A CASE STUDY ON IMPLEMENTATION OF JUST-IN-TIME (JIT) PRODUCTION SYSTEM IN MALAYSIA AUTOMOTIVE INDUSTRY

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A CASE STUDY ON IMPLEMENTATION OF JUST-IN-TIME (JIT) PRODUCTION SYSTEM IN MALAYSIA AUTOMOTIVE INDUSTRY

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Thesis submitted in fulfillment of the requirements
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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Engineering Manufacturing or Bachelor of Manufactuirng Engineering

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Dedicated to my beloved parents

Abd Aziz Ismail

Rosilah Rashid

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ABSTRACT

This thesis deals with production system and management used in automotive industry. Just-In-Time (JIT) production system is originates from Japan and claimed as one of the best production system that leads Toyota Motor Corporation (TMC) as one of the best car manufacturer in the world. Even there have been a lot of studies related to JIT production system in automotive industry globally; there is still lack of evidence that Malaysia automotive industry is practicing this remarkable production system. Because of that, this study conducted to explore and figure out on JIT implementation in Malaysia automotive industry. This study started on reviewing elements suggested by literature that are considered important to ensure the successfulness of JIT implementation in an organization. These identified elements then used in investigation of JIT implementation in Malaysia automotive industry. A set of questionnaire designed based on activities that related to elements figured in order to further investigate of JIT implementation in an organization. This questionnaire then distributed randomly to automotive companies all over Malaysia. All data then collected and tested by using a well-known statistical test, a Chi-Square test. Chi-Square test used to find the relationship between elements and activities with types of industry practices in Malaysia automotive industry. These elements are then analyzed and decided either independent or dependent on types of industry. The findings are then summarized with some recommendations suggested to automotive company that is planning to implement JIT in their organization.

ABSTRAK

Tesis ini berkaitan dengan sistem pengeluaran dan pengurusan yang digunakan dalam industri automotif. *Just-In-Time (JIT)* merupakan sistem pengeluaran yang berasal dari Jepun dan dikatakan sebagai salah satu sistem pengeluaran terbaik yang mendorong *Toyota Motor Corporation (TMC)* sebagai salah satu pengeluar kereta terbaik di dunia. Walaupun terdapat banyak kajian yang berkaitan dengan sistem pengeluaran JIT dalam industri automotif di peringkat global; masih terdapat kekurangan bukti bahawa industri automotif Malaysia mengamalkan sistem pengeluaran ini. Oleh kerana itu, kajian ini dijalankan untuk meneroka dan mengkaji pelaksanaan JIT dalam industri automotif Malaysia. Kajian ini dimulakan untuk mengkaji unsur-unsur yang dicadangkan oleh sastera yang dianggap penting untuk menentukan kejayaan pelaksanaan JIT dalam sesebuah organisasi. Unsur-unsur yang dikenal pasti ini kemudiannya digunakan dalam penyiasatan pelaksanaan JIT dalam industri automotif Malaysia. Set soal selidik direka berdasarkan aktiviti-aktiviti yang berkaitan dengan unsur-unsur yang digambarkan bagi mengkaji dengan lebih lanjut pelaksanaan JIT dalam sesebuah organisasi. Soal selidik ini diedarkan secara rawak kepada syarikat-syarikat automotif di Malaysia. Semua data yang kemudiannya dikumpulkan dan diuji dengan menggunakan ujian terkenal statistik, ujian *Chi-Square*. Ujian *Chi-Square* digunakan untuk mencari hubungan antara elemen-elemen dan aktiviti-aktiviti bersesuaian dengan jenis amalan industri automotif Malaysia. Unsur-unsur ini kemudian dianalisis dan diputuskan sama ada bebas atau bergantung kepada jenis amalan industry automotif negara. Hasil kajian ini kemudiannya diringkaskan dengan mengutarakan beberapa cadangan kepada syarikat automotif yang merancang untuk melaksanakan JIT di dalam organisasi mereka.

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LIST OF ABBREVIATION

JIT	Just-In-Time
LPS	Lean Production System
QC	Quality Circle
TMC	Toyota Motor Corporation
TPS	Toyota Production System
TQC	Total Quality Control

CHAPTER 1

INTRODUCTION

1.1 TOYOTA PRODUCTION SYSTEM

Toyota Production System (TPS) is one of a well-known successful manufacturing system all over the world. TPS is developed by Japanese and being adapted in either manufacturing or in management world since it brings enormous benefits to Toyota, the first implemented company.

