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IMPACT OF MANUFACTURING FLEXIBILITIES ON FIRM PERFORMANCE

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ABSTRACT

The study aims to find out the association between dimensions of manufacturing flexibilities and firm performance—the dimensions of manufacturing flexibilities, machine flexibility, routing flexibility, HR flexibility, and material handling flexibility. The study gets consistent support from the Theory of constraints approach to measuring dimensions of manufacturing flexibilities and firm performance. The study determines the sample based on the judgemental sampling method, including employees from Estonia as inclusive criteria and other countries excluded. The correlation outcome has presented that manufacturing flexibilities have been associated with firm performance. All the manufacturing flexibilities have a robust positive association with firm performance.

The study assesses the criteria using seven-point Likert scale constructs. With the help of regression, the study found that HR flexibility has a 68.1% impact, followed by 57.8% for volume flexibility, 47.6% for routing flexibility, 34.1% for machine flexibility, and 29.2% for mix flexibility. The study finds that the highest impact can be seen in HR flexibility, whereas the least influence is on mixed flexibilities. Also, all the flexibilities have a certain percentage of impact on firm performance.

Keywords: Manufacturing flexibilities, machine flexibilities, mix flexibilities, volume flexibilities, firm performance

INTRODUCTION

The business environment fills with uncertainty, which led to the need for flexibility in the workplace. (Agus 2011). Flexibility considers as one of the operational capabilities of the firm (Brettel *et al.* 2016). It looks like a prominent tool that helps to meet the challenges imposed by the external environment. Flexibility defines as the ability to change or react based on the penalty imposed by time, effort, and performance (Upton 1994). Manufacturing firms giving more importance to flexibility.

Flexibility in manufacturing has the potential to help the organization respond to change in a better way (Mishra *et al.* 2008). It is becoming an integral part of the worldwide concept that has been proclaimed as "The next competitive battle" (Brettel *et al.* 2016).

Statement of problem: In recent days, many manufacturing companies overwhelming by the crisis which anticipates having a 53.1% negative impact on operations (Annika 2020). Thus, the companies need to deal with a crisis like ramping up instant production, staggered shifts, hiring a temporary workforce to meet instant demand for the products in the market. All the aspects will prioritize flexibility as an important aspect to face unprecedented demand in the market. The companies are increasing flexibilities to mitigate unprecedented drops in volumes (Austen 2020). Out of many manufacturing companies, Stora Enso is also the organization that has contingency plans to overcome the outbreak situation. They are working more on supplying hygiene products to customers worldwide. Also, it is keen on protecting the employees and alleviate the business impact globally. The organization is keen on assessing the current market situation, make strategic actions, and enable greater flexibility operations inside the organization. Thus, the aspects induce the researcher to assess the manufacturing flexibility dimensions of the organization. Also, it assesses whether there is any relationship exists between manufacturing flexibilities and firm performance.

Dimensions of manufacturing flexibilities include machine flexibility, routing flexibility, product flexibility, labour flexibility, and material handling flexibility. Also, the study assesses how

dimensions of flexibilities influence firm performance. Similar work has also been carried out by (Avunduk 2018) in which the relationship between both variables is evaluated using a qualitative approach. The outcome derived from the study stated that a strong positive relationship was identified between flexibility and firm performance. Thus, the researcher evaluates the variables using quantitative research.

Background of the study: The theory of constraints got public attention in 1984 through the novel called "The Goal," written by Goldratt. TOC uses to plan the process, allocate the resources to meet the competition in the external environment. TOC has to undergo the below-stated steps

- It is vital to identify the bottlenecks
- Second, must decide on exploiting the bottlenecks
- Subordinate it to make the decision
- Elevate the system bottleneck (Cox, Goldratt 1993)

Bottlenecks for the manufacturing firm may arise because of a machine or process or HR (Coughlan, Darlington 1993). To remove the blockages, the manufacturing firm needs to restructure and realign the resources. To realign it, then the firm should have flexibility. Manufacturing flexibility comprises various flexibilities, namely HR, machinery, mix, volume, and material handling flexibilities. Having flexibility makes it easier to recombine the resources, utilize them effectively. Besides, the action reduces the switching costs, speed resource recombination, and facilitates synergy creation (Seebacher, Winkler 2014). Adopting the TOC approach with manufacturing flexibilities paves the way to reduce the lead time, cycle time, lower the inventory and accelerate productivity and quality (Fry, Cox 1989; Rezaee, Elmore 1997).

Research aim: The study aims to find out the relationship between dimensions of manufacturing flexibilities and firm performance. The outcomes of the association assist the manufacturing companies to know most significant attributes and most least attributes which influence the firm performance.

Research objectives

Task 1: The objectives of the study are to analyse the association that exists between dimensions of manufacturing flexibilities and firm performance.

Task 2: Also, the study assesses the impact of dimensions of manufacturing flexibilities on firm performance

Research questions

What are the dimensions of manufacturing flexibilities have considered for the study?

What is the correlation between dimensions of manufacturing flexibilities and firm performance?

Whether the relationship that exists between the variables is strong?

What is the impact of dimensions of manufacturing flexibilities on firm performance?

With the help of past support, the researcher would like to assess how manufacturing flexibilities impact firm performance. To provide a solution to the research concern, the study proceeds to determine the aspects using quantitative research. The study gets considerable support from (Camison, López 2010), who extends the study by giving specific importance to statistically significant flexibilities and assess it with firm performance. The study provides manufacturers with the extent of manufacturing flexibilities and their impact on the firm's performance. It assists the producers to use the flexibilities and get it to benefit from them.

The chapter schemes used in the thesis are explained in detail. The first chapter is the Theoretical background of the study. It has sections like flexibilities, manufacturing flexibility, machine flexibility, routing flexibility, product flexibility, HR flexibility, and how the relationship exists between manufacturing flexibilities and firm performance, the types of flexibilities used, HR flexibilities, machine flexibility, routing, mix, volume flexibility, and firm performance.

The second chapter is the research methodology, the empirical study, and the recommendations. It includes research onion, research philosophy, research approach, research method, time horizons, population, samples, target area, sampling, sampling technique, data collection, and ethical considerations.

The third chapter the empirical study, and the recommendations. Also, the study implements the results using statistical tools. The survey provides a snapshot of the demographics of the respondents. Descriptive statistics indicate the appropriate accuracy of variables. Correlation can be used to analyse the correlation between two different variables. Finally, by using regression analysis, researchers can plot the effect of independent variables on variable's dependent ones.

1. THEORETICAL BACKGROUND OF THE STUDY

1.1. Flexibilities

Flexibility refers to the potential and actual flexibility of the organization. Flexibility is defined as changes made in the organization or reacting to the penalty from the external environment for their performance. The disadvantage is in the form of time, followed by effort and cost. It also refers to the system's quality, which permits the response to the change effectively. Upton (1994) and Sushil (1997) have pointed out that flexibility is considered the synthesis or dynamic interplay in a continuum. It represents an interactive and innovative manner with less time and effort. Potential flexibility refers to the degree of flexibility in which managers believe about the system or resources. The main intention is to accomplish the flexibility in the resources. However, actual flexibility indicates the degree to which the resources or plant, or organization is currently achieving. Manufacturing firms giving more importance to firm flexibility. However, the demand and supply of products can induce the organization to make a necessary change. Variability of the product indicates the flexibility made in offering the products and carrying out the various manufacturing process.

The variability of outputs can be seen in two dimensions. Firstly, the actual result is produced from the complete works. Secondly, some variations are made in system output over time. Interpretations are made in terms of volume or part of the product or even mix and time. The need for flexibility arises when there is a variability of the demand for the products, whether it may be random or seasonal. It may emerge when there is a shorter life cycle of the products and technologies. Besides, it focuses on increasing customized products within a short period. The manufacturing system makes an essential dissimilarity between the two types of changes. It includes unplanned and planned growth. Unexpected change which made independently because of system intention, but it has to respond immediately. These changes induce the organization to have an unexpected change in demand and a machine breakdown.

Planned changes arise because of managerial action, which intends to alter some aspect of the system. It is having a close relationship with the environment. The best instance of planned change is implementing a program that focuses on improving the product's quality. Various types of changed create the need for flexibility. Changes include resource change, design and demand change, technological changes, and socio-political changes (Viswandham, Raghavan 1997). Resource changes represent the variations in human and machine resources on the factory floor. Because of absenteeism followed by machine failure, transport `breakdown, and supplier disturbance—design and demand changes are related to planned changes. The changes induce the organization to introduce new products, beat the competition.

However, unplanned changes were created by random customer demand and inaccurate forecasting of the market's development. Technological changes are continuous or discontinuous. The best instance of erratic changes is Hard disk drives. To cope with the changes, the company should forecast and develop competencies for future products. They should evaluate the risk involved in a new venture—finally, socio-political changes that impact many industries. The liberalization of specific markets creates new prospects, and in some situations, it may be dependent on legislation—generally, uncertainties are classified as internal and external uncertainties. Former occurs within the organization. It includes equipment breakdown, varying task times, queuing delays, workforce changes, shortage of resources, and resource acquisitions. External changes occur outside the organization. It includes changes made in the product demand, product price changes, product mix changes, technological changes, and macroeconomic policies (Viswandham, Raghavan 1997).

Chang (2012) considering changes, flexibility thought an essential concept in the present day. The main reason behind emergence as a new concept is that globalization increases competitive pressure, frequent fluctuations in the market, and more demand from specialized products. All the attributes put immense pressure on the companies to produce a wide variety of products at low costs. Hence, the organization works a lot to gain a competitive advantage in the market through flexibility (Kaur *et al.* 2016)

External changes are the primary reason for the company to adopt flexibility in its organization. Exterior changes are possible because environmental uncertainty and variability of products and processes induce the organization to adopt flexibility. Environmental fate indicates that

unexpected changes are made within and outside the organization. Inside the organization, there is a frequent machine failure change, which affects product quality.

In simple words, flexibility refers to the changes made based on the internal environment and external environment. Pyoun and Choi (1994) have shown that flexibility arises because of physical prerequisites, operating policies, and management practices. Generally, flexibility has a wide array of hues to fit into based on different people's requirements. The best instance for flexibility components is that product ranges, mobility, and uniformity of performance have various synonyms based on situational and environmental contexts.

1.2. Manufacturing flexibility

Manufacturing flexibility enables firms to produce products of the desired quality that meet customer demand quickly and efficiently. (Baykasoglu, Ozbakır 2008). In other words, it represents a product to several enablers like corporate culture, process technology, facility layout, and information system. An organization using manufacturing flexibility is to respond to the environmental changes made externally. The objective of using the cost of manufacturing flexibility is much lower than the price of managing unexpected changes. If properly used, it will have a positive impact on the performance of the organization. Generally, manufacturing firms engage in developing a wide array of products. It is primarily because every company comprehends that manufacturing flexibility is used adaptively or proactively. The former strategy indicates the reactive application of flexibility to meet the unknown risks that emerged in the external environment. It assists the organization in addressing internal problems and external problems (Slack 1983). A later strategy represents manufacturing flexibility as it can adapt or change the organization.

