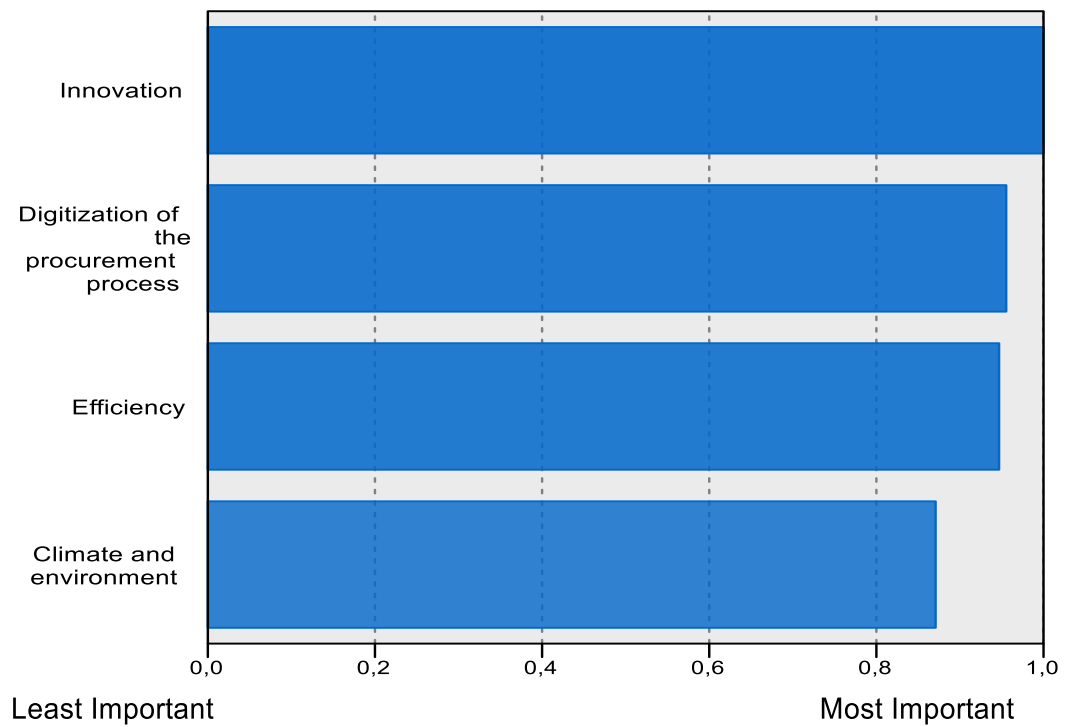


Figure 5. Predictor importance of inputs

In response to research question one, regarding the number of clusters and number of cluster members, we process the cluster into smaller numbers. All the respondents need to fit into one of the new clusters according to new segmentation. The new segmentation has been labelled as “Advanced Strategic Organizations (Advance)”, “Intermediate Strategic Organizations (Intermediate)” and “Selective Strategic Organizations (Selective)” to reflect the varying degree of public organizations strategy. Advanced clusters belong to public organizations applying all four strategies. The cluster is the same as the original cluster generated by SPSS, Cluster 2. Intermediate clusters are public organizations who implement procurement strategy efficiency, digitization of procurement process, climate and environment but not innovation. The cluster is the same as the original cluster generated by SPSS, cluster 8. While these two clusters remain from the original, other six clusters (cluster 1, 3, 4, 5, 6, and 7) are merged into one new cluster named selective clusters which having combination of two or three procurement strategies as well as only one procurement strategy (see Table 8), however the number of populations is relatively low compared to advanced clusters and intermediate clusters.

