Centralized vs. Decentralized Procurement: A Literature Review

Edgars Kanepejs and Marite Kirikova

Riga Technical University, Latvia
edgars.kanepejs@rtu.lv, marite.kirikova@rtu.lv

Abstract. Often centralization is viewed as a means for complexity reduction, as well as a means for achieving higher efficiency. However, in reality this is not always true. This systematic literature review examines different aspects of centralization vs. decentralization in the procurement domain. The results of the review give a better insight into benefits and drawbacks of centralization and decentralization; and help to find the ways of proper combination of both centralized and decentralized methods in procurement. While procurement as a specific domain is in focus of the paper, still the results might be interesting also for researchers and practitioners working in other domains where the centralization and decentralization issues are relevant.

Keywords: Centralized systems, Decentralized systems, Procurement, Types of centralization.

1 Introduction

In this paper we address the problem of centralization and decentralization which often has to be handled in complex business and other types of systems. There are particular benefits and drawbacks in decentralized and centralized activity handling. The purpose of this research was to analyze related work on centralization and decentralization in one domain to have a practical and manageable scope of research. While there are many works on centralization and decentralization, an overall survey of different aspects of them so far is missing. In this paper we close this gap of research in one area by providing a literature review in the context of procurement systems. Procurement is defined as all activities that are required in order to get the product or service from the supplier to its final destination [1], [2]. The aim of the review of related works is to examine existing researches while finding evidence of positive and negative impacts caused by both centralized and decentralized procurement systems. The procurement context was chosen due to a particular problem that had to be solved in a middle-sized construction company that had to deal with the problem of finding the effective way to obtain materials for different construction sites. It was less expensive to by larger amounts of materials, but this had to be balanced with the specifics of construction sites and resources needed for materials redistribution. The review

presented here was used as background knowledge in designing new procurement procedures in the company.

The paper is structured as follows. Section 2 presents the research method used. Further sections are explaining the research results on different aspects of centralization and decentralization. Section 3 concerns the structure of organizations that are performing procurement activities. Section 4 considers types of centralization. Section 5 discusses the notion of degree of centralization. Benefits and drawbacks of centralization and decentralization are amalgamated in Section 6. Section 7 concludes the paper with a brief conclusion.

2 Literature Review Method

For clear understanding for reader and convenient usage of results, the review should be based on some structure [3], [4], because initially established review execution structure reduces potential misinterpretations, bias or gaps. In this paper the review is based on the structure suggested in [3] and reflected in Fig. 1. It consists of 10 stages combined in three phases. This literature review model comes from the research area of software engineering; however, it is appropriate for being used to execute literature review on procurement systems, because it is rather universal and includes all necessary steps in logical sequence.

The first step is to identify questions that should be answered during the review. These questions will largely determine what data should be extracted from previous studies and what should be entered in search engines. The questions are based on the research objectives stated earlier and they are:

- What benefits and drawbacks come from a centralized procurement?
- What benefits and drawbacks come from a decentralized procurement?

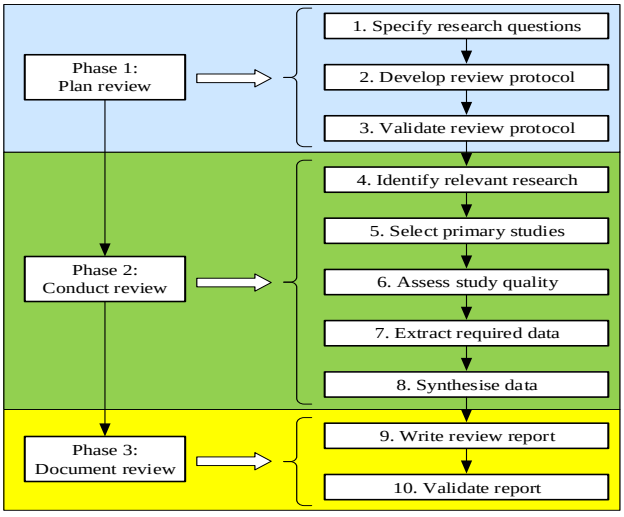

Fig. 1. Literature review process [3]

The second step is to develop a review protocol that defines plan, specifying procedures to follow and conditions to take in consideration during the selection of primary studies. It lists:

- What databases will be used?
- What types of resources will be used (research articles, conferences, books)?
- What will be used as search strings in automated searches (keywords, phrases)?
- What parts of articles will be used for search (titles, abstracts, conclusions, full text)?
- What will be the eligibility criteria?