An optimistic view of using flexibility in the organization is that they can reap the competitive advantage. Using flexibility can raise customer expectations and accelerate the uncertainty for its competitors. Besides, it permits the organization to redefine market risks or influence customers' expectations from the industry. Manufacturing flexibility can have the capability to cope with a wide array of changes made in the external environment. From this viewpoint, it is clear both proactive and adaptive are different. But similar in conveying the same feeling that it helps to meet the uncertainty. From the organizational perspective, manufacturing flexibility

considers as a customer-driven approach. It uses to develop quality products, meet the customer needs accordingly. It may fall under adaptive or proactive or a combination of both. Hence manufacturing flexibility uses to respond to environmental changes efficiently and at the same time effectively. The main intention is to produce high-quality customized products at a reasonable price. Effectiveness indicates the system's ability to meet the product requirements according to quality, followed by quantity. Efficiency means optimally utilize the system resources.

Importance of manufacturing flexibility: Manufacturing flexibility has its importance, and it has various benefits. It has the power to reduce the set-up time, followed by manufacturing lead time, equipment idle time, and inventory levels. By doing so, it increases productivity and betterment in the control of the process. Manufacturing flexibility considers as a strategy that is high on the agenda of many manufacturing companies (Beach *et al.* 2000). Manufacturing flexibility is different based on various authors. Some states that it can respond based on the manufacturing system at low cost and appropriate speed. They can have the changes planned way or unexpected way. Changes can be possible in both internal and external environments (Roll *et al*. 1992). Another set of researchers focuses on assessing the manufacturing flexibilities to cope with changes that help achieve potential and realizable flexibility (Sethi, Sethi 1990; Pyoun, Choi 1994). Flexibility varies based on different things to different people. A flexible plant is the one that can do comparatively well. It paves the way to do various tasks within a specified range (Upton 1994).

However, manufacturing flexibility helps to easily overcome the changes and avoid the effects or adjust it based on the environment (Das 1996). Manufacturing flexibility is vital to gain a competitive advantage (Chen *et al.* 1992). Consequently, the organization wants to make its environment flexible, and then it is vital to adopt a flexible manufacturing cell. Only then can the company be able to gain rivalry in the external environment. The flexible section is defined as a flexible automated system directed by production equipment. It has one or more multifunctional machines, coupled with automatic tool changes with an automatic transfer system for parts. It helps to have been machined before or after ATC. The manufacturing flexibility intention is to combine the existing technology, automate material handling, computer hardware, and software. With the help of the above-stated resources, the organization can integrate the system for automated random processing of palletizing parts for various workstations. Combining the manufacturing system with advanced technologies paves the way

to give a high level of automated production system for the entire organization (Sharma, Sushil 2002).

Types: Manufacturing flexibility considers as a multi-dimensional concept, but it may vary based on underlying dimensions. Generally, it is having various types of manufacturing flexibility, and it may be used interchangeably. Nearly seven dimensions represent manufacturing flexibility Gupta and Somers (1996) suggest nine and Gerwin (1993). Strategic dimensions contain product line diversification, product innovation, and responsiveness based on consumer specifications and strategic adaptability. Some of the tactical dimensions include shortages in raw materials components, making some job routing adjustments to bypass a disabled machine or disable process (D'Souza, Williams 2000). Browne *et al.* (1984) has stated that there are eight dimensions.

Consequently, (Sethi, Sethi 1990) extend the classification to three primary dimensions. IT includes material handling flexibility, followed by program and market flexibility. Thus, eleven flexibility dimensions come under three Basic heading flexibilities, system, and aggregate flexibilities (Browne *et al.* 1984). However, organized manufacturing flexibility was developed by (Koste, Malhotra 1999). It is four levels: individual resource level followed by the shop floor level, plant level, and functional level.

Manufacturing flexibility consists of eleven types, which are generally classified as an essential system and aggregate—necessary flexibility, including flexibility in machine handling, operation, and material handling. Expansion, process, product, routing, volume flexibility falls within system flexibility, and program and production flexibility fall within the category of aggregate flexibility. (Sethi, Sethi 1990)

Machine, material, and operations flexibilities consider as the components of essential flexibilities. Other types of flexibilities covered below

1.3. Machine flexibility

It defines as a machine that can be able to various operations without requiring any effort to switch over from one process to another. It can understand the prerequisites of devices and can be able to perform quickly. It helps to ease the operation, assist in changing the machine from

one part to another. It considers the most straightforward kind of flexibility. It needs a building block for further assessment of total flexibility (Tsourveloudis, Phillis 1998).

For any manufacturing system, it is vital to have machines because it is an essential hierarchical element. Modern devices have been equipped with exchange mechanisms to perform various operations in short and unloading and tool exchange times. It determines with the help of existing hardware because it relies more on change over time. Change over time represents the time required for making the machine switch over from one part to another. It involves set-up tools or part program transfer and transportation time. Besides, it determines based on machine versatility because various operations can perform and primarily associate with several motion axes, high accuracy, range of cutting speed, quantity, and diversity of workpieces on which the machines operate. It is determined based on the adjustability of the device. The adjustability of a machine refers to the size of the working space. It is primarily associated with the maximum and minimum dimensions of the part which can handle using devices (Tsourveloudis, Phillis 1998).

Purpose: In this flexibility, the machine-level offers a basic framework for flexibility. Software functions are not helpful to meet out in providing extra flexibility to the department. If machines are hard and expensive to change in a department, then machine flexibility is not suited flexibility. The primary purpose of using flexibility is to produce complex parts and provide better quality (Ranta, Alabyan 1988; Gerwin, Tarondeau 1986).

Benefits: It is using machine flexibility applicable for smaller batch sizes. Because it reduces the lead time involved in changing the design of products, saves maximum time spent for work in process, helps introduce new products, and changes production programs. It effectively utilizes the workforce and machine (Sarkar *et al.* 1994).

1.4. Material handling flexibility

It indicates the moving of different parts types of machines virtually. The main intention is to have proper functioning and processing of devices in the organization. With the help of manufacturing flexibility, it is possible to load and unload parts. Intermachine transportation is possible, and storage of parts under various conditions of the manufacturing facilities. The material handling system uses to transport larger part types of machines properly. Besides, it

helps to improve both the routing and process flexibility of the system. Having a flexible material handling system can accelerate the availability of devices. It increases the utilization and diminishes the throughput times. Generally, it relies more on the routing factor, indicating the material handling system's ability to change path time automatically. Also, it helps to reduce the set-up time and cost. Besides, it increases the variety of loads like workpieces, tools, jigs, and fixtures. It is restricted by the product volume, followed by dimension and weight. The material handling system also relies on several connected elements that indicate the connection among the manufacturing system elements like machines and buffers (Sethi, Sethi 1990; Tsourveloudis, Phillis 1998).

Purpose: It plays a vital role in the organization while determining the flexibility. It has more availability of machines. Hence all the devices were utilized adequately. The action, in turn, reduces the throughput times. Material handling robots help make automated storage, retrieve it fast to increase the production system's information process capabilities. Rattner *et al.* (1988), material handling robots and automated storage and retrieval systems increase

1.5. Routing flexibility

It can produce a part by substitute routes with the help of the system. Also, it has the power to continue the production with the given part mix. Even though the machines had internal disturbances like break down or failure. Failure represents the tool breakages followed by controller failures and machine breakdown. Consequently, machine breakdown can happen; corrective measures should be taken to restore the situation. Whenever machines are under an abnormal period, it is vital to check the production and maintain them in various volumes. In turn, the action helps to meet the product delivery within the prior dates, and it helps to meet the competitiveness which faced in the external environment. The manufacturing system should have enough resources, and hence it can lead to gain the desired level of performance with the presence of failures.

Generally, redundancy is created when the production department is using interchangeable and multipurpose versatile machine tools. The action is due to processing each part of the machines through various routes, and each operation is performed on more than one device. Maintenance of production tools helps to resolve the internal disturbances. Thus, these kinds of flexibility

help to make a quick reaction and react to unexpected events. Also, it diminishes the effect of interruptions of the production process. The organization uses versatile machine tools and has a universal material handling system and reschedule it using control software. The organization can meet the demand with high investment and process the production excessively high cost.

Routing flexibility considers as the intrinsic property of the manufacturing system. It relies more on operation commonality. Operation commonality refers to the number of standard operations that a group of machines performs to produce parts. It can also rely on substitutability, which refers to the system's ability to reroute the parts and reschedule them effectively. The main intention is to utilize it even in failure conditions, and it is positively associate with the material handling system and machine layout. It is quite different from operation flexibility. Because it is a part of a single operation sequence which processed with the help of different routes. Doing so accelerates the increasing number of ways in the system and accelerates the machines' operation capability. It also effectively accelerates devices' underutilization (Viswanadham, Narahari, 1992; Tsourveloudis, Phillis 1998; Stecke, Raman 1995).

Purpose: It allows us to have efficient scheduling of parts. It helps to have machine loads in a balanced way. Besides, it permits the system to produce a given set of part types with a reduced rate. It has the power to utilize the machines even at the unanticipated breakdown, later receipt of tools, or the proactive order of parts. Therefore, it is vital to contribute to the strategic requirements to meet customer delivery times. It facilitates expanding the capacity limit to a great extent (Gerwin, Tarondeau, 1989).

1.6. Product flexibility

It eases the operation either by adding new parts or make changes in the existing features. In simple words, it denotes the ease with which the part mix can change inexpensively and rapidly. In other words, it associates with the highest number of products that are produced and assembled by the manufacturing system at an appropriate time. Product flexibility considers as the most critical flexibility from a marketing perspective. It measures the firm responsiveness based on market changes in the external environment. Also, it assists the firm in meeting the demand by introducing new products quickly. It is highly influenced by a variety of products, change over effort, and part commonality. Changeover effort indicates time and cost vital for

developing a new product. Besides, it also expresses the system's ability to absorb market variations. However, part commonality suggests the common parts utilized in the final product assembly. It measures the ability to develop new products in a fast and economical way. (Tsourveloudis, Phillis 1998, Sethi, Sethi 1990)

Purpose: It allows the organization to respond to the market demand considerably by bringing about new products quickly. Though future product design is unknown, it is vital to design and develop the production flexibility to be flexible. Small companies have followed the strategy to meet the competition faced in the external market. It helps to handle complicated and non-standard orders effectively.

By doing a significant operation, the organization can quickly get new products. Product flexibility considers as the essential growth phase than its mature stage. Within a short period, product flexibility with sophisticated computer-aided design capability offers the company to gain competitive advantage (Carter 1986; Gerwin, Tarondeau 1989; Hayes, Schmenner 1978; Tombak 1988).