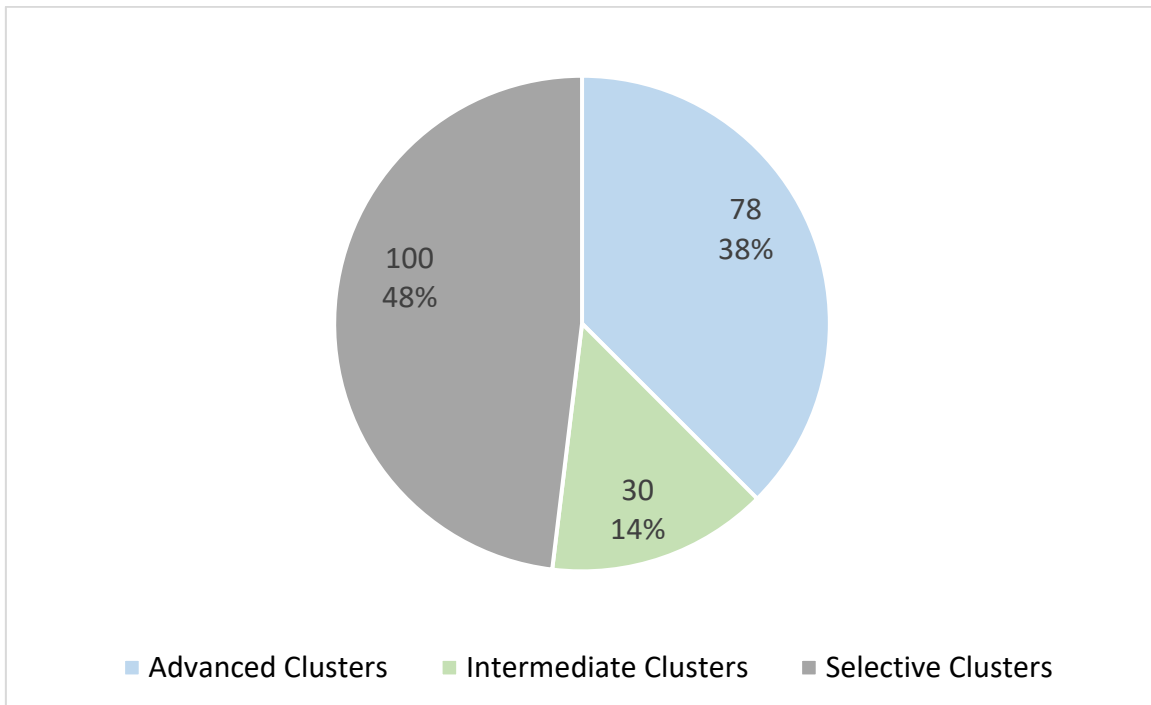


Figure 6. New cluster distributions

4.2 Statistical Test

In response to research question two, regarding the characteristics of segments related to expertise and resources and the tendency of the public organizations that have sufficient level of expertise and resources, mean value of all cluster shown in Figure 7. It basically shows that advanced clusters have the highest score of all the expertise and resources and time compared to two other clusters.

Regarding the expertise in digitization of procurement, advanced clusters scores mean an average of 4.13 while intermediate clusters is 4.00 and selective clusters have a mean value of 3.54. Regarding expertise in climate and environment, advanced clusters again highest in mean value with 3.46, while intermediate clusters scores lower mean value than selective clusters, intermediate clusters 3.07 and selective clusters 3.15. Regarding resources and time, the same mean value scored by both advanced and intermediate clusters while selective clusters scores lower mean value, 2.87.