The search was executed in IEEE, Springer, ACM, Science Direct, Wiley and DOAJ resources; also Scopus and Web of Science indexes were considered. The entered search strings were:

- Centralized procurement;
- Decentralized procurement;
- Procurement centralization;
- Procurement decentralization.

The search criteria were set to *Articles*. The search was performed among articles written in English. To retrieve recent trends, creation date was set between year 2010 and 2018.

Articles were considered for review according to inclusion criteria:

- Article provided answer to research question;
- Article provided relevant information that could be useful for achieving research objectives.

Articles were rejected according to exclusion criteria:

- Article did not provide answer to any of questions.
- It was not possible to retrieve any information that could be useful for achieving research objectives or suggesting future research related to research objectives.

The article selection started with automatic search comparing article titles and texts to entered search strings. Then all articles that conformed to other pre-set conditions like language and publication year were individually opened and reviewed. Initial review consisted of reading just abstracts for each article. If the abstract featured any of inclusion criteria, then the article was considered for reading its full text. If abstract did not contain any of including criteria, then the next step was trying to find evidence of relevant information judging by titles of article sections and conclusions. If they did not reveal any signs of useful information for research objectives, then the article was excluded from the future use in this research. If there was at least one of including criteria fulfilled, then the article qualified for reading its full text. However, if after reading the full text it turned out that the article did not provide any appropriate information after all, it was excluded from further consideration. Knowledge from those articles, what were not excluded after reading full text, formed the scope of the literature review.

The literature search and application of article selection criteria resulted in the list of 27 relevant articles. All these articles provided evidence of potentially useful knowledge for the research objectives. Obviously, all the articles were based on information obtained from other previous research, and, in some cases, it was necessary

to search deeper for the original information source and increase the number of reviewed articles. Fig. 2 represents home countries of academic institutions involved in developing research articles identified by the original literature search. It shows the countries, where in the last decade issues regarding procurement centralization have been explored. They include such global economic powers as the United States, China, Japan, India and Europe's Germany and Great Britain.

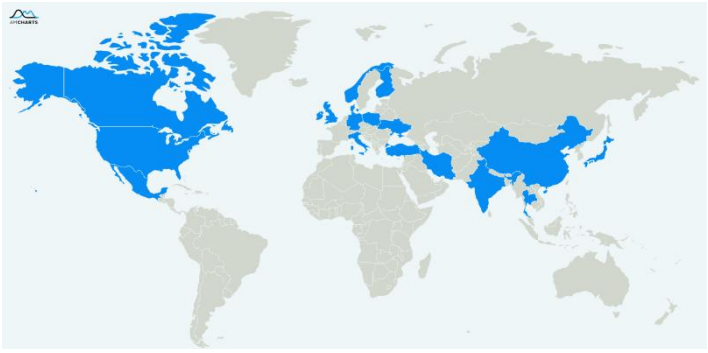

Fig. 2. Research geographical distribution. (Created with AMCharts Pixel Map Generator)

Although the selected articles provided sufficient amount of relevant information to satisfy the research objectives, they did not fully satisfy all previously stated questions. Numerous researches had identified large number of positive and negative aspects that could be caused by implementing a centralized or decentralized procurement system. However, practically, none of them provided a clear sequence of actions that shapes procurement execution in a centralized or decentralized system. During the review two general characteristics of the articles were outlined. They can be grouped either by type institution they are dedicated to or by type of the research method (see Table 1).

Table 1. Reviewed article comparison by the context

		Type of institution	
		Public institutions	Private enterprises
Research method	Descriptive	[1], [5], [6]	[1], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18]
	Mathematical	[19], [20], [21]	[2], [17], [21], [22], [23], [24], [25], [26], [27], [28], [29]

Two types of institutions featured in the articles are public institutions – governmental entities, and private enterprises. Types of research method are a descriptive analysis of a model application in different situations or a mathematical model that eventually serves to support decision making. Some of the articles contain both values, so they

can be included in several groups. Most of initially selected articles contained research about processes in private enterprises. Slightly larger part of researchers had used descriptive approach.

3 Structure of a Purchasing Organization

Procurement is defined as all activities that are required in order to get the product or service from the supplier to its final destination [1], [2]. Procurement refers to a process in which organizations establish agreements for the acquisition of goods or services or purchase of goods or services in exchange of payment [1]. In most of reviewed articles words "*procurement*" and "*purchasing*" were used as synonyms. Previous studies have reviled that centralization is only one of structural characteristics of a purchasing organization. Glock in his research [15] has identified six main structural characteristics of a purchasing organization. They are centralization, standardization, specialization, formalization, involvement, and configuration.