The basic goal and objective of TPS is to reduce their lead time (Ohno, 1987; Liker, 2004). Lead time can be described as a moment when a customer place an order to the point where they receive the order and manufacturer collect the cash (Ohno, 1987). Reducing lead time, Toyota aimed to reduce non-value added waste.

According to the founder of Toyota Motor Company (TMC), the best way to survive in automobile manufacturing is that having all the parts for assembly at the side of their line just in time for their use (Ohno, 1987). As automotive industry is viewed as one of the toughest industries existed in the world, a good management system is highly important to ensure the continuity of the business.

The idea of having all parts for assembly ready at their line only when they are needed leads to the invention of a remarkable system called Just-In-Time (JIT). Because of its efficiency, the system is then classified as one of the pillars of TPS. Referring to Ohno (1987), the famous TPS is build up with two important pillars. As one of the pillars is JIT, the other pillar is called Jidoka. These two pillars are considered important and lead to the successfulness of TPS. Further understanding of TPS can be illustrated in a house diagram (Shook, 2009).

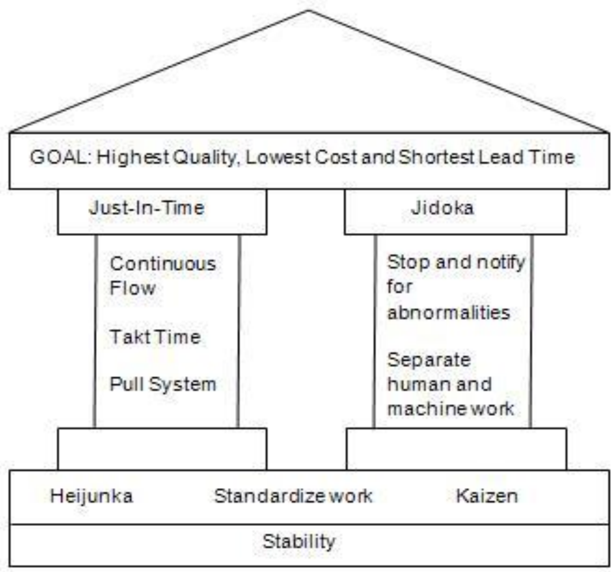

Figure 1.1: Toyota Production System (TPS) House (Shook, 2009)

Referring to Fig. 1, the successfulness of the great TPS is driven by a lot of supporting factors. Stability of a company in term of material, process, man power as well as machine play major role as it is considered as a basic fundamental of TPS house. Heijunka, means leveling the production amount, standardized work where all process and action were recorded and established in a fix step-by-step instruction, and Kaizen, meaning that continuous improvement practiced are also considered as the fundamental of TPS house (Ohno, 1987; Shook, 2009).

Toyota goal as been stated in TPS house is to produce highest quality product with lowest cost with a shorter lead time. Achieving this goal, two pillars needed despite of the fundamental elements that have been described earlier. These two pillars are JIT and Jidoka. JIT can be considered as manufacturing techniques that produce and deliver part or product in just amount needed. To achieve JIT conditions, three elements listed. These elements are continuous flow, takt time production, and pull system. Another pillar of TPS is Jidoka. Jidoka means automation with human touch. According to this pillar, machines should be able to stop and notify abnormalities. Human work and machine work also should be separated. Companies that implement JIT are able to reduce inventory level and approach zero inventory conditions (Ohno, 1987).

According to Ohno (1987) and Liker (2004), the concept of JIT in Toyota works in a reverse direction where the final assembly line is taken as a starting point. The final process withdraws the required quantities of production from the preceding process at a certain time (Ohno, 1987). This procedure is repeated in reverse order up through all the earlier processes. Visualizing the concept of JIT, a good flow of process coordination required. Hence, a signal card called Kanban being introduced (Ohno, 1987). Kanban able to ensure all movements in plants could be unified and systematic (Liker, 2004). Kanban carries three categories of information. Those information are pick up information, production information, and transfer information.