1.7. HR flexibility

Human resource flexibility act as the foundation for the flexibility pyramid of the system. Subsequently, it needs more effort to accomplish it in the organization (Karuppan 2004). In other words, it defines as the number and variety of operations that must perform by personnel with the minimum penalty and expects maximum performance from them (Koste, Malhotra 1999, 75). Human resources had the power to perform various operations. Besides, they can also perform complex and even unstructured functions.

1.8. Manufacturing flexibility and firm performance

Al-jawazneh (2012) has focused on how manufacturing flexibility impacts the performance of organizations in Jordan. The study considered the flexibilities to be machine followed by volume, material handling, mix, and routing flexibilities. Consequently, performance assesses in terms of quality, followed by cost, speed, and reliability. The study found that manufacturing flexibilities have an impact on organizational performance. Finally, machine and material

handling flexibilities have a high impact, whereas mix, volume, and routing do not affect the organization. From the study, the researcher derives out that there is a statistical impact on organization performance. The researcher uses all the variables in their research.

Brettel *et al.* (2016) have claimed that the authors had developed a conceptual framework to establish the relationship between flexibility in manufacturing and performance. Advancements made in manufacturing industries have created a revolution of 4.0. The study provides an outcome that the industrial revolution will bring about an iterative production process that, in turn, will provide an effective strategy in both proactive and reactive terms.

Camison and López (2010) focused on how innovation is associated with flexibility in manufacturing and firm performance. In this study, the authors used to change as a mediation attribute. The study is based on the quantitative aspects in which the survey method is used to evaluate the model using the least partial squares. The partial least square Structured equation model is one of the most widely used methods of mediation analysis. The result is that all three innovation classifications mediate the impact of the flexible, productive system. It has a significant influence on the performance of the organization. The researcher understands from the study that the effect of flexibility in manufacturing has been seen in organizational performance. The researcher, therefore, includes this objectively. The researcher, therefore, finds that the study is beneficial in determining the impact of the variables.

Mishra (2016) have opined that the investigation of the adoption of the flexibility of manufacturing, the constraints faced by the respondents in implementing it in large companies in India. According to the authors, the mixed methods used have been considered in the graphic design. A survey of 121 firms and semi-structured interviews with 16 people was conducted. The study shows that the adoption practices are different based on the nature of the industries, and therefore the firms have different results in terms of achieving flexibility. However, the study shows that in countries like India, the concept is still emerging. The researcher concludes from the survey that mixed methods are used to determine the research concern's practical outcome. As a result, the researcher intends to know the flexibility of production and its processes to assess the firm performance outcome.

Nayak and Ray (2010) has shown that the study intention was to assess the relationship between manufacturing flexibility and firm performance. The authors adopted qualitative research in

which case study techniques were adopted. The findings of the study highlight that flexibility and performance have an empirical relationship with one another. From the study, the researcher derives out the correlation between the two variables used in the study.

Wei *et al.* (2017) have claimed that how internal manufacturing flexibility plays a crucial role in sustaining the manufacturing organization from external antecedents. Application of the theory of constraints and business ecosystem theory the study assess the firm performance. They were applying quantitative research useful in determining the outcome of the course. Findings of the study highlight that manufacturing flexibility accelerate efficiency and novelty centered model design. Consequently, it increases firm performance too. The researcher derives out that manufacturing flexibility and firm performance can assess with the help of quantitative research. Besides, it was found from the study that there is a close relationship between manufacturing flexibility and firm performance. It is also acting as an essential aspect to strengthen the organization by gaining a competitive advantage in the market.

1.9. Types of Manufacturing Flexibility

Kumar *et al.* (2017) has pointed out that the competition, changes in the external environment, high complexity, and emergence of customized products created a concern for manufacturing industries. To provide a solution to the external problem increases satisfaction without sacrificing profitability, it is vital to adopt new technologies and reap benefits from them. Manufacturing companies are nowadays giving more importance to embrace flexibility in manufacturing technologies. The present study assesses various flexibility types and how it impacts the performance of the manufacturing system. The theoretical model was adopted to know the factors that influence the performance of the organization. The pyramid model pinpoints that only certain flexibilities offer benefits, and it's vital to react based on the external environment. Hence, it concludes that firms must give more importance to flexibility types and the degree essential for sustainable growth.

Mishra *et al.* (2018) has stated that how attributes have an impact on manufacturing flexibility. The authors evaluated it using quantitative research in which the postal survey has adopted. It identified operational improvement practices, technology, HR, supplier flexibility followed by supplier and customer integration, product process technology, marketing, and manufacturing

integration. The study clarifies that all the attributes impact the manufacturing flexibilities of the organization. A closer look at the review shows that it is keen on evaluating manufacturing flexibilities, but no focus is made on measuring firm performance. It is giving more importance to the attributes which support uplifting the manufacturing flexibilities.

Tan (2016) was stated that how flexibility in manufacturing influences manufacturing performance and business performance. It includes mix flexibility, new product flexibility, labor flexibility, machine flexibility, material handling flexibility, routing flexibility, and volume flexibility. However, business performance is assessed as product-market performance, customer satisfaction, and profitability. At the same time, manufacturing production is evaluated in terms of product quality, cost reduction, lead time reduction, inventory minimization, and productivity. The study assesses attributes using a quantitative analysis in which the questionnaire was used as a tool to obtain an opinion from five manufacturing companies in Malaysia. The result of the study is that the variables are highly correlated and highly interdependent. Regression analysis showed that both manufacturing and busines s performance had a positive impact. The study helps the researcher to understand the relationship and effects of the variables. The researcher identifies that all the variables included in the survey are highly correlated. The variables are also statistically significant, so the researcher uses the research to select and use statistically significant variables in the study.

1.10. HR Flexibility and firm performance

Natasaputra and Kusumastuti (2016) has focused on evaluating both internal and external labor flexibility on firm performance. To assess the study, the author uses quantitative research in which survey techniques are adopted. Partial least squares structural equation model pinpoints that internal labor flexibility severely impacts the organization's performance. However, previous literature has discussed that labor flexibility is one of the manufacturing flexibilities that affect firm performance. However, the researcher identifies the study's flaws that give primary importance to internal flexibility but failed to state the external flexibility impact on firm performance.

Way *et al.* (2018) have shown that the firms were using more employees in the North American Industry classification system. The main intention of the study was to assess the impact of HR

flexibility on firm performance. The study found that flexible business strategy and high-performance work systems altogether enrich the organization's HR flexibility. Applying HR flexibility helps to overcome the issues raised from external attributes like industry dynamism and growth. Besides, the study found that exterior details are having a substantial impact on HR flexibilities. In turn, the effect helps overcome the competitiveness present in the industry and increases its performance. From the study, the researcher understands that there is a close connection between HR flexibility and firm performance. Besides, the impact of HR flexibility is also there, which in turn has the power to gain a competitive advantage. The fact that derives from the study helps the researcher use HR flexibility as an essential variable in their research.

Sekhar *et al.* (2016) has represented in their study that identifying the causal relations between HR flexibility and firm performance. The authors used the DEMATEL method to prioritize and map the relationship between the two variables. The study got the data using the survey method, and it provides an outcome that HR flexibility offered diversity to the work environment, individuality, shared responsibility among the employees. Besides, it can apply to the work schedules and career paths across the organization. Finally, the study map that there was a close association between both dimensions. From the study, the researcher derives out the conceptual relationship between two measurements. However, no clear statement regarding the methodology applied failed to highlight the DEMATEL method's outcome.

Úbeda-García *et al.* (2017) have explored how HR flexibility influences firm performance. Besides, the authors focus on how HR flexibility increases the development of ambidexterity in the organization. With support from quantitative research, the authors applied partial least square methods. It highlights the outcome that ambidexterity act as a mediating variable in the industry. Consequently, mediating variables portrays that there is a significant relationship between HR flexibility and firm performance. From the study, the researcher knows that HR flexibility has a statistically significant association with firm performance. The researcher also derives out that the author did not focus on determining HR flexibility on firm performance. Hence the researcher assesses the aspect in their study. However, there is no clear outcome stating that whether the variables directly impact firm performance. Such unclear consequences induce the researcher to use only HR flexibility and firm performance attributes from the study.

1.11. Machine flexibility and firm performance

Mohamed *et al.* (2001) have focused on assessing the relationship between the degree of machine flexibility and system performance. The organization developed both machine loading and routing model to know the effect of changing machine flexibility on performance. The study also uses aspects like makespan, routing flexibility, capacity flexibility, and inventory effects. The study's findings state that every change made in machine flexibility influence the measures than other aspects. Besides, a 24% decrement in machine flexibility increases makespan by 17%, routing flexibility decreases to 13%, capacity flexibility decreases to 38%, and inventory drops to 26%. Finally, the study concludes that an increment in flexible manufacturing system workload creates a different increment in machine flexibility. The researcher determines the machine flexibility and performance as an essential attribute in a manufacturing organization from the study. However, the study fails to represent whether both variables are having a relationship with one another. Consequently, there is no information regarding the methodology followed to achieve the objective of the study.

1.12. Routing flexibility

Ali (2010) has shown that flexibility plays an essential aspect in the manufacturing sector. Because when market pressure increases, it is vital to produce more products with decreased volume and respond faster. Considering the factors, the authors keen on assessing the existing manufacturing system with a flexibility-based manufacturing system. The authors had adopted a simple demo simulation model to compare both methods. The model is used to compare the performance measures of total production and total production time. The findings of the study state that introducing flexibility decreases makespan time. A higher amount of reducing makespan time increases routing flexibility from 0-1. Finally, the total production of parts accelerates with an increment in the level of flexibility.

Ali and Khan (2019) have indicated how the routing flexibility simulation accelerates manufacturing performance. The study evaluates four attributes: routing flexibility, system load condition, system capacity, and four-part sequencing rules. To assess the characteristics routing flexibility enabled manufacturing system adopted. It is used to measure the performances like makespan time, system load conditions followed by system capacity, and work in process. The study finds that the performance of the manufacturing system improved to a great extent. It was

because of routing flexibility at the initial level, along with other attributes. Finally, the organization can reap the benefits of gaining a higher level of routing flexibility.

Ali and Wadhwa (2010) has assessed the impact of routing flexibility and control strategies on performance. The authors used the Taguchi method to determine the attributes relating to FSIM. ANOVA provides an outcome that the increment in routing flexibility cannot be considered a system improvement. Besides, there is an impact of control strategies on FSIM performance. Finally, the study concludes that system performance impacts the system's most extensive load condition and the smallest pallet number.

Khan and Ali (2017) has pointed out that a flexible manufacturing system's performance is evaluated based on a simulation-based experimental study. The study assesses FMS using routing flexibility, system load conditions, and sequencing rules. Besides, four routing flexibilities, along with system load conditions and sequencing decisions, have been considered. The study finds that system performance improved substantially. It was because of incorporating routing flexibility. Benefits decreases at a higher level of routing flexibilities by including all the combinations in it. Besides, sequencing rules and system load conditions have also affected the performance of the system.