All the characteristics are gathered, together with supply chain questions and types of organizations, in a diagram that is reflected in Fig. 3. It represents key study objects in the reviewed articles. Red line in Fig. 3 outlines study objects for this review. To reach better result in the procurement process, selection of degree of centralization is not the only variable that should be adjusted. It should be complemented with improvements in the area of specialization, formalization and standardization [18] that will be investigated more closely, too. Supply chain management questions like calculation of order quantity or replenishment period will not be widely studied.

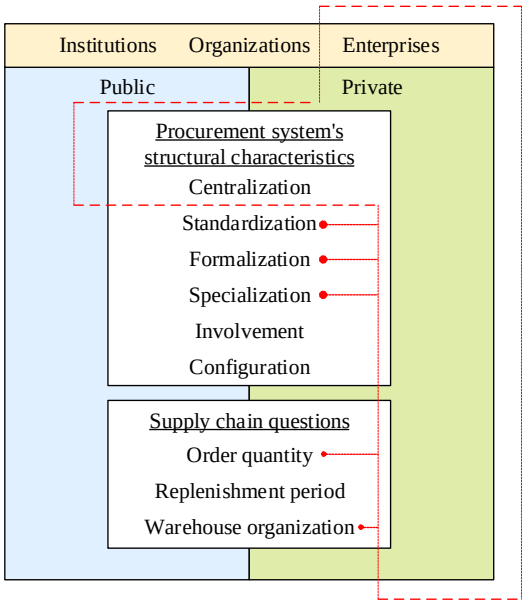

Fig. 3. Research outline

The structural variable called configuration refers to the design of the authority structure of the organization and includes dimensions such as vertical and lateral spans of control, criteria for segmentation and numbers of positions in various segments [15], [30]. A high degree of configuration in purchasing results in a purchasing organization that implements a high number of different design elements, such as positions, departments, formal communication channels or control structures. Another system design element that may be summarized under heading "configuration" is the hierarchical position of the purchasing department [15]. The position of organizational unit helps to assess the status this unit has in the organization and the degree to which an organizational unit can influence decisions on the strategic and tactical levels [31].

Involvement is a structural character that is rather similar to configuration. They both describe physical structure of purchasing organization. Involvement may be subdivided in lateral involvement and vertical involvement. Lateral involvement measures the number of separate departments, divisions or functional areas participating in the purchase decisions, but vertical involvement measures the number of hierarchical levels involved [32]. As the number of departments involved in the purchasing process increases, more information becomes available, which helps to reduce uncertainty [15].

Another structural characteristic is formalization. It describes the degree to which an organization relies on rules and procedures to direct the behavior of its members [33]. Formalization can be achieved by defining roles and authority relations or by establishing rules that regulate decision process, the communication of employees, or the processing of information in the organization [34]. The definition of roles and authorities along with the description of rules, procedures and policies should be reflected in formal documents [17], [35]. Organizations formalize the behavior of their members to reduce its variability and to predict and control it [15]. Higher degree of formalization is achieved by establishing rules, regulations and guidelines that dictate how each procedure is supposed to be executed ensuring that identical operations are performed identically by different members of the same organization. One benefit of high degree of formalization, possibility, is to switch among employees from different organizational units with the same everyday responsibilities. Since one type of procedure in whole company is executed in the same way, no additional training is required. Formalization is all about reducing variability in process and it is opposite to creativity. That can result in reduction of employee motivation and finally lead to lower efficiency. In other words, formalization is standardization of procedures.

Several authors define standardization of process similarly to formalization. The only difference is that formalization require establishment of tangible documents. However, Quintens, Pauwels and Matthyssens regarding standardization of purchasing have conceptualized three distinct dimensions [36]:

- Purchasing process standardization;
- Product standardization;
- Purchasing personnel standardization.

Although their provided definition: "*standardization of purchasing process is defined as the degree to which purchasing takes place in a standardized way*", does not

say much about purchasing, they have identified the following four main phases of purchasing process:

- Investigation of the market and screening of suppliers;
- Supplier selection;
- Negotiation and contracting;
- Supplier evaluation and follow-up.

Product standardization is defined as the degree to which characteristics of the product that is bought are standardized in the same way throughout the company [36]. Using a set of the same components or materials that are used in production of different final products would provide reduction of types of materials. Standardization of purchasing staff is a unified way how employees and their tasks are structured and organized throughout whole organization.