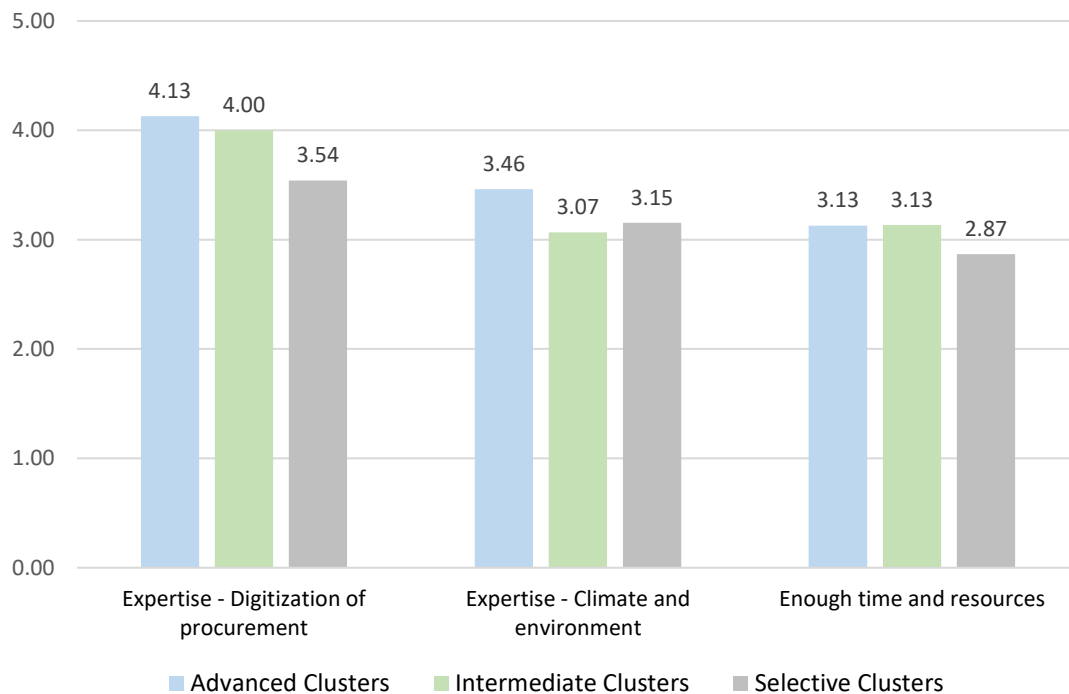


Figure 7. Average means value of expertise and resource and time of clusters

The significance difference between each cluster is then examined to see if the cluster is significantly higher in expertise and resources and time. T-test is performed between procurement strategy and related property, procurement strategy in digitization of procurement process with the expertise in digitization of procurement process, procurement strategy in climate and environment with expertise in climate and environment, procurement strategy in efficiency and innovation with resources and time.

Table 9. T-test results for each cluster according to expertise and resources

Variable / Test Variable	Characteristics / Group Variable	N	Mean	df	p-value
Expertise - Digitization of procurement	Advanced clusters	78	4.13	106	0.22
	Intermediate clusters	30	4.00		
	Advanced clusters	78	4.13	174	0.00
	selective clusters	98	3.54		
	Intermediate clusters	30	4.00	67	0.00
	Selective clusters	98	3.54		
Expertise - Climate and environment	Advanced clusters	78	3.46	106	0.02
	Intermediate clusters	30	3.07		
	Advanced clusters	78	3.46	174	0.02
	Selective clusters	98	3.15		
	Intermediate clusters	30	3.07	126	0.34
	Selective clusters	98	3.15		
Enough time and resources	Advanced clusters	78	3.13	106	0.49
	Intermediate clusters	30	3.13		
	Advanced clusters	78	3.13	174	0.04
	Selective clusters	98	2.87		
	Intermediate clusters	30	3.13	126	0.09
	Selective clusters	98	2.87		

Prior to t-test and mean value comparison, two observations found to have missing value. One observation has respondent answer “do not know” on question about expertise and climate and environment, and another observation has respondent answer “do not know” on question about expertise in digitization of procurement. The treatment to these two observations is elimination, therefore, mean value comparison and t-test done are to 206 observations.

Expertise in digitization of procurement process found to be significantly different between advanced clusters and intermediate clusters compared to selective clusters (see Table 9). The p-value of advanced clusters against intermediate clusters is 0.22 ($p > 0.05$) means that the clusters is not significantly different, and the assumption is the mean value of both clusters are around the same. While t-test of advanced clusters and intermediate clusters against selective clusters is significant as p value is 0.00, much lower than 0.05, means that the mean value of advanced clusters and intermediate clusters is significantly different. Therefore, the assumption is advanced clusters and intermediate clusters confidently having a higher mean value compared to selective clusters regarding the expertise in digitization of procurement.