1.13. Mix and Volume flexibility

Bengtsson and Olhager (2002) has focused more on product mix flexibility. It refers to producing a wide range of products or producing a high yield with low changeover costs. The value of capability is significant for the firm in ensuring the flexibility offered at the right level. The authors adopted the option pricing theory in knowing the considerable influence of mix issues on flexibilities. The model application is to produce multiple products, capacity constraints, and set up costs. The authors considered the matters to be several products, demand variability, the association between the works, and the relative demand distribution made with product mix. The study's findings state that there is an impact of product mix flexibility on the value of flexibility. However, the study provides implications that increasing the flexibility value by increasing the number of products, decreasing the increasing volatility, and reducing the correlation between the products.

Devaraj *et al.* (2012) have shown that purchasing volume and mix flexibilities offer benefits to the organization. The authors assess the objectives of an economic and social perspective. An increment in purchase volume and mix flexibility increases the performance in terms of cost, quality, and delivery. With the help of quantitative research, the study finds that both flexibilities significantly impact its performance. The researcher derives out that both flexibilities were having a close relationship with the organization from the study.

From the above-stated literature support, the study finds that manufacturing flexibilities have a statistical association with firm performance. Thus, the study considers mix flexibility, volume flexibility, HR flexibility, routing flexibility, and machine flexibility as the independent variable and firm performance as the dependent variable.

2. RESERACH METHODOLOGY

This chapter provides an outlook on how to execute the study to achieve its objectives. The study directs the methodology using the research onion framework. Besides, it provides the information on population, identifies the ways to determine the samples, techniques used to derive samples from the population, sample size, ways of collecting responses from the respondents, and the application of tools. Also, the study uses statistical tools like frequency distribution (Percentage analysis), descriptive statistics, correlation, and regression.

2.1. Developing research questions

Before evolving the methodology of research, the main question is 'What are the dimensions of manufacturing flexibilities have considered for the study?' The secondary questions are 'What is the correlation between dimensions of manufacturing flexibilities and firm performance?' and 'Whether the relationship that exists between the variables is strong?' and 'What is the impact of dimensions of manufacturing flexibilities on firm performance?' To fulfil the objectives were set as follows.

- The objectives of the study are to analyse the association that exists between dimensions of manufacturing flexibilities and firm performance.
- Also, the study assesses the impact of dimensions of manufacturing flexibilities on firm performance

When the questions of the research have been set, the methodologies related to the research could be identified. The theoretical assumption of this study is composed on the ground of operation management study in which the evolving of knowledge based on or characterized by the methods and principles of science is made. In this study the methods of the knowledge argue are to arrange and classify things or occasions to make better comprehension of these things or events. So, the methodology used is quantitative method using a survey approach.

2.2. Research onion

The study frames the methodology with the help of the research onion approach, and it is the simplest way of explaining all the methodology concepts in an onion format. It has various layers, indicating using the research onion framework (Saunders *et al.* 2007).

Research philosophy: The first layer in the research onion framework represents the belief or assumptions made to develop the knowledge on dimensions of manufacturing flexibilities and its impact on firm performance. Generally, there are types of assumptions which include ontology, epistemology, axiology. Justification: The study uses assumptions as epistemology, and the philosophy is backed up by the evidence in (Castree 2005), which supports the beliefs in it. The main intention behind using epistemology is that it relates to law-like generalizations (Saunders *et al.* 2016). Subsequently, the researcher picks out positivism because it presents the importance of what is given. Also, positivism is of using pure data and facts which is free from human bias (Malhotra *et al*. 2010; Saunders *et al.* 2012; Brotherton, 2008). It focuses on raising questions related to what happens (Collis, Hussey, 2014; Saunders *et al.* 2012; Carson *et al.* 2001). Justification: Angeles *et al.* (2017) show that positivism is the best way to determine the effect of manufacturing flexibility on firm performance.

Research approach: The second layer assists the researcher on how to start the work either to start the work from theory or observe the theory from the data. The research approach is of two types namely inductive and deductive (Ketokivi, Mantere 2010, 315). Justification: The study plans to arrive out the results logically and thus the best-suited approach is deductive. It assists the study to interpret the information from the environment. Thomas (2006) has found that the deductive approach is of generating the patterns from the researcher experience. Harari *et al.* (2018) have shown that clear, healthy, and well-documented evidence supports the concept of deductive approach and hence the same utilized in the study.

Research method: The third layer uses to determine the way of collecting the data to meet out the research objectives. There are two types of methods one is qualitative and the second is quantitative. The quantitative analysis presents the outcome in a mathematical form whereas qualitative is of processing the information through images and words (Zikmund *et al.* 2013). Justification: Malik *et al.* (2017) represented that the benefits derived out from using quantitative analysis and how the way helps to reach an effective outcome. To get a deep and exciting

experience, the researcher uses a quantitative approach and gets the benefits out of it similar to the previous researcher.

Time horizon: Adjacent layer of the research onion is the time horizon. It portrays that the way of planning the research and to find out an effective outcome. To do so, the cross-sectional approach uses to a great extent. The objective of using the approach is that is limited time and resources. Within the respective time and resources, the study has to get an outcome for the research questions. Justification: (Mendes, Machado 2015; Woun *et al.* 2017) have shown that the cross-sectional approach is considered an effective way to determine manufacturing flexibility.

2.3. Population and Samples

The population refers to the complete persons who are involved in the organization. In other words, it represents the entire group who give information for the study (Banerjee, Chaudhury 2010, 60). However, samples are small which have to take it from the wide population (Collis, Hussey 2014). In Stora Enso, 26000 employees are working all over the world. Samples are picking out the Estonian production employees among whole employees.

Target area: The researcher considers employees in Stora Enso. Twenty-six thousand employees are working in the organization worldwide (Annual report 2020).

Sampling: It defines as deriving out the samples through imposing statistical tools from the population of interest (Kamangar, Islami 2013). The word “population of interest” refers to the individuals who are applying for the study. They are also considered as respondents. The present study has the respondents as production employees who belong to Stora Enso, Estonia.

Sampling technique: A sample represents how the researcher takes a small amount of data in empowering the research to a great extent (Kolb 2008; Saunders *et al.* 2012). Techniques are of two types namely probability and non-probability sampling. Among two samplings, the study chooses the non-probability sampling, the subset of judgemental sampling which fixes inclusion criteria as the employees working in Estonia. However, the study excluded the employees of Stora Enso working in other countries.

Sample size: With the help of a sample size calculator, the study fixes the sample size. Fixing 5 as CI, confidence level as 5%, the population as 89, and thus the sample size as 72. The study adopts quantitative research to derive the outcome for research concern. The method considers as an effective method to resolve the research issues.

Data collection: Data collection refers to accumulating the respondents' opinions, fix hypotheses, apply statistical tools, and deriving the outcome (Paradis *et al.* 2016, 263). The study accumulates the data through a structured questionnaire. It includes both open-ended and close-ended questions. Also, the instrument has Likert scale questions to measure the dimensions of manufacturing flexibilities and firm performance (Malhotra *et al.* 2012).

Types of data collection: There are two types of data collection namely primary and secondary data. Primary data is of collecting the respondent's opinion for the first time. It should not be changed or altered at any point in time. It has a higher validity (Gratton, Jones 2010, 21). Therefore, the study uses the primary data sources to collect the respondent's opinions through Google forms. However, secondary data uses to direct the researcher to find out the appropriate outcome through articles and journals. The objective of using secondary data sources is to eliminate the hassles and to give proper weightage to the present topic.

Data processing and analysis: Data processing is one of the most important steps in processing the raw data (Cooper, Schindler 2011, 160). The study downloads the raw data from google form in excel format. Coding applies to transform the raw data from excel to SPSS to perform the statistical tools. SPSS provides the information in a valuable form and the researcher represents the data in tables and charts. (Brotherton 2008).

Statistical tools: In this study, percentage analysis was utilized to assess the respondents' profile. Descriptive statistics used to measure the dependent and independent variables. Consequently. Correlation tests were used to determine the relationship between dependent and independent variables. Regression was used to identify the impact of an independent variable on the dependent variable.

Validity: It is a tool to measure how the collected data covers the dimensions of manufacturing flexibilities and firm performance (Taherdoost 2016). Validity classifies as criterion validity,

face, content, and construct validity. Among these types, face validity is the suitable one to check the research instrument constructs. Face validity helps to prevent whether the constructs are relevant and precise (Oluwatayo 2012, 391). The researcher examines instruments' face validity with company official experts' help through a dichotomous scale with option yes or no. The study assesses the validity through the Cohen Kappa Coefficient, and the outcome discusses below

Table 1. Validity

Particulars	value
Mix flexibilities	0.989
Volume flexibilities	0.912
Machine flexibilities	0.923
HR flexibilities	0.987
Routing flexibilities	0.945

Source: Author's calculation

The above table shows that the kappa coefficient values range from 0.91 to 0.98, which shows perfect agreement and the dimensions suitable for assessing manufacturing flexibilities.

Reliability: It measures the constructs and states whether the constructs are dependable (Heale, Twycross 2015, 66). The study assesses it with the help of Cronbach alpha, which primarily uses to test the internal consistency of the items. The Cronbach alpha evaluates it through SPSS, and the outcome presents below

Table 2. Reliability

Particulars	value
Cronbach alpha	0.887

Source: Author's calculation

The study gets the Cronbach alpha as 0.887, which is above minimum internal consistency. Thus, it suits the best one to measure Likert scale items' internal consistency relating to dimensions of manufacturing flexibilities and firm performance.

Hypothesis

Dimensions of manufacturing flexibility (HR flexibility, machine flexibility, routing flexibility, mix and volume flexibility) has a close association with firm performance.

Dimensions of manufacturing flexibility (HR flexibility, machine flexibility, routing flexibility, mix and volume flexibility) have a statistical influence on firm performance.

Ethical considerations: The researcher needs to have a look at ethics before carrying out the research process. Ethics may differ based on the nature of the subject. The study is keen on framing the questions that have not to affect the dignity of the respondents. Also, it did not harm either physically or psychologically. Besides, the researcher focuses more on confidently keeping the respondent's opinion. Also, it induces the respondents to make voluntary participation. The study in no way involuntarily makes the respondents participate in it. Finally, it respects the respondent's independence. Finally, the study addresses the principles already stated by (Bell, Bryman 2007, 63)

3. EMPIRICAL STUDY AND PRACTICAL IMPLICATIONS

3.1. Empirical analysis

The data analysis section considers being the most significant one to derive the outcome for the research questions. The researcher uses quantitative methods, especially with percentage frequency distribution, descriptive statistics, correlation and regression.

3.3.1. Demographic profile of respondents

Age: The table showed that 33.3 percent of participants are age ranging from 20 to 25 years, while 16.7 percent of respondents between 25 and 30 years of age, followed by 30.6 percent of respondents between 30 and 35 years of age, and 19.4 percent of respondents between 35 and 40 years of age. Thus, the observation portrays that the highest number of respondents is between 20-25 years.