Another structural characteristic is specialization that refers to the division of labour in the organization [15], [37]. Specialization is subdivided in two directions – by functions or by objects. Functional specialization implies jobs being broken down into simple and repetitive tasks that may be efficiently executed. Object-oriented specialization helps to reduce interface problems since employees are responsible for different tasks that are logically interconnected [15]. Employees, who are specialized in specific fields, may perform particular tasks more efficiently than those, who have wide range of different responsibilities. In addition, specialization may provide higher procurement quality, because the likelihood that an experienced specialist would make a mistake is lower than for employee who has to take care of different kinds of tasks.

Centralization is defined as the degree to which authority, responsibility and power are concentrated within an organization or buying unit [11]. The degree of centralization – decentralization in purchasing organizations is the structural variable that has most often been used in purchasing research [15]. Different aspects and consequences of centralization and decentralization will be described in detail in further sections.

Similarly, structural characteristics are described in research articles [6] and [11]. However, the authors call them differently – micro-level dimensions of purchasing and supply chain organization. One alteration comparing to division in [15] is that involvement and configuration are combined and substituted by participation. In addition, they propose that distinction of the previously mentioned characteristics is not enough to fully describe and analyse a procurement system. Therefore, they provide four macro-level dimensions [11]:

- Category;
- Business unit;
- Geography;
- Activity.

In a category based division, departments or employees are organized by what is procured. It can be, for instance, separation by raw materials, outsourced services or manufacturing equipment. Business unit based structure implies that, for instance, procurement functions are organized within business units. Geographical division means that departments are organized according to geographical location. In activity

dimension departments are organized by certain process into different activity clusters [11], [6].

4 Types of Centralization

One of definitions for centralization is “the degree to which authority, responsibility and power are concentrated within an organization or buying unit” [11], [30]. The literature review has revealed that in previous studies two different constructs have been meant by the centralization. Suppose, in one company different organizational units individually purchase materials directly from different suppliers. This is a fully decentralized procurement system and it is represented in Fig. 4, with arrows representing directions of orders.

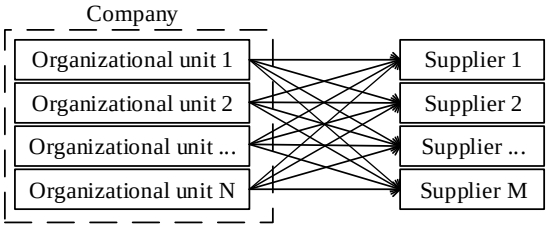

Fig. 4. Representation of decentralized procurement system

The two types of centralization that are used by the authors of the reviewed articles are centralization of outgoing orders and centralization regarding number of suppliers. They can be referred as internal centralization and external centralization. Strangely enough, none of the articles provided an explanation of which of these types the study is referred to. Moreover, no one has mentioned such classification.

Centralization of outgoing orders is when all organizational units in the company according to the structure of macro-level dimensions, mentioned in the previous subsection, place orders for required materials to their internal procurement departments, which summarize them and then place orders to material suppliers. It is discussed in [1], [6], [8], [10], [12], [14], [15], [18], and [19]. Fig. 5 illustrates this type of centralization.

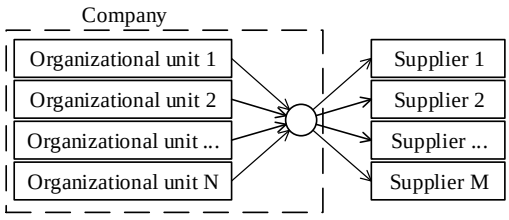

Fig. 5. Representation of centralized procurement system with internal procurement department

Centralization regarding number of suppliers means that most of materials are provided by one supplier and it is responsible for dealing with wholesalers [5], [7], [9], [22], [26]. Fig. 6 illustrates this type of centralization. Research works that were dedicated to this type of centralization mostly contained evaluation of risks that were depending on only one supplier.

As another structural organization oriented option, an assessment of exclusion of the procurement functions is provided; in other words – outsourcing. Outsourcing in the context of purchasing and supply management refers to transferring tasks, such as order placement and source selection, outside the boundaries of the firm [6], [29]. Previous studies provide conflicting opinions about potential benefits of outsourced material procurement functions. Several researchers [6] used data that predicted that outsourcing of purchasing and supply management is expected to grow by near future (data from year 2014). However, other studies claimed that the costs of procurement were lower for integrated systems [24].