As Kanban only send signal to production on what should only be produced, the usage of Kanban help Toyota to eliminate waste of overproduction as well as waste of inventory. A company that has more inventory, will have the less likely what they need (Liker, 2004). Reducing inventory helps company to save cost. For example, reducing inventory can eliminate the need of ware house and its manager. Having a high inventories also makes problems are explicitly hard to detect (Ohno, 1987). Kanban helps Toyota achieve their objective by reducing waste, smoothen the production flow as well as satisfying their customer by having on time delivery. Achieving JIT environment, Kanban is considered a powerful tool that able to visualize the situation (Ohno, 1987).

1.2 THE DEFINITION OF JUST-IN-TIME (JIT)

TPS was being implemented across nation after the oil crisis in fall of 1973 (Ohno, 1987). This mean, JIT was also adopted by other automotive manufacturers as well as electronic manufactures in Japan (Moreira and Alves, 2008). Moreover, Japanese manufacturing firm is to be told having the best globally manufacturers reputation for superior quality and growth in productivity by implementing JIT system (Keller and Kazizi, 1993). As JIT approach are simple and able to control inventories, US industries were pleased to use and implement JIT method in order to catching up with Japanese fast rising industries (Moreira and Alves, 2008). Since then, JIT is being implemented globally (Schonberger, 1982).

According to TPS, JIT means that; in a flow process, the right parts needed in assembly reach the assembly line at the time they are needed and the amount needed (Ohno,1987). But, as JIT has been spread globally, the word JIT have been interpreted in various definitions as it being introduce outside Japan. Some claimed JIT as a manufacturing philosophy that utilize all value added sources and activities as well as seeks and eliminate waste efficiently (Moreira and Alves, 2008). JIT also is defined with the emphasizing of continuous improvement in adapting organization (Hum and Ng, 1994).

Most importantly, JIT is a pull system (Ohno, 1987), where, successful companies that implement JIT will strikes two major objectives, which are, improving in quality of product produced with the ability of controlling production time and delivery to customer (Fullerton and McWatters, 2001). Above all, the definition of JIT can be simplified for better understanding. JIT can be defines as a manufacturing philosophy that makes and delivers just what is needed, just when is needed, and just amount needed.

1.3 OBJECTIVE

JIT is globally adapted in world-wide companies especially among automotive manufacturers. Owing to the lack evidence of JIT production system practices among Malaysian manufacturer especially in automotive companies, the objective in this paper is to study on implementation of JIT in automotive companies in Malaysia. With that, it is hope this study will be beneficial for the Malaysia automotive industries in adopting the world greatest manufacturers' philosophy, for profitable business, and better production performances in implementing companies.

1.4 SCOPE OF STUDY

Scope of study will cover the system and management use in automotive companies all over Malaysia. As JIT is originally developed from automotive company back in Japan, it is assumed that the best field to implement the system outside the country is in the same field which is automotive. This is because they share the same nature, almost similar production, and shares likely same problems.

In this study, automotive companies will be selected randomly and assessed based on their JIT implementation in production system.

CHAPTER 2

LITERATURE REVIEW

2.1 VARIOUS ELEMENTS OF JIT IMPLEMENTATION

JIT is viewed as more of a philosophy than a series of manufacturing techniques (Sohal *et al*., 1989). It also is viewed as a set of management technologies in global world (Brox and Fader, 1997). Because of that, JIT has been famous to the world. United States has become the earliest country that implements JIT in year 1982 (Moreira and Alves, 2008). However, implementing JIT is not easy. Since JIT being introduces, lot of studies conducted assessing the best implementation method. But, until today, there is no specific guideline and best method outlined in any studies related to the best implementation practices.

JIT requires a complex changes in organization (Ahmed *et al*., 1991). As JIT viewed as organizational philosophy, an organization needs to modify its operating procedures, production system and its organizational culture (Yasin and Wafa, 1994). Besides that, in order JIT to be effective, JIT has to be viewed as organization wide (White *et al*., 2010; Matsui, 2007; Fullerton and McWatters, 2001 and Gilbert, 1990).

Many researchers argue that culture is the most critical element to the successful implementation by Japanese. Moreover, the effectiveness and success of TPS is claimed derived from the Japanese culture amongst themselves (Brox and Fader, 1997). So, to enjoy the fruit of JIT, it requires an organizational to change their organizational culture (Yasin and Wafa, 1994). Many organizations failed adopting and implementing JIT because of difficulties to adopt new methods due to present culture they have in organization (Aghazadeh, 2004). This present work culture that organization has is a way different than strong Japanese work ethic (Brox and Fader, 1997).