Gender: Out of 72 respondents, 50 percent male (n=36) and 50 percent female (n=36). Thus, there were no gender-based differences made in the study with the help of the sample.

Work experience: The above table data represents the work experience of the participants in the analysis. These have found that the least work experience (n=11) in the study is between 5 and 7 years, while the second is less than one year (n=12). The third was more than seven years, of which 14 respondents have ticked, and the fourth is between 1 and 3 years of experience, of which 17 respondents have selected. Thus, the 18 participants who had worked experience between 3 and 5 years in this study are the highest.

Designation: The study uses the respondents from various designations. The designation includes HR, improvement manager, sales and senior manager, senior development engineer, and RF product integration engineer. Among 100% of respondents, 12.5% of from HR designation, while 26.4% of the improvement manager, followed by 20.8% of sales and senior manager and then 12.5% of senior. The next designation is development engineers, who offered around 15.3%

and 12.5% from RF product integration engineer. Hence it is evident that most respondents come from the improvement manager.

Department: The table above found that 13 participants belonged to the HR department, while 11 participants were Product Quality Management, led by 8 participants in water treatment, and then 9 were Spanish participants. The next one is 11 PCSW participants, while 12 are Product Test Development, and 8 are IT departments. As a result, the largest number of participants in this study are the HR department was noticed.

Reasons for manufacturing flexibilities: Out of a total of 72, 9.7 percent of the participants had advanced technologies and new failures, while the incorrect linkages between the database were able to attract 19.4 percent of the participants accompanied by 8.3 percent of the participants were Prevent difficulties, 15.3 percent of the participants were Remove programming bugs, and Improper gripping and 22.2 percent were others. Thus, it was observed that the most significant number of participants in this study were incorrect linkages between datasets.

Factors deriving manufacturing flexibility in the organization: The table above reveals that 27.8% of respondents stated that demand characteristics influenced them to opt for manufacturing flexibility. Besides, competitors' behaviour of 22.2% and 20.8% of the product life cycle are the factors that derive the organization's manufacturing flexibility. Finally, it observes that the maximum number of respondents stated that demand characteristics are the primary attribute that influences the organization to have manufacturing flexibility.

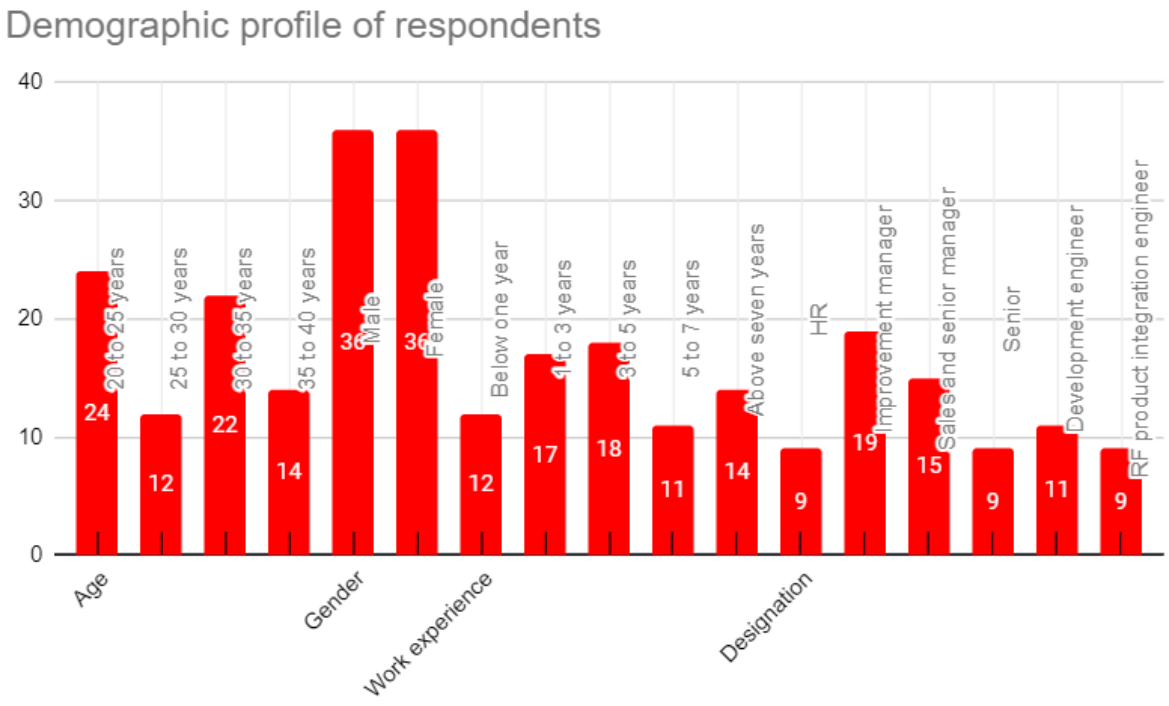


Figure 1. Demographic profile of respondents
Source: Author's calculation

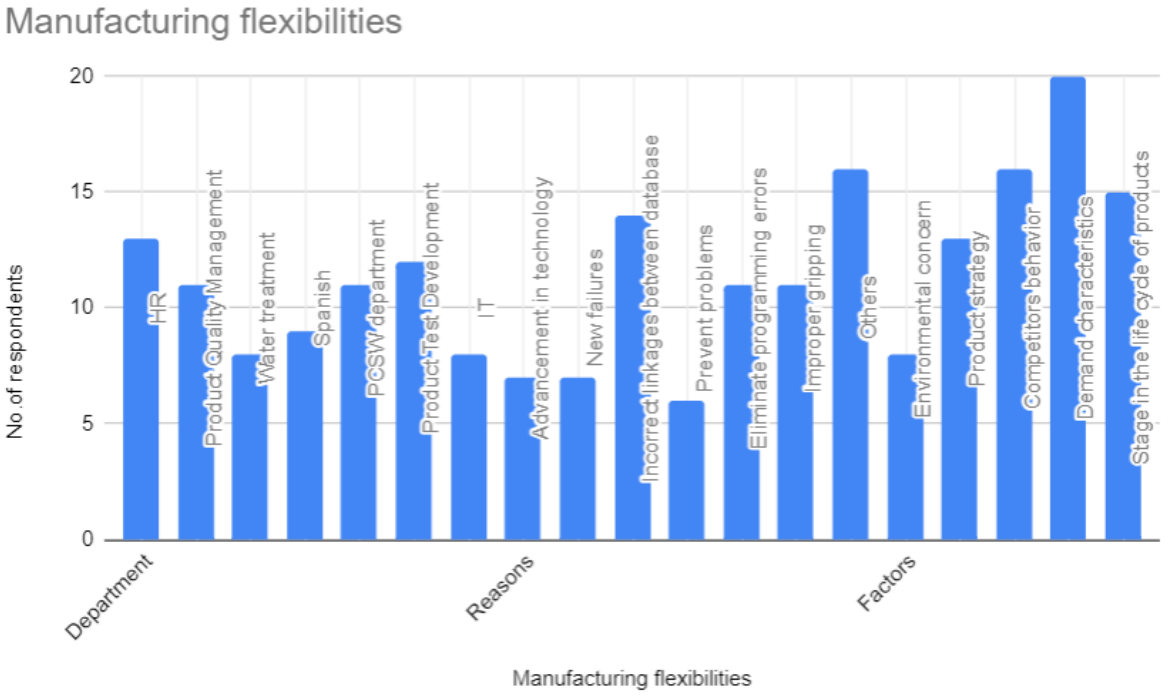
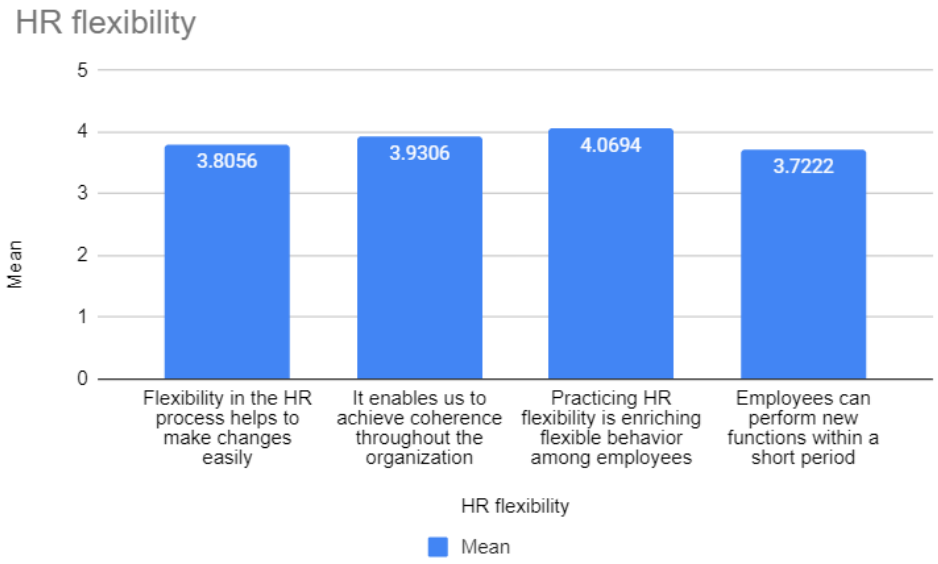


Figure 2. Manufacturing flexibilities
Source: Author's calculation

3.3.2. Descriptive statistics for Manufacturing flexibilities and firm performance

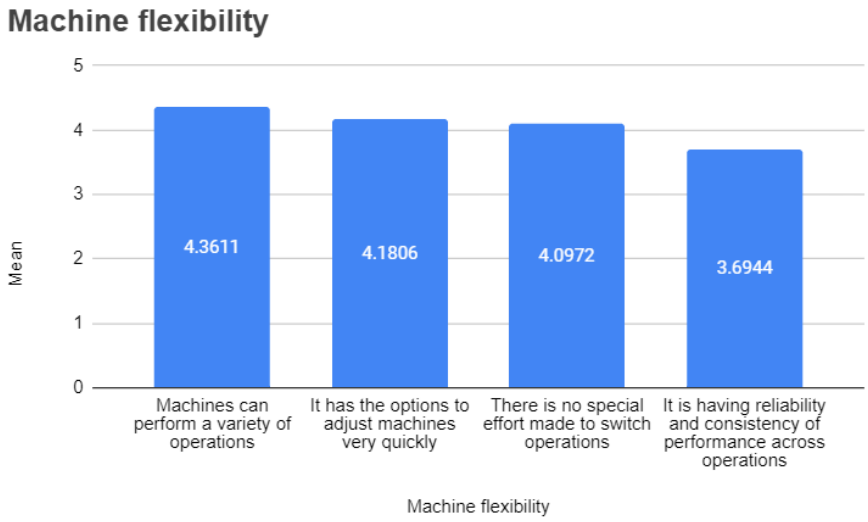
It is a specific method that uses to describe and summarise the Likert scale questions logically, meaningful, and effective (Vetter 2017, 1797). The researcher reported the outcome in the tables and graphs. The study uses basic concepts of descriptive statistics like mean and standard deviation. Mean provides the variability of the scores that varies from strongly agree to disagree strongly. Consequently, standard deviation depicts average variability's Likert scale variables (Urdan 2016; Salkind, Frey 2019).