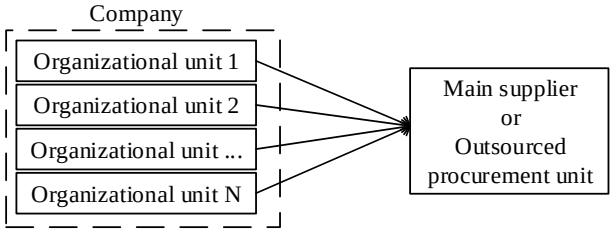

Fig. 6. Representation of centralized procurement system with one main supplier

5 Degree of Centralization

Very rarely firms use completely centralized or completely decentralized procurement systems. Decentralized systems could be more frequently found in new businesses – not because of choice or decision, but usually because of the lack of experience and management skills. Centralization is very common in public procurements. Public institutions tend to have larger buying centres and use a higher degree of specialization, formalization and complexity in organizing their purchasing functions. That might be caused by legal regulations, which require that public funds have to be spent transparently and which necessitates a formal and complex public purchasing process [15]. The service supply chain differs from a manufacturing supply chain to a certain extent because a quality product (service) requires a careful coordination of all activities [14]. Service providers cannot store their products – services in warehouse. They must perform when the customer is present, very similar to just-in-time production. Manufacturing companies and project based companies have a stronger tendency to decentralize or more often partially decentralize their purchasing activities [15], [8].

Most companies use a hybrid system that contains elements of both centralized and decentralized systems. It is an attempt to obtain benefits from both systems at the same time excluding drawbacks of both systems. Centralization or decentralization of

a purchase structure depends on how the responsibilities are divided [6]. The success of any supply chain system depends on its level of collaboration and integration [24]. This proposes that in order to achieve more successful procurement all business units have to cooperate. Cooperation between different business units has been studied in several articles. One of them provides comparison to autonomous intelligent agents. The agent paradigm originates from the distributed artificial intelligence domain. Three types of agents and corresponding three types of behaviours of separated business units were identified [21]:

- Cooperative agent – aims at maximizing the sum of the agents' profits. Similarly, it is a business unit that works in a manner that serves for increasing total profit for whole company, even though that could mean losses or require more effort from the particular units.
- Self-interested agent – wants to maximize its own profit and has no interest in others' well-being. This is close to situation with full decentralization where each unit individually takes responsibility for its performance, receiving awards and punishment individually.
- Hostile agent – also aims at maximizing its utility which increases with its own profit but decreases when the competitors' profits increase. It is even higher level of individualism than in self-interested agent's case. From the perspective of top management that kind of behaviour of business units is unacceptable.

The way how the agents – business units – are supposed to behave should be regulated by company's internal documents and structure that everyone must comply to. Three decisions that should be made regarding the degree of centralization are the following: (1) whether to price centrally, (2) whether to actually purchase centrally and (3) whether to store the materials in a central warehouse [12].

The first option is price individually. Each business unit or department select their suppliers and negotiate on prices separately. That logically leads to individual purchasing and delivering directly from supplier's factory or warehouse to warehouse, production plant or construction site assigned to the business unit. This is complete decentralization.

The second option is centralized pricing that requires negotiation with vendors about company-wide contracts that includes fixed prices for orders from all business units. At the same time each unit can place orders, purchase and store materials individually. Goods are delivered directly from supplier's factory or warehouse to a location assigned to the business unit. This is called centralized pricing with decentralized purchasing [12].

The third option contains centralized pricing and centralized purchasing. The items are purchased from one location and delivered to a central warehouse where they may stay for some time until requested for distribution to the individual sites

The fourth option is centralized pricing and purchasing without central warehouse. The company purchases the items from a supplier and all items are delivered to a location assigned to the business unit. Purchases are made on a periodic basis, so this represents a type of joint replenishment problem [12].

6 Positive and Negative Aspects of Centralized and Decentralized Procurement Systems

There are positive as well as negative aspects of both, centralized and decentralized procurement structures. As the most of authors of the reviewed articles consider centralized procurement system as more mature and sorted out; this section of the review will start listing benefits that could be obtained with centralization.

Procurement centralization creates purchasing synergy benefits, which can be divided into three main categories [31], [18]:

- Economies of scale;
- Economies of process;
- Economies of information and learning.