A lot of phases, methods and elements implementing JIT suggested by researchers appeared in literature. But, these methods or phases are different from each other. Based on TPS, three elements should be considered in implementing and ensuring JIT success (Ohno, 1987). First element is takt time production. Takt time production indicates time required to produce a product to meet customer demand. As the production follows takt time, there will be no over production or shortage in production. Second element is smooth flow production. Smooth flow production will ensure the continuous flow of material in a production line. Last element is pull production. Pull system withdraws subsequent part from preceding process and works in reverse direction. Pull system works in reverse direction in a process flow with the aid of Kanban card.

Creativity and consideration of many aspects are needed in implementing JIT outside Japan due to the differences of work culture. Hence, various implementation elements appeared in literature day by day. As an impact, various numbers of crucial elements recorded in research. Some researches suggest only three crucial elements in implementing JIT (Aghazadeh, 2004). But, these elements are different from JIT pillar of TPS (Ohno, 1987). A study conducted by Spencer and Guide (1993) suggest four elements. Other researchers, Nellemann and Smith (1982) suggest eight elements, fourteen elements suggested by research conducted by Voss and Robinson (2007), sixteen elements (Sakakibara *et al*., 1993) or as many as twenty elements (Mehra and Inman, 1992) that is considered important in JIT implementation.

Simplifying the discussion of implementation problems, a classification of effort towards JIT is then classified into four different levels (Safayeni *et al*., 1991). Another study also found that implementation of JIT should be involving only three phases with detail building block (Cheng, 1991). This building block consist of waste elimination, total employee involvement and workplace organizations. According to Cheng, a company must do justification of awareness development and strategy formulation as the first step. Next phase should be with the organization, where setting up steering committee, recruiting JIT champion, selecting project teams and developing project leaders should be done in the phase. JIT champion is a person who initiates JIT implementation and usually will be responsible for and takes a leadership role in entire implementation process (Zhiwei and Meredith, 1995). In contrast, another study had listed only ten elements that should be considered in implementing JIT (Cheng, 1996).

Some research used alternate model to conduct a study on elements of JIT implementation (Chong *et al*., 2001). The model consists of three elements to ensure successful of JIT implementation. Organizational support that leads to JIT implementation will produce performance improvement. Different from another study conducted by Lawrence and Hottenstein (1995), factors includes employee, managers, and suppliers are identified as the most critical elements in order to ensure firms that implement JIT gains benefits.

Employee involvement also has been considered a major factor of JIT implementation elements (White *et al*., 2010). To support employee involvement, quality circle and total quality controls are being practiced (Arogyaswamy and Simmons, 1991). To make short, a review and analysis been conducted in order to detect the most important and crucial elements needed to implement JIT at a company that can ensure JIT success.

2.2 JIT MOST FREQUENT IMPLEMENTATION ELEMENTS ANALYSIS

Since there have been a lot of arguments in defining critical elements of JIT implementation, an analysis of case studies, journals and books from available resources for the past 33 years are summarized. Each critical element identified and recorded. The frequencies of critical elements mentioned noted. The result is shown in Table 2.1. Table 2.2 shows researcher and year of research. Based on Table 2.1, Table 2.3 summarized element that mentioned in literature at least ten or more than ten times. These elements are considered crucial in implementing JIT at a company.