The situation in t-test in expertise in climate and environment is different compared to the former. advanced clusters are found to be significantly higher than the other two clusters. The p-value of advanced clusters compared to intermediate clusters is 0.02 and the same p-value occurred when advanced clusters compared to selective clusters. While p-value when intermediate clusters and selective clusters compared is 0.34.

Regarding Enough time and resources, advanced clusters are significantly higher than in mean value compared to selective clusters with p-value 0.04 but not to intermediate clusters (p-value 0.49). While intermediate clusters and selective clusters documented p-value 0.09.

Besides clusters, the variable of expertise and resources also test to both observations implementing certain procurement strategy or not. The properties of the t-test of procurement strategy according to expertise and resources are shown in Table 10.

Table 10. T-test results for each procurement strategy according to expertise and resources

Variable / Test Variable	Characteristics / Group Variable	N	Mean	df	p-value
Enough time and resources	0 / Not select Procurement Strategy - Efficiency	52	2.94	204	0.29
	1 / Procurement Strategy - Efficiency	154	3.03		
Expertise - Digitization of procurement	0 / Not select Procurement Strategy - Digitization of the procurement process	54	3.56	78	0.01
	1 / Procurement Strategy - Digitization of the procurement process	152	3.93		
Expertise - Climate and environment	0 / Not select Procurement Strategy - Climate and environment	27	3.04	44	0.05
	1 / Procurement Strategy - Climate and environment	179	3.29		
Enough time and resources	0 / Not select Procurement Strategy - Innovation	91	2.96	204	0.26
	1 / Procurement Strategy - Innovation	115	3.04		

The t-test on variable resources to procurement strategy of efficiency and innovation shows that they are having insignificant mean value (p-value 0.26 and 0.29) between public organizations implementing the procurement strategy and not implementing. While different situations happen in the results of both expertise. The value of expertise in digitization of procurement between public organizations implementing procurement strategy in digitization of procurement process and not implementing is significantly different as p-value is 0.01. The value of expertise in climate and environment between public

organizations implementing procurement strategy in climate and environment and not implementing is significantly different as p-value is 0.05.

In response to research question three, the mean value of all cluster against all five contributions of digital tools is being examined. The mean value comparison between clusters can be seen in Figure 8. The mean value situation of all the cluster is different in each group of digital tools contribution. For instance, advanced clusters have the higher mean value in reduce time spent, 3.94, and the other two clusters have the same mean value with 3.80, while in reduce waiting time advanced clusters has the lowest mean value, 3.17, while intermediate clusters are 3.38 and selective clusters are 3.36. Intermediate clusters have the lowest mean value in both groups support to management and increased control of budget, while in these two groups advanced clusters have the highest mean value and selective clusters are second. Regarding the reduced number of errors, intermediate clusters have the highest mean value, 4.05, while intermediate clusters are the lowest and advanced clusters are second.