HR flexibility: The study uses the succeeding statements to assess HR flexibility. Flexibility in the HR process helps make changes quickly, helps achieve coherence, enriches flexible behaviour, and allows employees to perform new functions within a short period. It observes that the constructs direct to measure the HR flexibility. The mean value of HR flexibilities ranging from 3.7 to 4.1. HR flexibility statement represents "Practicing HR flexibility is enriching flexible behaviour among employees" secures mean value of 4.06 with 2.15 as a standard deviation. The statement has the lowest accuracy among other statements. However, the lowest mean value for the HR flexibility statement is "Employees can perform new functions within a short period" is 2.03 which has the highest accuracy.

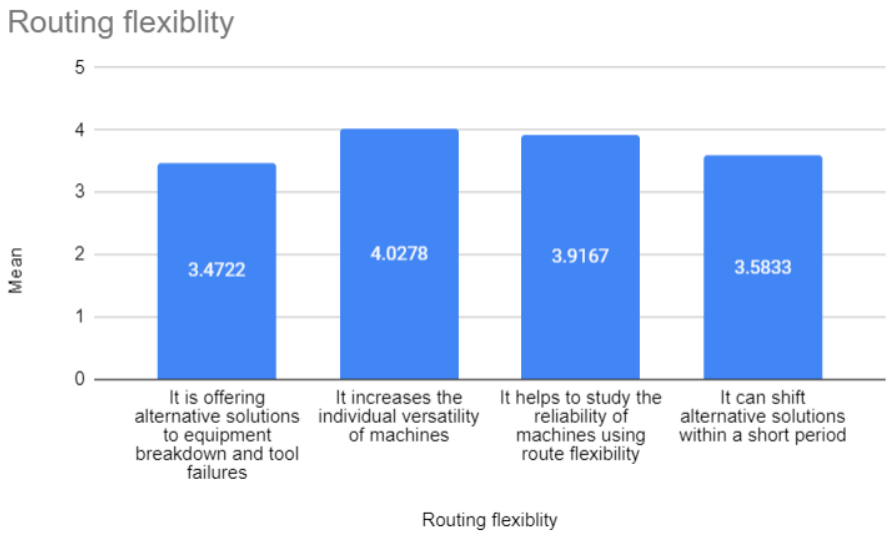


Machine flexibility: The study measures the machine flexibility statements with the help of five points Likert scale. It presents the respondent's opinion in the form of mean and standard deviation. The study has the constructs like machines can perform various operations, adjust it

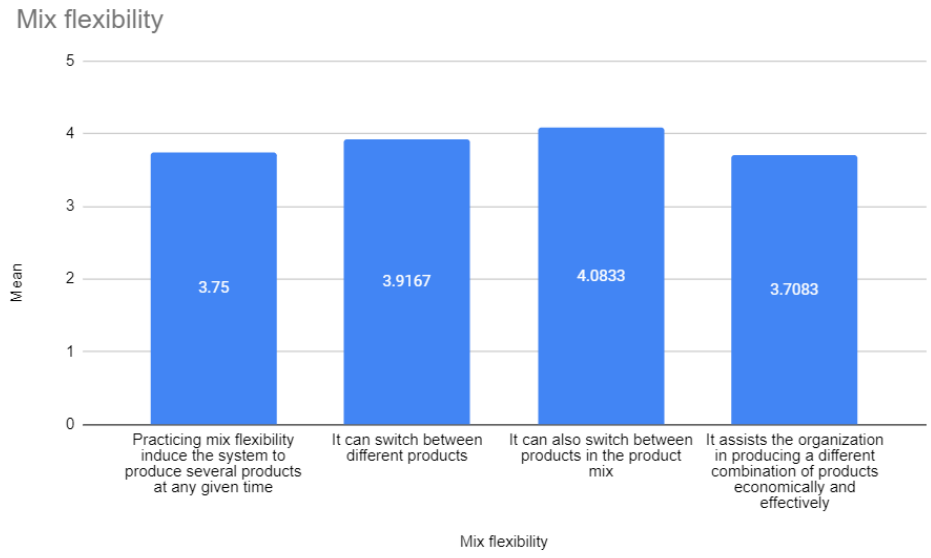
quickly, no special efforts made to switch functions, and the reliability and consistency of performance across operations. Machine flexibility has an average value ranging from 3.6 to 4.4. Thus, the highest standard deviation for the statement is 2.1 for the statement “It is having reliability and consistency of performance across operations”, which has the lowest precision. The least standard deviation for the statement “Machines can perform a variety of operations” is 1.88 which has the highest accuracy.



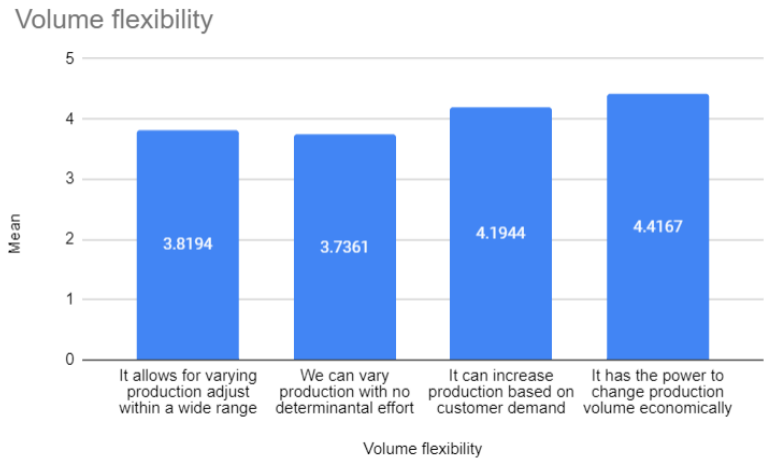
Routing flexibility: The constructs have been framed to measure the routing flexibility using a five-point Likert scale. Constructs include an alternative solution to equipment breakdown and tool failures, increasing machine versatility, recognizing machine reliability, and changing alternative solutions quickly. The average values of the routing flexibility ranged between 3.4-4.1. Thus, the maximum standard deviation for the statement “It can shift alternative solutions within a short period” is 2.07 which has the lowest precision. The least standard deviation for the statement “It increases the individual versatility of machines” is 1.74 which has the highest accuracy.



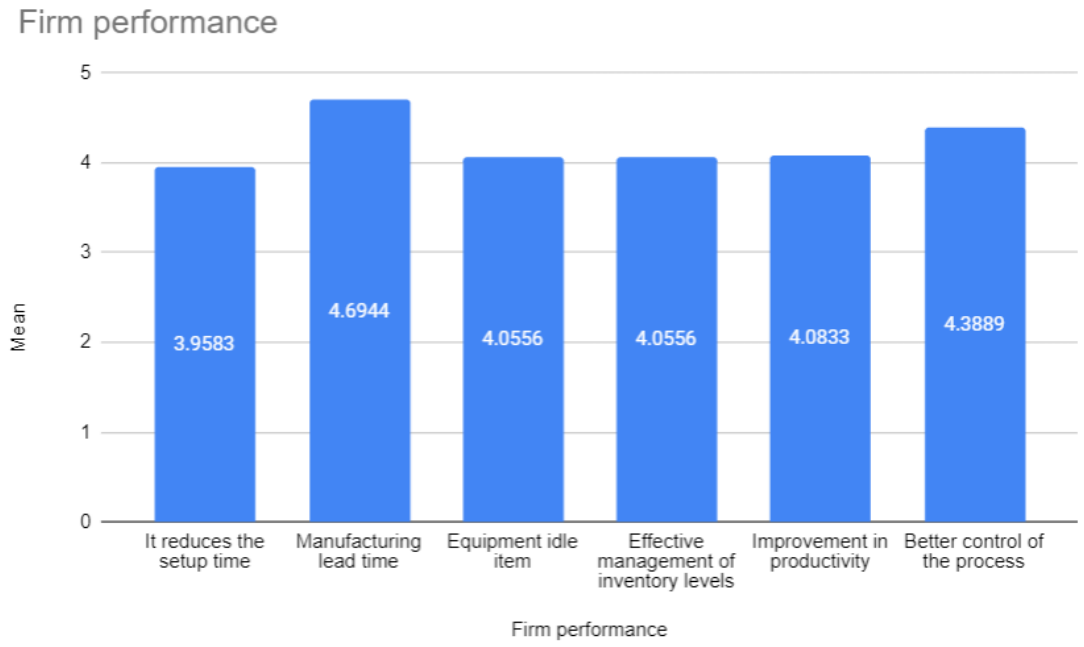
Mix flexibility: Constructs like mix flexibility produce several products at an appropriate time, switch between different products, switch between products in the product mix, and help the organization make a different combination of products economically and effectively. All the constructs relating to mixing flexibility assess with the help of the Likert scale. The average mean values of mix flexibilities vary from 3.7 to 4.1. Hence the highest standard deviation for the statement is "It assists the organization in producing a different combination of products economically and effectively" is 2.05 which has the lowest accuracy. The least standard deviation for the argument "It can switch between different products" is 1.81 which has the greatest precision.



Volume flexibility: The study has the constructs portraying the volume flexibility. Some of the constructs allow for varying production adjusts within a wide range, alter production with no determinate effort, increase production based on customer demand, and change production volume economically. Volume flexibility has an average value ranging from 3.7 to 4.4. Hence the highest standard deviation for the statement "It allows for varying production adjust within a wide range" is 2.07 which has the lowest precision. The least standard deviation for the statement "We can vary production with no determinantal effort" is 1.97 which has the highest accuracy.



Firm performance: The study has utilized the constructs like reducing setup time, lead time, equipment idle time, effective management of inventory levels, improvement in productivity, and better control of the process. All the statements portraying the firm performance and the same assessed using a Likert scale. The firm performance has a mean value varying from 3.9 to 4.7. Therefore, the highest standard deviation for the assertion is 1.98 for reduced setup time, which has the lowest accuracy. The lowest standard deviation for the assertion is 1.78 for better process control.



3.3.3. Relationship between Manufacturing flexibilities and firm performance

The technique uses to measure the association between the variables. If the changes of 1 variable increase, then the other variable must do the same operation. However, changes in one variable increases, then the other variable decreases to a great extent. Both conditions are possible in the Pearson correlation coefficient. The study did a correlation coefficient for all the independent variables (HR, machine, routing, mix, and volume flexibility) and firm performance (dependent variable). But the researcher uses the correlation outcome as to where the independent variable and dependent variable meet.