Table 2.1: Elements and frequencies identified by researchers

No	Element	Researcher	Total
1.	Education and training	3, 5, 10, 15, 11, 16, 18, 23, 25, 28, 30, 32, 35, 37, 38, 42, 43, 44, 47, 51	20
2.	Employee involvement	3, 4, 11, 12, 15, 17, 18, 26, 27, 31, 33, 35, 43, 44, 46, 47, 49, 52, 56	19
3.	Total quality control or quality circle	3, 4, 9, 11, 14, 15, 16, 17, 19, 23, 24, 25, 27, 29, 34, 36, 37, 41, 43, 44, 46, 47, 48, 50, 53, 55, 56	27
4.	Simplification product design	3, 4, 14, 15, 24, 27, 42, 55	8
5.	Reduce inventory	15, 55	2
6.	Decrease lot size	1, 2, 6, 4, 7, 10, 14, 15, 17, 20, 26, 27, 29, 37, 42, 43, 44, 45, 47, 49, 54	21
7.	Vendor/supplier relationship	3, 5, 11, 15, 16, 18, 23, 30, 34, 37, 44, 46, 47, 48, 49, 51	16
8.	Total preventive maintenance	3, 5, 10, 14, 15, 24, 26, 27, 29, 36, 37, 42, 43, 44, 47, 50, 53, 55, 56	19
9.	Eliminate waste	1, 2, 3, 6, 15, 33, 34, 44, 46, 51	10
10.	Workplace organization	33, 42	2
11.	Withdrawal by subsequent process (pull system)	1, 2, 5, 6, 7, 10, 14, 17, 20, 26, 27, 29	12
12.	Smooth flow production	1, 2, 3, 4, 5, 6, 7, 10, 11, 14, 15, 17, 19, 20, 21, 24, 26, 27, 28, 29, 30, 48, 52, 53, 55, 54	26
13.	Leveling of production	1, 2, 6	3
14.	Setup time reduction	1, 2, 3, 4, 5, 6, 7, 10, 14, 17, 20, 24, 26, 27, 29, 36, 37, 42, 43, 44, 45, 47, 50, 51, 53, 54, 55, 56	28

Table 2.1: Continued

No	Element	Researcher	Total
15.	Mixed model	3, 24, 45, 55	4
16.	Standardization	3, 24, 53, 55	4
17.	Kanban	3, 10, 24, 29, 36, 42, 45, 49, 50, 52, 54, 55, 56	13
18.	Top management commitment	5, 9, 12, 16, 24, 25, 30, 37, 43, 44, 47, 48	12
19.	Continuous improvement	33, 51, 55	3
20.	JIT scheduling	10, 42, 45, 49, 54	5
21.	Adaption of MRP System	42, 52, 54	3
22.	Pilot project	35, 37, 47	3
23.	Group technology	10, 29, 36, 44, 47, 49, 50, 56	8
24.	JIT team	47, 48	2
25.	Communication	44, 47	2
26.	Process and workers flexibility	1, 2, 5, 6, 10, 14, 20, 23, 27, 29, 36, 42, 47, 50, 53, 55, 56	17
27.	JIT purchasing	10, 29, 36, 50, 53, 55, 56	7
28.	Reduce number of supplier	23	1
29.	Uniform workload	1, 2, 6, 4, 5, 7, 10, 14, 17, 20, 26, 27, 29, 36, 50, 56	16

Table 2.2: Researcher and year of research

No	Researcher	No	Researcher	No	Researcher
1.	Sugimori et al. (1977)	20.	Shingo (1988)	39.	Young (1992)
2.	Monden (1981)	21.	Westbrook (1988)	40.	Brown and Inman (1993)
3.	Schonberger (1982)	22.	Inman and Mehra (1989)	41.	Inman and Boothe (1993)
4.	Wantuck (1983)	23.	Sohal et al. (1989)	42.	Sakakibara et al. (1993)
5.	Lee and Ebrahimpur (1984)	24.	Gilbert (1990)	43.	Spencer and Guide (1993)
6.	Pegels (1984)	25.	Harber et al. (1990)	44.	Ramarapu et al. (1994)
7.	Suzaki (1985)	26.	Piper and McLachlin (1990)	45.	Flynn et al. (1995)
8.	Walton (1985)	27.	Sakakibara et al. (1990)	46.	Lawrence and Hottenstein (1995)
9.	Celley et al. (1986)	28.	Schmenner and Rho (1990)	47.	Zhiwei and Meredith (1995)
10.	Finch and Cox (1986)	29.	White and Ruch (1990)	48.	Yasin and Wafa (1996)
11.	Schonberger (1986)	30.	Ahmed et al. (1991)	49.	Sriparavastu and Gupta (1997)
12.	Walleigh (1986)	31.	Arogyaswamy and Simmons (1991)	50.	Chong et al. (2001)
13.	Voss and Harrison (1987)	32.	Billesbach et al. (1991)	51.	Biggart and Gargeya (2002)
14.	Voss and Robinson (1987)	33.	Cheng (1991)	52.	Aghazadeh 2004
15.	Buker (1988)	34.	Golhar and Stamm (1991)	53.	Kumar and Grewal (2007)
16.	Crawford et al. (1988)	35.	Safayeni et al. (1991)	54.	Matsui (2007)
17.	Hay (1988)	36.	Davy et al. (1992)	55.	Voss and Robinson (2007)
18.	Krafcik (1988)	37.	Mehra and Inman (1992)	56.	White et al. (2010)
19.	Schmenner (1988)	38.	Snell and Dean (1992)		