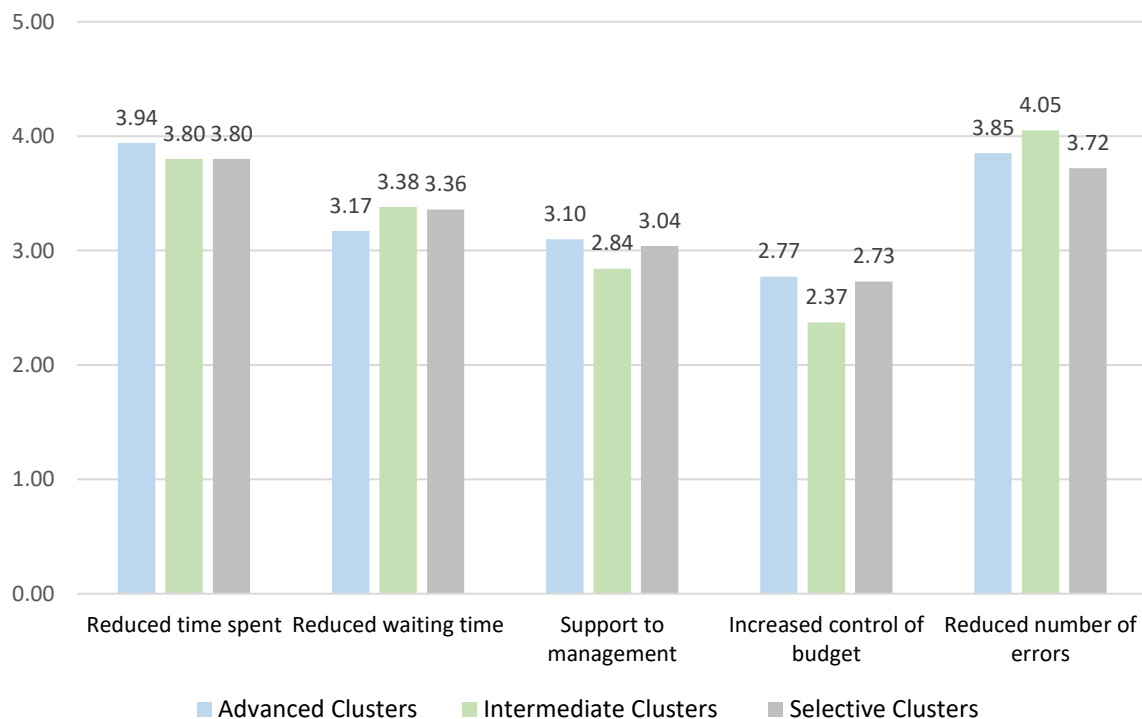


Figure 8. Average means value of digital tools contributions of clusters

The significant difference between each cluster is then examined to see if the cluster is significantly higher in terms of digital contribution score. T-test is then performed between clusters and digital tools contribution. In this case we will use all 208 observations as no missing value, respondent answer “do not know”, found.

Regarding the reduced time spent, no significant difference is found between clusters. The p-value of all clusters is found to be far more than 0.05 (see Table 11). The p-value of t-test between advanced and intermediate clusters is 0.27, the p-value of t-test between advanced clusters and selective clusters is 0.11, and the p-value of t-test between intermediate clusters and selective clusters is 0.50. The assumption to this t-test is that mean value of all clusters relatively the same as there are no significant difference found between clusters.

The same situation happens to another group of t-test, reduced waiting time, support to management and increase control of budget (see Table 11). All p-value are found to be far more than 0.05 which means that the mean value between clusters is not significantly different. The t-test group of reduced number of errors shows slightly different results, the p-value of t-test between advanced clusters and intermediate clusters is 0.14 and t-test between advanced clusters and selective clusters is 0.13. The different results on this group are t-test between intermediate clusters and selective clusters where mean value found to be significantly different.

Table 11. T-test results for each cluster according to digital tools contributions

Variable / Test Variable	Characteristics / Group Variable	N	Mean	df	p-value
Reduced time spent	advanced clusters	78	3.94	40	0.27
	intermediate clusters	30	3.80		
	advanced clusters	78	3.94	176	0.11
	selective clusters	100	3.80		
	intermediate clusters	30	3.80	37	0.50
	selective clusters	100	3.80		

Reduced waiting time	advanced clusters	78	3.17	106	0.19
	intermediate clusters	30	3.38		
	advanced clusters	78	3.17	176	0.09
	selective clusters	100	3.36		
	intermediate clusters	30	3.38	39	0.48
	selective clusters	100	3.36		
support to management	advanced clusters	78	3.10	106	0.15
	intermediate clusters	30	2.84		
	advanced clusters	78	3.10	148	0.34
	selective clusters	100	3.04		
	intermediate clusters	30	2.84	38	0.23
	selective clusters	100	3.04		
Increased control of budget	advanced clusters	78	2.77	106	0.06
	intermediate clusters	30	2.37		
	advanced clusters	78	2.77	149	0.40
	selective clusters	100	2.73		
	intermediate clusters	30	2.37	40	0.08
	selective clusters	100	2.73		
Reduced number of errors	advanced clusters	78	3.85	106	0.14
	intermediate clusters	30	4.05		
	advanced clusters	78	3.85	176	0.13
	selective clusters	100	3.72		
	intermediate clusters	30	4.05	128	0.02
	selective cluster	100	3.72		