Table 3. Relationship between flexibility attributes and firm performance

Particulars		value
HR Flexibility	r	.825*
	sig	(.000)
Machine Flexibility	r	.584*
	sig	(.002)
Routing Flexibility	r	.690*
	sig	(.002)
Mix Flexibility	r	.540*
	sig	(.000)
Volume Flexibility	r	.760*
	sig	(.001)

Source: Own calculation

The above table reveals the correlation between flexibility attributes as independent variables and firm performance as dependent variables.

H_1: There is no correlation between HR flexibility and firm performance

The first variables (HR Flexibility and firm performance) showed that the Pearson correlation value is (0.825) and the significant value (0.000) indicates that HR Flexibility has a positive and robust relationship with firm performance, and it is statistically significant

H_2: There is no correlation between machine flexibility and firm performance

The second variable (Machine Flexibility and firm performance) have shown that the person's correlation (0.584) value and the significant (0.002) value indicate that the statistical assessment represents the machine Flexibility is closely linked to firm performance and statistically significant.

H_3: There is no correlation between routing flexibility and firm performance

The third variable (Routing Flexibility and firm performance) suggested that the person's correlation (0.690) value and the significant (0.002) value indicate that there is a close correlation exists between the variables. Also, the strength of the variable is positive.

H_4: There is no correlation between mix flexibility and firm performance

The fourth variable (Mix Flexibility and firm performance) has said that the person's correlation (0.540) value and the P-value denote significant value. Therefore, a correlation existed between the parameters, and their strength is a strong positive.

H_5: There is no correlation between volume flexibility and firm performance

The last variable (volume flexibility and firm performance) has found that the person's correlation (0.760) value and the P-value (0.001). Therefore, the statistical assessment represents a close relationship between the variables, and their strength is positive.

3.3.4. Impact of manufacturing flexibilities on firm performance

Simple linear Regression considers as a technique in calculating how strongly the independent variable is on the dependent variable (Kumari, Yadav 2018, 33). There are two types of regression, namely simple linear and multiple linear regression. The study applies simple linear

regression, which has one dependent and one independent variable. It denotes the succeeding equation. Y=c+mx.

$$y = c + mx \quad (1)$$

$where$

$c = estimated\ coefficient,$

$y = dependent\ variable,$

$x = independent\ variable,$

m=slope of the line.

The impact of HR flexibility on firm performance: Independent variable is HR flexibility whereas the dependent variable is firm performance. With the help of simple linear regression, the study assesses whether the variables are having a linear association between HR flexibility and firm performance. Also, variation in firm performance is assumed to be related to variation in HR flexibility.

Table 4. Impact of HR flexibility on firm performance

Particulars	r	r^2	f	sig	B	t	sig
C	.825	.681	1.399	.000[b]	4.033	14.108	.000
HR flexibility					.045	.632	.000

Source: Own calculation

The model description illustrates the relationship between the dependent and independent variables in a context. R-value is 0.825, and R square is 0.681, which is high, suggesting a close relationship between the variables. The R square value shows that the HR Flexibility on firm performance is 68.1 percent. F value for the variable is 1.399, and the p-value is 0.000. This shows a close relationship between the variables.

The regression test shows that the coefficient's value is 0.825, t is 0.632, and P-value is 0.000. It is also clear that HR flexibility has a strong and positive impact on firm performance. Thus, it denotes it with the help of the equation. Firm performance =4.033+.045 HR flexibility. Lastly, one unit of changes in HR flexibility makes 0.045-unit changes in firm performance.

Table 5. Impact of machine flexibility on firm performance

Particulars	r	r^2	ANOVA		b	t	sig
			f	sig			
C	.584	.341	1.518	.002	3.796	11.090	.000
Machine flexibility					.100	1.232	.002

Source: Own calculation

The study considers machine flexibility as the single explanatory variable—also, the association between the variables (machine flexibility and firm performance) through linear function. Besides, variation in the firm performance is assumed to be related to variation in machine flexibility. The model description of the above table shows the relationship between the dependent and independent variables in a context. R-value is 0.584, and R square is 0.341, which is high, suggesting a close relationship between the variables. The R square value shows that the machine flexibility on firm performance is 34.1 percent. F value for the variable is 1.518, and the p-value is 0.002. This shows a significant relationship between the variables.

The regression test shows that the coefficient's value is 0.584, t is 1.232, and P-value is 0.002. Therefore, it concludes that machine flexibility has a strong and positive impact on firm performance. The simple linear regression equation is firm performance=3.796+0.100 machine flexibility. Thus, it is clear that one unit of changes in machine flexibility makes 0.100 changes in machine flexibility.

Table 6. Impact of routing flexibility on firm performance

Particulars	r	r^2	ANOVA		b	t	sig
			f	sig			
C	.690	.476	3.892	.002	3.583	11.010	.000
Routing flexibility					.166	1.973	.002

Source: Own calculation

From the above table it is clear that the relationship between the dependent and independent variables in a context. R-value is 0.690, and R square is 0.476, which is high, offering a close relationship between the variables. The R square value shows that the routing flexibility on firm performance is 47.6 percent.

F value is 3.892, and the p-value is 0.002. This shows a close and positive relationship between the variables. The regression test shows that the coefficient's value is 0.690, t is 1.973, and P-value is 0.002. Hence it concludes that routing flexibility has a significant impact on firm performance. Simple linear regression is firm performance =3.583+0.166 routing flexibility. Finally, one unit of changes in routing flexibility makes 0.166-unit changes in firm performance.

Table 7. Impact of mix flexibility on firm performance

Particulars	r	r^2	ANOVA		b	t	sig
			f	sig			
C	.540	.292	1.103	.000	4.225	11.548	.000
Mix flexibility					.005	.054	.000

Source: Own calculation

The impact of mix flexibility on firm performance: It considers one single independent variable, i.e., mix flexibility. It assesses the association between two variables, namely mix flexibility and firm performance. The study also presents the variation in firm performance assumed to be related to variation in mix flexibility. The model description indicates the relationship between the dependent and independent variables in a context. R-value is 0.540, and R square is 0.292, which is high, offering a close relationship between the variables. The R square value shows that the mix flexibility on firm performance is 29.2 percent. F value is 1.103, and the p-value is 0.000. This shows a close relationship between the variables.

The regression test shows that the coefficient's value is 0.540, t is 0.054, and P-value is 0.000. Therefore, it is evident that mix flexibility has a strong and positive impact on firm performance. Equation is firm performance = 4.225+0.005 mix flexibility. Thus, it is clear that one unit of changes in mix flexibility makes 0.005 changes in firm performance.

Table 8. Impact of Volume flexibility on firm performance

Particulars	r	r^2	ANOVA		b	t	sig
			f	sig			
C	.760	.578	1.114	.001	4.096	12.158	.000
Volume flexibility					.027	.337	.001

Source: Own calculation

The model description shows the relationship between the dependent and independent variables in a context. R-value is 0.760, and R square is 0.578, which is high, offering a close relationship between the variables. The R square value shows that the volume flexibility on firm performance is 57.8 percent. ANOVA shows that the F value is 1.114, and the p-value is 0.001. This shows a close relationship between the variables.

The regression test shows that the coefficient's value is 0.760, t is 0.760, and P-value is 0.001. Thus, it is inferred that volume flexibility has a strong and positive impact on firm performance. Hence, the linear regression equation is firm performance =4.096+0.027 volume flexibility. Finally, one unit of changes in volume flexibility makes 0.027-unit changes in firm performance.

3.4. Summary of results

The percentage frequency distribution outcome expresses in percentage. The most important findings are presented in the subsequent section.

The study finds that 33.3% of respondents are between the age category of 20-25 years. Besides, respondents are having work experience of 3-5 years (25%). Nearly, 26.4% of respondents having their designation as improvement manager. Out of 26.4% (16.7%) belong to the product test development department. However, the researcher observes that the maximum number of departments are using flexibilities due to incorrect linkages between the department. The primary reason behind using flexibilities is that demand characteristics influenced them to opt for manufacturing flexibility in the organization.

Data of descriptive statistics reported as the mean and standard deviation. The average mean values of HR flexibilities construct varying from 3.7 to 4.1. Machine flexibility has an average value ranging from 3.6 to 4.4. Routing flexibility gets an average value of 3.4 and 4.1. Mix flexibility, which shows the mean value varies from 3.7 to 4.1. Volume flexibility shows the average value ranging from 3.7 to 4.4.

Correlation test uses to determine the association between manufacturing flexibilities and firm performance. There is a correlation found between the five subgroups in terms of HR flexibility & firm performance, machine flexibility & firm performance, routing flexibility & firm

performance, mix flexibility & firm performance, and volume flexibility& firm performance. Thus, it must be noted that all the variables having a strong positive correlation between the variables. From the regression analysis, it is found that the most affected attributes is HR flexibility whereas least affected attribute is mix flexibility.

3.5. Discussion

Manufacturing organizations must give more importance to flexibilities. It is playing a pivotal role in determining every function of the organization. Manufacturing organizations integrate it with flexibilities to be highly responsive to meet the customer need and address the organization's objective. Thus, increasing manufacturing flexibilities accelerate some aspects of organizational performance (Rogers 2008). Thus, it gains a lot of attention recently to upsurge the performance. It leads to gain a competitive advantage in the market (Oke 2005). The observations of the studies like (Nayak 2010; Al-jawazneh 2012; Brettel *et al.* 2016; Mishra 2016; Camison, López 2010; Wei *et al.* 2017) consistent with the outcome that manufacturing flexibilities and performance is statistically significant. With the close agreement of the results with the literature suggested, the researcher to raise below questions

Research question 1: What are the dimensions of manufacturing flexibilities have considered for the study?

Taking inspiration from (Chang *et al.* 2005), the dimensions that influence internal efficiency have been considered. According to the author, machine and routing flexibilities are associated with demand, whereas mix and volume are integrated with uncertainties present in the environment and demand variations. Tan (2016) assist the researcher in took HR flexibility also have an impact on firm performance. Thus, the study fixes flexibilities' dimensions as mix flexibility, volume flexibility, HR flexibility, routing flexibility, and machine flexibility. The above-stated dimensions relating to manufacturing flexibilities have been acquired from the literature support. The study did not apply any tools to derive the dimensions of manufacturing flexibilities in the study.

Research question 2: What is the correlation between dimensions of manufacturing flexibilities and firm performance?

All the dimensions of manufacturing flexibilities have a strong positive association with firm performance. HR flexibility has a strong association with firm performance: The present results were directly compared with the previously reported findings on (Way *et al.* 2018; Úbeda-García *et al.* 2017). Machine flexibility has a strong association with firm performance: The study's outcome stated indirectly in (Mohamed *et al.* 2001). The primary reason for using one article is that no studies have been made directly on machine flexibility. Besides, no study states the association between the variables. But the study assesses the aspects. Other flexibilities like routing, mix, and volume also has an association with firm performance. A similar outcome is also achieved indirectly in studies like (Devaraj *et al.* 2012; Bengtsson 2002; Khan, Ali 2017; Ali, Khan 2019).