Economies of scale refer to attaining lower unit costs by increasing market power through volume bundling and standardization of categories [31], [18]. Centralized procurement could provide maximum discount from the supplier, because large quantity of required materials in one purchase allows supplier to feel safe about higher revenue and it would be willing to reduce the price. Some cost estimates of the savings achieved through centralized purchasing have been presented in the literature, and they vary between 10% and 20% comparing to the decentralized purchasing [18]. In purchasing the two most common quantity discount forms are [12]:

- All units – the lower price applies to all units purchased, not just those above the price break;
- Incremental – only those units within a price break interval receive that interval's discount.

Economies of process mean less administrative work and a decrease in administration duplication in addition to reduction of purchasing organization expenses as a purchasing synergy benefit [18]. The company that is making the purchase should at first collect information about material requirements from all units internally. That would reduce number of outgoing orders and incoming invoices, what would reduce work load on accountants who register expenses. The same improvement would happen on supplier's side as well leading to mutually beneficial cooperation. It is convenient for modern management and reduces the management on repeating actions [8].

Economies of information and learning mean sharing all available purchasing knowledge on suppliers, new technologies, internal users, applications and the prevention of mutually incompatible negotiating strategies [18]. Centralization often enables companies to assign certain categories of items to specialists, who tend to be more efficient because they are able to concentrate their efforts on relatively few categories, which they are responsible for when negotiating the agreements [31]. Several authors emphasize importance of a unified reasonable bid evaluation program that allows dealing with all suppliers in already established understandable way [8]. Bid evaluation program can help to reduce time on decision making in supplier selection. Most companies do not form an effective evaluation system; they still adopt subjective methods such as the review of vendor qualification, consulting the vendor's promotional materials and so on to evaluate suppliers [25].

One more advantage for centralized bulk procurement is a limited number of suppliers. While, this is not an advantage as such, it would provide a limited number of used material brands that could improve quality control. Using the same material in whole company is an increase in other structural variable – standardization, and it would reduce risk of shortage of materials, because in case of sudden need for extra materials, it is possible to borrow materials from other departments safety stocks. It is quite often that working with different materials requires specific knowledge and skills. Limited number of brands of the same type of material would reduce the set of knowledge and skills required to successfully execute construction works. That would allow quick integration in work for construction employees rotated from other departments without any additional time-consuming training.

Centralized procurement is not without drawbacks. The disadvantages of centralization stem largely from attitude problems, such as maverick buying, and difficulty of controlling process remotely. Another identified problem is related to excessive overhead costs and slow response to divisional matters [33], [18].

Reduced number of orders usually means reduced number of deliveries. That allows reducing cost on transportation. Especially big improvement would be achieved with relatively cheaper materials comparing to transportation cost. Cost for dry land transportation by trucks basically consists of fuel, salary for the driver and maintenance for the truck. However, researches show that, for example in construction, instead of collecting all deliveries in the warehouse and then distributing materials to construction sites, it would be more cost and time efficient to send materials directly to the construction site [8]. This works for big deliveries, when it is possible to load full truck with materials required by one construction site. Regarding difficulties in making decisions about the most suitable material transportation strategy, decentralized procurement system could provide better cost economy for projects with construction sites on remote locations [20]. If distances between central warehouse or supplier that would be selected according to lowest price offered for the centralized procurement and construction site or manufacturing plant, or any other type of place, where materials are supposed to be consumed are too huge, that positive advantage achieved by discount for big centralized order would disappear. Or even expensive transportation in that case can make the centralized procurement structure disadvantageous comparing to the decentralized structure. Decentralized procurement buying locally and having direct deliveries from supplier to constriction site can be more suitable decision for geographically distributed projects.

Many tasks in companies are based on projects with defined schedules. If one company is working on several projects at the same time, project development for different projects most probably are in different phases as well as defined material usage schedule. That could propose that for project based business model decentralized procurement procedure would be more suitable, because it would be easier to purchase materials considering just one project without taking in account needs for other projects. Another positive feature for decentralized procurement is flexibility. That is very important while working on tight schedules. Suppose that it is necessary to urgently buy more materials, because it has happened that something has been broken during the assembly or has not been ordered in a required number in the first

place. Pushing the order through a centralized procurement system would take a lot of time or even cause delay of whole project that could cost in fines. Fast and flexible procurement system could prevent from that.

Another reason for choosing decentralization is related to reducing risks related to sudden supplier failure to supply [22], [9]. This is a problem for regions with high probability for natural disasters like Japan, where earthquakes are common thing. An earthquake can damage supplier's manufacturing facility and it is unable to ensure deliveries that could cause blockage of production processes. Solution for that could be diversification in number of suppliers. It means working with several suppliers at the same time with proportion of delivered materials according to price, probability of breakdown and recovery time [22]. When one supplier breaks down, there is hope that deliveries from other suppliers keep coming and they could even compensate the missing supplier.