5.0 DISCUSSION

The objective of the study aims to respond to the research problem, to what extent do public organizations differ in their strategic focus, and how can these variations be classified and

analyzed to gain insights into public procurement practices? To provide structured answer, three research questions designed, (1) “What distinct segments of procurement strategy can be identified regarding the topics described in the procurement strategy of public organizations?”, (2) “What are the characteristics of segments related to expertise and resources and what is the tendency of the public organizations that have sufficient level of expertise and resources?” and (3) What are the characteristics of segments related to the contributions of digital tools?

In response to research question one, public organizations in procurement operations are grouped according to their procurement strategy using cluster-based segmentation analysis. Three distinct segments for procurement strategy of public organizations are Advanced, Intermediate, Selective. The Advanced is the group that runs all four procurement strategies. The Intermediate is the group that runs all procurement strategy except innovation. The Selective is the group that either runs one or three procurement strategies, aligned with the name, this group is selective in deciding the procurement strategy implemented shown by the low number of respondents on each subgroup before merged into one group.

The segmentation is necessary as it is not possible to address all the preference or combination of procurement strategies implemented by public organizations. The finding demonstrates three different groups with their preference in procurement strategies. The first group, Advanced (38%), represents the public organizations that play vital roles in achieving government objectives as they cover all four important strategic plans in their procurement process (Patrucco et al., 2017). Public organization like this generally contribute to economic goal strategy (Murray, 2009).

The second group, Intermediate (14%), possess a similar procurement strategy implemented except innovation. These types of public organizations tend to cover wide range of government direction into procurement strategy but unwilling to emerge strategic contributions that will leads to improvement or creating new value (Mikalsen & Farshchian, 2020; Pekolj et al., 2019). The group with the most members, Selective (48%), represents that the majority of the public organizations contribute less to strategic roles or can be said not playing a strategic role or in government objective. Half of the members of this group cover three procurement strategies and the rest cover one and two procurement strategies.

This group is deemed as a non-transformed group that does not function strategically, signifying that their role within the organization is primarily that of organizational servants (Patrucco et al., 2017).

In response to second research question, respondents that belong to the Advanced are more likely to have higher level of procurement expertise in general compared to other two groups and respondents that belong the Intermediate are more likely to have higher level of procurement expertise compared to the last group, Selective. Regarding the expertise in digitization of procurement, the t-test shows a significant difference on the test between the Advanced and Selective as well as the Intermediate and Selective but not on the Advanced and Intermediate. Meaning that respondents that belong to Advanced and Intermediate clearly have higher level of expertise in digitization compared to Selective groups.

The public organizations having the expertise in digitization of procurement tend to digitize their procurement operations by implementing the strategy as well as the public organizations having the expertise in climate and environment tend to make the procurement process more sustainable. There seems to be no significant difference between either group of public organizations who implement and not implementing procurement strategy efficiency with time resources they have. The same situation also happens to procurement strategy innovation. This means that there is no tendency for public organizations to implement this strategy because they have adequate resources and time.

The interpretation of the results shows that the more expertise and resources owned by public organizations, the more advanced procurement strategy implemented. When the public organizations owned the necessary competency, they tended to advance their procurement plan. The study support the idea that in order to achieve the goal of what has been planned in the strategy they need to ensure that sufficient levels of competency are owned (Pekolj et al., 2019). It is believe that the public organizations with lower levels of competency will have less procurement strategy, as the lack of expertise seen as the barriers to its adoption (Ilhan & Rahim, 2020).