Research question 3: Whether the relationship exists between the variables is strong?
The study observes that the dimensions have a positive association with firm performance. The outcome is quite a surprise to the researcher, and the dimensions are also statistically significant.

Research question 4: What is the impact of dimensions of manufacturing flexibilities on firm performance?
It is entirely unsurprising to find a considerable percentage of the impact of manufacturing flexibilities on firm performance.

3.6. Practical implications

The findings of the study lead to below implications
HR flexibility: Firms have HR practices to implement or make changes quickly. They are practicing it effectively. The outcome also proves with the statistical output that HR flexibility has an impact on firm performance. The impact was 68.1%, and hence it is vital to accelerate to more extent can accelerate the organization's value. The firm must practice a remuneration system not based on the description of jobs. Following a flexible pay, the system makes the organization to practice it quickly. Faster changes have a direct link with profits, which in turn increases the profits of the organization. Besides, they must follow similar practices in all units to have coherence all over the organization. The action can upsurge innovativeness among employees. Apply innovativeness in production directly leads to achieving competitive advantage.

Mix flexibility: The study identifies that the organization has a 29.2% effect on firm performance. Hence it portrays clearly that the organization has less ability to deal with uncertainty. They are finding difficulty in producing a different combination of items economically and efficiently with the available resources. To upsurge mix flexibility, organizations must recruit skilled workers and use more programmable equipment. The action of doing must need huge investment. Investing in materials and human resources assist in producing more products within a short period. Consequently, it enables the organization to gain rivalry by producing various products in a short time.

Volume flexibility: The effect of flexibility is 57.8% on firm performance. Thus, it states that the organization can accelerate the production volume based on market demand. They keep their inventory low when the demand is low in the market. They can adjust production based on limits. The organization must concentrate on two aspects: speed of response and variation rage to upsurge volume flexibility. Both can help to protect the organization from uncertainty in demand level. Besides, it also protects the excellent range of the organization.

Machine flexibility: Machine flexibility has an impact of 34.1% on firm performance. It suits producing a meagre number of products, but the organization occasionally receives such kinds of orders. Even though the organization is equipped with technology, material, and resources, frequency leads to lower performance. Thus, it is advisable to train the operators more on technical aspects like programming, maintenance, and diagnostic skills. The action can increase the machine utilization based on demand and available capacity.

Routing flexibility: This kind of flexibility relies on machine reliability. Regression analysis shows that the organization impacts machine flexibility 47.6%, which is on firm performance. It observes from the study that routing flexibility is the second least flexibility of the organization. It is crucial to give importance to routing flexibility to eliminate delays and deterioration in the production area. Hence it is advisable to have an algorithm to schedule flexibility with various routes. Consequently, the production area should have alternative machines to increases the machine versatility in the respective areas. The action of doing can eliminate the system deadlock with the breakdown and downtime.

CONCLUSION

Manufacturing flexibilities are considered the organization's abilities to cope with changes made in the external environment. Besides, it can organize the process to generate different products based on unexpected business environment changes. It helps the organization cope with new products with minimal time, cost, effort, and performance. The aspects influenced the researcher to study whether there is any relationship between manufacturing flexibilities and firm performance. Manufacturing flexibilities include HR flexibility, machine flexibility, routine flexibility, mix flexibility, and volume flexibilities. However, firm performance measures in setup time, manufacturing lead time, equipment idle time, better control in the process, and productivity improvement. To assess the relationship, the researcher considers the respondents' opinions from various departments. It includes HR, product quality management, water treatment, product test department, and IT. Respondents' views assess using correlation, which provides an outcome that the flexibilities have a close relationship with firm performance. The association is strongly positive and statistically significant—however, the impact of flexibilities represented in percentages. Consequently, HR flexibility has a 68.1% impact, followed by 57.8% for volume flexibility, 47.6% for routing flexibility, 34.1% for machine flexibility, and 29.2% for mix flexibility. Also, all the flexibilities have a certain percentage of impact on firm performance.

Scope for further research: Every organization is applying manufacturing flexibilities that help to reconfigure the resources efficiently through various products. Hence, manufacturing flexibilities paves the way for the organization to widen the product ranges at low cost and time. Thus, the study assesses flexibilities in terms of HR flexibility, machine flexibility, routine flexibility, mix flexibility, and volume flexibilities. But there is no effort made to find out how the flexibilities are modifying the business model design. The obtained results justify further development of adding mediating aspects as business model design with the dependent and independent variable. Besides, measuring future elements can indicate that manufacturing flexibilities impact the mediating variable (business model design). Also, it helps to know the effect of manufacturing flexibilities on firm performance mediating by business model design.

Limitations of the study: The researcher surveys Stora Enso, Estonia. The organization has various locations like Finland, Sweden, China, Poland, Germany, and Russia. The study extends it to the above-stated locations; then, there is a chance to generalize the outcome. The organization has an average of 26,096 employees, but the researcher limits its geographical location to Estonia. Also, the sample size to be 72. Hence, the samples did not represent the whole population. The study considers the employees from HR, product quality management, water treatment, product test department, and IT. Due to limited time constraints, the researcher could not get the opinion from other departments. Besides, the pandemic situation restricts the researcher to limit departmental employees.

Summary: The central theme of the thesis is to determine the association between manufacturing flexibilities and firm performance. From the in-depth analysis, the study finds that the manufacturing flexibilities have a strong positive association with firm performance. Simple linear regression points out that the manufacturing flexibilities like HR flexibility, machine flexibility, routine flexibility, mix flexibility, and volume flexibilities have an impact on firm performance. The study finds that the highest impact can be seen in HR flexibility, whereas the least influence is on mix flexibilities. The outcome of the study offers insights that the department in an organization has the flexibilities to meet the target on time. Thus, it is advisable to have flexibilities in all departments which induce the employees to come up with innovative ideas that would lead to achieving higher productivity.

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APPENDICES

Appendix 1. Questionnaire

1. Age

   ……

2. Education qualification

   ……

3. Work experience

   …….

4. Designation

   ……

5. Department

   …….

6. Which kind of flexibilities is highly using in your department?
   a. HR flexibility
   b. machine flexibility
   c. Routing flexibility
   d. Mix flexibility
   e. Volume flexibility

7. What are the reasons to go for manufacturing flexibilities?
   a. Advancement in technology
   b. New failures
   c. Incorrect linkages between database
   d. Prevent problems
   e. Eliminate programming errors
   f. Improper gripping

g. Others

8. What are the factors deriving manufacturing flexibility in the organization?
   a. Environmental concern
   b. Product strategy
   c. Competitors behaviour
   d. Demand characteristics
   e. Stage in the life cycle of products

9. Please indicate whether you agree or disagree with each of the following statements, and how strongly, by ticking one box for HR flexibility? (7- Strongly agree to 1-Strongly disagree)

Particulars	7	6	5	4	3	2	1
Flexibility in HR process helps to make changes easily							
It enables us to achieve coherence throughout the organization							
Practicing HR flexibility is enriching flexible behaviour among employees							
Employees can perform new functions within a short period							

10. Please indicate whether you agree or disagree with each of the following statements, and how strongly, by ticking one box for machine flexibility? (7- Strongly agree to 1-Strongly disagree)

Particulars	7	6	5	4	3	2	1
Machines can perform a variety of operations							
It has the options to adjust machines very quickly							
There is no special effort made to switch operations							
It is having reliability and consistency of performance across operations							

11. Please indicate whether you agree or disagree with each of the following statements, and how strongly, by ticking one box for Routing flexibility(7- Strongly agree to 1-Strongly disagree)

Particulars	7	6	5	4	3	2	1
It is offering alternative solutions to equipment breakdown and tool failures							
It increases individual versatility of machines							
It helps to study the reliability of machines using route flexibility							
It can shift alternative solutions within a short period							

12. Please indicate whether you agree or disagree with each of the following statements, and how strongly, by ticking one box for Mix flexibility(7- Strongly agree to 1-Strongly disagree)

Particulars	7	6	5	4	3	2	1
Practicing mix flexibility induce the system to produce several products at any given time							
It can switch between different products							
It can also switch between products in the product mix							
It assists the organization in producing a different combination of products economically and effectively							

13. Please indicate whether you agree or disagree with each of the following statements, and how strongly, by ticking one box for Volume flexibility (7- Strongly agree to 1-Strongly disagree)

Particulars	7	6	5	4	3	2	1
It allows for varying production adjust within a wide range							
We can vary production with no determinantal effort							
It can increase production based on customer demand							
It has the power to change production volume economically							

14. Please indicate whether you agree or disagree with each of the following statements, and how strongly, by ticking one box for Firm performance (7- Strongly agree to 1-Strongly disagree)

Particulars	7	6	5	4	3	2	1
It reduces the setup time							
Manufacturing lead time							
Equipment idle item							
Effective management of inventory levels							
Improvement in productivity							
Better control of the process							

Appendix 2. Descriptive statistics results

Table 9. HR flexibility

Particulars	mean	standard deviation
Flexibility in the HR process helps to make changes easily	3.8056	2.08711
It enables us to achieve coherence throughout the organization	3.9306	2.06463
Practicing HR flexibility is enriching flexible behaviour among employees	4.0694	2.15149
Employees can perform new functions within a short period	3.7222	2.03644

Table 10. Machine flexibility

Particulars	mean	standard deviation
Machines can perform a variety of operations	4.3611	1.87876
It has the options to adjust machines very quickly	4.1806	2.03024
There is no special effort made to switch operations	4.0972	2.02213
It is having reliability and consistency of performance across operations	3.6944	2.10056

Table 11. Routing flexibility

Particulars	mean	standard deviation
It is offering alternative solutions to equipment breakdown and tool failures	3.4722	1.83834
It increases the individual versatility of machines	4.0278	1.74398
It helps to study the reliability of machines using route flexibility	3.9167	1.82124
It can shift alternative solutions within a short period	3.5833	2.06752

Table 12. Mix flexibility

Particulars	mean	standard deviation
Practicing mix flexibility induce the system to produce several products at any given time	3.7500	1.94103
It can switch between different products	3.9167	2.01927
It can also switch between products in the product mix	4.0833	1.81349
It assists the organization in producing a different combination of products economically and effectively	3.7083	2.05171

Table 13. Volume flexibility

Particulars	mean	standard deviation
It allows for varying production adjust within a wide range	3.8194	2.07144
We can vary production with no determinantal effort	3.7361	1.97158
It can increase production based on customer demand	4.1944	2.02546
It has the power to change production volume economically	4.4167	1.99118

Table 14. Firm performance

Particulars	mean	standard deviation
It reduces the setup time	3.9583	1.98187
Manufacturing lead time	4.6944	1.86622
Equipment idle item	4.0556	1.89059
Effective management of inventory levels	4.0556	1.82231
Improvement in productivity	4.0833	1.82895
Better control of the process	4.3889	1.78850

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(*title of the graduation thesis*)

supervised by Maris Zernand-Vilson, Ph.D,

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