There are researches, which conclude that organizations with a centralized procurement structure perform only slightly better than those with decentralized. The results indicate that organizational structure is not necessarily the primary factor in obtaining superior procurement performance [10]. What makes bigger influence on cost reduction is improvement in procurement processes like unified purchasing, inventory and billing. Market analysis helps to select the most suitable solution. If there is one system understandable for everyone, it is easier to monitor and adjust the processes.

7 Conclusion

This paper contributes a literature review on centralization and decentralization issues in the domain of procurement. It amalgamates knowledge on the following issues of centralization and decentralization: (1) the issues of organizational structure, (2) types of centralization, and (3) degree of centralization. The review revealed that procurement centralization creates purchasing synergy benefits, which can be divided into three main categories: economies of scale, economies of process, and economies of information and learning; it also helps have a high level of standartization. The disadvantages of centralization stem largely from attitude problems, such as maverick buying, and difficulty of controlling process remotely. Other identified problems are related to excessive overhead costs and slow response to divisional matters. The benefits of decentralized procurement are fast action, flexibility, and reducing risks related to sudden supplier failure to supply. The drawback of centralized procurement is the lack of synergetic benefits mentioned above.

Finding the right balance between centralization and decentralization is a problem of high complexity. Knowledge amalgamated in this article may help to solve this problem. This knowledge has been successfully applied in a middle-sized construction company for developing its procurement processes and procedures.

While the knowledge presented here concerns solely a procurement domain, it still can be useful in other domains to the extent that the aspects discussed in this paper are applicable in these domains.

References

1. Pongsuwan, P.: How does procurement capability maturity affect e – procurement adoption and leverage purchasing in supply chain. International Journal of business and Economic Development, vol. 4(3), 45–54 (2016).
2. Giri, B. C., Bardhan, S.: Sub – supply chain coordination in a three – layer chain under demand uncertainty and random yield in production. International Journal of Production Economics, vol. 191, 66–73 (2017).
3. Brereton, P., Kitchenham, B., Budgen, D., Turner, M., Khalil, M.: Lessons from applying the systematic literature review process within the software engineering domain. The Journal of Systems and Software, vol. 80, 571–583 (2007).
4. Webster, J., Watson, R.: Analysing the past to prepare for the future: writing a literature review. MIS Quarterly, vol. 26(2), 13–23 (2002).
5. Keranen, O.: Dynamics of the transition process towards partnership thinking in centralized public procurement. Journal of Industrials Marketing Management, vol. 65, 91–106 (2017).
6. Bals, L., Turkulainen, V.: Achieving efficiency and effectiveness in purchasing and supply management: organization design and outsourcing. Journal of Purchasing and Supply Management, vol. 23, 256–267 (2017).
7. Xiaofeng, L., Kun, F.: Purchase cost control research based on centralized procurement method. In: MSIE 2011, pp. 1004–1006 (2011).
8. Li, L., Zhang, Y., Sun, H.: Research on centralized procurement mode of construction project materials. Applied Mechanics and Materials, vol. 193–194, 333–336 (2012).
9. Kobayashi, R., Mori, M., Samejima, M., Komoda, N.: An evaluation method of reduced procurement risks by decentralized ordering in supply chain. In: 2013 11th IEEE International Conference on Industrial Informatics, pp. 82–85 (2013).
10. Partida, B.: Looking beyond centralized and decentralized procurement. Supply chain management review, vol. 18(2), 63–65 (2013).
11. Bals, L., Laine, J., Mugurusi, G.: Evolving purchasing and supply organizations: A contingency model structural alternatives. Journal of Purchasing and Supply Management, vol. 24, 41–58 (2018).
12. Munson, C. L., Hu, J.: Incorporating quantity discounts and their inventory impacts into the centralized purchasing decision. European Journal of Operational Research, vol. 201, 581–592 (2010).
13. Singh, D., Verma, A.: Inventory management in supply chain. Materials Today: Proceedings, vol. 5(2), 3867–3872 (2018).
14. Mrnjavac, E., Pavia, N., Cerovic, M.: Procurement in the supply chain: An element of hotel product competitiveness. Contemporary Economy, vol. 7(4), 81 – 92 (2016).
15. Glock, C. H.: Purchasing organization and design: A literature review. BuR – Business Research, vol. 4(2), 149 – 191 (2011).
16. Gunasekaran, A., Subramanian, N.: Sustainable operations modelling and data analytics. Computers and Operational Research, vol. 89, 163–167 (2018).
17. Wang, X., Kopfer, H.: Collaborative transportation planning of less – than – truckload freight. OR Spectrum, vol. 36(2), 357–380 (2010).
18. Karjalainen, K.: Estimating the cost effects of purchasing centralization – Empirical evidence from framework agreements in public sector. Journal of Purchasing & Supply Management, vol. 17, 87–97 (2011).
19. Sysoiev, V.: Optimization models of the supply of the power structures' organizational units with centralized procurement. Economic Annals, vol. LVIII, No. 198 / July – September 2013, 137–164 (2013).
20. Sysoiev, V.: Dynamic model of optimized supply for organizational units for armed forces at decentralized procurement. Poznan university of economics review, vol. 13(3), 91–106 (2013).