They who do not have sufficient competencies tend to have less strategy implemented, the clearest results are in the “expertise in digitization of procurement”, the Selective is the one

that have the least competence, as a result they have a smaller number of strategies in the body compared to other two groups. The benefits from implementing procurement strategy is wide, but having the competency as the core support of the implementation is fundamental (Pekolj et al., 2019).

This indicates that the level of expertise possessed by the public organizations plays a crucial role in determining the extent to which the procurement strategy is effectively incorporated into their action plan.

In response to the third research question, the results show that there is no significant higher contribution of digital tools in procurement process perceived by the public organizations except on the “reduced number of errors”, the Intermediate clearly perceived higher contribution by performing digital tools than Selective.

The interpretation of the results shows that although the test proves which public organizations have higher and lower digital expertise, results from the following test tells that almost all variables being tested is not significantly have higher results between groups. Similar results occur in all the group tests. Roughly referring to the mean values, the majority of test results is Advanced shows they obtain higher contribution level of digital tools while as shown in Table 11 that each test related to how far digital tools bring contribution in procurement process, the majority says they are insignificant. The results indicate that although some public organizations have relatively higher competency at digitization than other public organizations, they do not obtain higher contributions level at the end. According to what is shown in the significance difference between groups, public organizations that have more complex strategy and less strategy implemented are also relatively perceived the same level of contribution from digital tools. Productivity due to the use of digital tools in procurement process is seen relatively not much changing, it indicates that productivity paradox in procurement process occur. It might be occur because of inadequate or inappropriate methods of measuring it or ineffectively managing the technology (Palmer, 2015).

These findings do not fit with the theory that having an advanced level of competency brings significant benefits, as at this study the level of benefits seems insignificantly different.

Many sources claim that training and development is needed to correct the system as insufficient expertise claim to minimizing the use digital tools in the practice (Pekolj et al., 2019). Despite considering themselves highly competent, the organizations involved in this study were found to possess insufficient expertise to fully leverage the technology.

6.0 CONCLUSIONS

6.1 Research Summary

This study aimed to analyze the public organizations in their strategic focus and aim to classify and analyze these variations to gain insights into public procurement practices. The analysis includes procurement strategies, procurement expertise and the digital tools contribution in the procurement operations of public organizations. Public organizations' procurement action plan drive by procurement strategy decided, the expertise and resources served as a tool to achieve the goals while contribution of digital tools seen as proof of modern procurement process.

This research analyzes the public procurement organizations in Norway using secondary data and perform explanatory research on the data. Cluster analysis and statistical tests are used to answer the research questions. The research questions help the study to structure the explanation.

The findings revealed that the more sophisticated public organizations in terms of procurement strategy implemented, the higher the level competency owned. Although the level of competency is higher, the findings show that there is no significant difference in the benefits of implementing digital tools in procurement process with the public organizations who owned the lower level of competency.

In conclusion, the findings indicate a clear correlation between the advancement of procurement strategy and procurement expertise which expected since the beginning of the study, while no substantial evidence supports the relationship between advanced public organizations and procurement expertise or the benefits of digital tools in procurement which assumed that productivity paradox occur on the procurement operations.

6.2 Managerial Implications

The findings of this study carry important managerial implications for public organizations engaged in procurement activities. One key aspect highlighted in the study is the positive correlation between a sophisticated procurement strategy and procurement expertise. This suggests that public organizations should prioritize the development of their procurement expertise and allocate sufficient resources before implementing their procurement strategies, especially when dealing with complex combinations of procurement strategies.

To achieve this, it is crucial for organizations to focus on cultivating a certain level of procurement expertise among their staff. This involves investing in training programs, workshops, and continuous professional development opportunities to enhance the skills and knowledge of procurement personnel. By doing so, organizations can build a competent and capable procurement team that can effectively implement sophisticated procurement strategies.

Furthermore, the study sheds light on the uncertain correlation between procurement expertise and the contribution of digital tools in the procurement process. Public organizations should assess their maturity level in managing technologies and ensure that their procurement teams have the necessary skills to optimize the usage of digital tools.