Table 2.3: Frequencies of elements mentions

No	Element	Total
1.	Setup time reduction	28
2.	Total quality control or quality circle	27
3.	Smooth flow production	26
4.	Decrease lot size	21
5.	Education and training	20
6.	Employee involvement	19
7.	Total preventive maintenance	19
8.	Process and workers flexibility	17
9.	Uniform workload	16
10.	Vendor/supplier relationship	16
11.	Kanban	13
12.	Top management commitment	12
13.	Withdrawal by subsequent process (pull system)	12
14.	Eliminate waste	10

Table 2.1 shows that there are twenty-nine elements that frequently appeared in literature and considered important in JIT implementation. Those elements are various and contradict to each other research. From Table 2.1, further analysis is being conducted to indicate which elements are actually important in implementing JIT.

Referring to Table 2.3, as been mentioned by researchers at least ten times or more, these fourteen elements are considered important in JIT implementation at a company or organization. From Table 2.3, we clearly indicate that there are fourteen elements that being mentioned at least ten times or more. These elements are considered crucial in order to implement JIT and the existence of these elements able to ensure the successful implementation of JIT at a company or organization.

2.3 TOP FOURTEEN JIT CRITICAL ELEMENTS

Setup time reduction is the most critical elements in implementing JIT at organization (White *et al*., 2010; Prasad, 1995; Sakakibara *et al*., 1993 and Monden, 1981). Reducing set-up time can enhance JIT production strategy towards better implementation of JIT (Mehra and Inman, 1992). Reduction of machine set-up time is required to accomplish the ideal lot sizes of one unit (Zhiwei and Meredith, 1994). The set-up and die changeover refers to the time lost between the productions of the last item until the production of the new item of comparable quality is made (Prasad, 1995). Evidence of setup time reduction can be shown through several activities. For example, changeovers are done in minutes rather than hours (Sugimori *et al*., 1977), changeover eliminated completely (McLachlin, 1997); and establishing special setup reduction team and projects (Sakakibara *et al*., 1993). Adding to that, reducing set-up time can eliminate waste (Aghazadeh, 2004). Waste is defined as any activity which does not advance the firm towards its stated objectives (Gilbert, 1990). Similar to Toyota objective, reducing waste can enables a company to achieve JIT environment.

Total Quality Control (TQC) or Quality Circle (QC) of an organization have been second leading elements appeared in literature for the past thirty-three years. TQC is defined by program that establishes quality as the top priority of the organization's business objectives; involving supplier and all function of employees. On the other hand, QC is defined by employee participation program where involve employee in problem solving and decision making (White *et al*., 2010). QC can guarantee continuous quality improvement and quality control of an organization (Ramarapu *et al*., 1993). In simple word, quality is one of the important elements that should be considered in implementing JIT at organization. This is because; the achievement of high quality levels is a prerequisite of successful JIT (Chong *et al*., 2001; Sohal *et al*., 1989 and Booth, 1988). Common use quality programs in support JIT includes zero defects, statistical process control and work team quality control (Voss and Robinson, 2007). TQC also consists of supplier quality level, where it is measured by the step to involve supplier in the planning and quality improvement process (Sakakibara *et al*., 1993). As the aim of JIT is to produce product to meet customer demand, with perfect quality together with zero unnecessary lead time (Brox and Fader, 1997) quality is considered one of important elements in implementing JIT.