21. Beaudoin, D., Frayret, J. M., LeBel, L.: Negotiation – based distributed wood procurement planning within a multi – firm environment. Forest Policy and Economics, vol. 12, 79–93 (2010).
22. Kobayashi, R., Mori, M., Samejima, M., Komoda, N.: An interactive evaluation method of decentralized procurement plan by multi objective genetic algorithm. In: 2013 International Conference on e-Business, pp 1–8 (2013).
23. Mohammaditabar, D., Ghodsypour, S. H., Hafezalkotob, A.: A game theoretic analysis in capacity – constrained supplier selection and cooperation by considering the total supply chain inventory costs. International Journal of Production Economics, vol. 181, 87–97 (2016).
24. Cardenas-Barron, L. E., Sana, S. S.: A production – inventory model for a two – echelon supply chain when demand is dependent on teams' initiatives. International Journal of Production Economics, vol. 155, 249–258 (2014).
25. Chunjie, L., Aiqiao, C., Zhulong, L., Yancong, C.: Based on DEA / AHP centralized procurement model of electrical equipment supplier optimization study. Advanced Materials Research, vol. 452 – 453, 888–893 (2012).
26. Guan, X., Liu, M.: Coordination in the decentralized assembly system with dual supply modes. Discrete Dynamics in Nature and Society, vol. 2013, 1–9 (2013).
27. Pinto, R.: Stock rationing. Omega, vol. 65, 55–68 (2016).
28. Tarnikulu, M. M., Sen, A., Alp, O.: A join replenishment policy with individual control and constant size orders. International Journal of Production Research, vol. 48(14), 4253–4271 (2010).
29. Fera, M., Fruggiero, F., Lambiase, A., Macchiaroli, R., Miranda S.: The role of uncertainty in supply chains under dynamic modeling. International Journal on Industrial Engineering Computations, vol. 8, 119–140 (2017).
30. Pugh, D. S., Hickson, D. J., Hinings, C. R., Macdonald, K. M., Turner, C., Lupton, T.: A conceptual scheme for organizational analysis. Administrive Sience Quarterly, vol. 8(3), 289–315 (1963).
31. Monczka, R. M., Trent, R. J., Handfield, R. B.: Purchasing and supply chain management, 2nd ed., South Western: Cincinnati, OH, pp. 66–69 (2002).
32. Johnson, W. J., Bonoma, T. V.: The buying centre: Structure and interaction patterns. Journal of Marketing, vol. 10(4), 143–156 (1981).
33. Pugh, D. S., Hickson, D. J., Hinings, C. R., Turner, C.: Dimensions of organization structure. Administrive Sience Quarterly, vol. 13(1), 65–105 (1968).
34. Hall, R. H., Haas, J. E., Johnson, N. J.: Organizational size, complexity and formalization. American Sociological Review, vol. 32(6), 903–912 (1968).
35. Kotteaku, A. K., Laios, L. G., Moschuris, S. J.: The influence of product complexity on the purchasing organization. Omega, vol. 23(1), 27–39 (1995).
36. Quintens, L., Pauwels, P., Matthyssens, P.: Global purchasing strategy: Conceptualization and measurement. Industrial Marketing Managements, vol. 35, 881–891 (2006).
37. Garrido-Samaniego, M. J., Guttierrez-Cillan, J.: Determinants of Influence and Participation in the Buying Center: An Analysis of Spanish Industrial Companies. Journal of Business and Industrial Marketing, vol. 19(5), 320–336 (2004).