In order to evaluate the performance and effectiveness of procurement activities, organizations should establish appropriate measuring methods. These methods can help assess the impact of procurement expertise and the utilization of digital tools on overall procurement outcomes. By having reliable performance metrics in place, public organizations can make informed decisions and identify areas for improvement, ultimately maximizing their procurement efficiency and effectiveness.

It is important for public organizations to carefully consider these factors to avoid wasteful investments and potential productivity paradox. By ensuring that the procurement team possesses the necessary expertise, optimizing the use of digital tools, and establishing effective performance evaluation mechanisms, organizations can minimize the risk of ineffective procurement processes and resource misallocation. This, in turn, can lead to

improved productivity and better utilization of resources within the organization especially when it comes to effectively implementing complex procurement strategies.

6.3 Limitations of The Study

This study was limited to analysis of 381 public organizations in Norway. The other limitation is the selection of variables for data analysis. The variables were selected due to the relevance with research problem, there may be other variables that could have been included but not considered. Regarding the data selection, the study did not consider variables that could be affected by the external factor like relation with supplier.

Another limitation is the use of secondary data which may contain errors or inaccuracies that could impact the precision of the data analysis. Whilst taking steps to guarantee the quality of the data, it is plausible that some errors may have gone undetected.

Finally, the study focused exclusively on variables: four procurement strategies, two procurement expertise, one resource and five contributions of digital tools.

6.4 Suggestions for Further Research

To further advance the understanding of the relationship between procurement strategy, procurement expertise, and digital tools in public organizations, future research could explore the dynamics and trends over a specific time period. Researchers can gain valuable insights into how procurement strategies and expertise evolve and impact procurement outcomes over time.

Another suggestion to delve into deeper understanding is to employ a qualitative approach. By utilizing qualitative research methods, researchers can delve into the intricacies and nuances of the procurement process, allowing for a more comprehensive exploration of the factors influencing procurement outcomes.

Another recommendation for further research is in the scope of procurement strategy. This study currently includes only four procurement strategies, to improve the accuracy of public organizations being analyzed. Therefore, future research should aim to incorporate a wider range of procurement strategies to provide a more comprehensive understanding of the diverse approaches employed by public organizations.

Additionally, to include contributions of digital tools which related to external factors like communication with suppliers and performance related to number of suppliers in competitions for further research. Such additional variables are believed to bring broader perspectives of public organizations characteristics related to the benefits on digital tools in procurement process.

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8.0 APPENDICES

Original Survey Question:

variableName	variableDescription
a_2_4	A2. Hvilke temaer beskrives i anskaffelsesstrategien? - Effektivisering (kostnadsbesparelser)
a_2_5	A2. Hvilke temaer beskrives i anskaffelsesstrategien? - Digitalisering av anskaffelsesprosessen
a_2_11	A2. Hvilke temaer beskrives i anskaffelsesstrategien? - Klima og miljø
a_2_12	A2. Hvilke temaer beskrives i anskaffelsesstrategien? - Innovasjon
c_7	C7. I hvilken grad opplever du at virksomheten har tilstrekkelig kompetanse på følgende områder ved gjennomføring av anskaffelser: - Digitalisering av anskaffelser
c_9	C9. I hvilken grad opplever du at virksomheten har tilstrekkelig kompetanse på følgende områder ved gjennomføring av anskaffelser: - Klima og miljø
c_14	C14. Vi har tilstrekkelig med tid og ressurser til å avklare behov og forberede konkurranser på en god måte
f_14	F14. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Redusert tidsbruk (pr. oppgave)
f_15	F15. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Redusert ventetid (vente på at noen skal gjøre noe)
f_16	F16. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Flere leverandører (pr. konkurranse)
f_17	F17. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Bedre beslutningsstøtte til ledelsen
f_18	F18. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Økt kontroll på bruk av tildelte budsjettmidler
f_19	F19. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Bedre kommunikasjon med leverandør
f_20	F20. I hvilken grad bidrar digitale verktøy til effektivisering på følgende områder: - Redusert antall feil