Other important elements implementing JIT is smooth flow production (Kumar and Grewal, 2007; Ahmed *et al*., 1991; Wantuck, 1989 and Shingo, 1988). Flow or physical layout of the production facilities is arranged to make the process flow is streamlined as possible (Voss and Robinson, 2007). Smooth flow production can be understood as reducing complexities of a manufacturing process (White *et al*., 2010). To smoothen the production flow, workplace organization is needed. Visual control or displays can helps in management by sight. Good visual or display system gives the warning prior to occurrence of problems as well as any corrective actions (Prasad, 1995). Another way to obtain smooth flow production is equipment layout (Matsui, 2007 and Sakakibara *et al*., 1993). The use of manufacturing cells, machine and process layout, and the use of equipment design for flexible floor layout are considered important. Adding idea to smooth flow production is when lines are run continuously and parts are move piece by piece down a line stopping for the addition of new pieces (Cheng, 1991). Mixed model also can be a good practice of smooth flow production where it can cuts the amount of floor space and inventory (Flynn *et al*., 1995 and Gilbert, 1990). One piece flow is the highest level of smooth production (Sugimori *et al*., 1977). One piece flow is that all processes approach the condition where each process can produce only one piece can convey it at a one time, and in addition have only one piece in stock both between the equipment and the process.

Decrease lot size is another element that is considered crucial in implementing JIT success (Ramarapu *et al*., 1993; Piper and McLachlin, 1990; Hay, 1988; Schonberger, 1986 and Pegels, 1984). Since both production and waiting time are directly proportional to lot sizes, the most effective way to shorten lead time is to reduce lot sizes (Cheng, 1991). Moreover, study found that reduce setup time is crucial to decrease lot sizes (Monden, 1981). Being able to produce smaller lot sizes enables JIT systems to operate effectively. Following benefits such as less work-in-process inventories, less space required, and increase flexibility in scheduling can be achieved (Zhiwei and Meredith, 1995). As reducing lot sizes, both the quality and timeliness of process feedback increases, leading to reduction in process variance (Flynn *et al*., 1995). Decrease lot sizes involve the evaluation of product mixes, reduction of set-up times, and leveling of production load. Suggestions from employees are also instrumental to the success of decrease lot size (Cheng, 1991). The performance measurement of an organization of having small lot sizes is evaluate through the level of activities the plant is taking to lower the lot sizes (Sakakibara *et al*., 1993).

Another studies conducted found that education and training is another important elements in implementing JIT (Safayeni *et al*., 1991; Sohal *et al*., 1989; Crawford *et al*., 1988; Finch and Cox, 1986; and Schonberger, 1982) and in one study conducted, it is found that on of the most common implementation JIT problems in Egyptian manufacturing plant is lack of formal training or education for either management or worker (Salaheldin, 2005). Another researcher once stated that the biggest mistakes a company can make when implementing JIT is to ignore interpersonal skills, education and training (Hayley and Garwood, 1989). Furthermore, without clear understanding of JIT, the conversion from old to new concept will be very difficult or perhaps even impossible (Cheng, 1991). Another study conducted found that training should concentrate on basic understanding of the technical aspects of JIT and the impact that JIT will have on the operating environment (Zhiwei and Meredith, 1995). Some programs suggested to be include in JIT education and training of an organizations are ongoing training and education rather than ad hoc programs, training is aimed at all employees not just salaried employees, training is aimed at more than purely technical skills, cross training for multiple skills, and extensive training upon hiring (McLachlin, 1997). Cross training for all workers is a must to develop multiple skills so that workers can do different jobs in the factory (Kumar, 2010). With proper training and education, it will help workers to understand the philosophy, concept and techniques of JIT.

Employee involvement comes to sixth element that is most frequently appeared in literature (White *et al*., 2010; Sriparavastu and Gupta, 1997; Safayeni *et al*., 1991 and Wantuck, 1989). All members in the factory, from upper management down to the shop-floor workers, must work as a team (Cheng, 1991). It also is a very important to create a congenial environment among co-worker (Zhiwei and Meredith, 1995). Plus, to make JIT implementation successful and to minimize the chances of creating conflicts, it is important to maintain support from all people involved in production (Aghazadeh, 2004). Some evidence listed of employee involvement factor (McLachlin, 1997). Some evidence listed are employees take initiative to resolve specific problems, employees willing to do extra job without reward, there are substantial number of group problem solving team, and team members' opinion are sought and considered. Employees should perform activities such as participate in improvement activities and problem solving, participate in decision making, assume responsibility for quality, and develop new skills as in effort to continuously eliminate wastes to achieve benefits of implementing JIT (Lawrence and Hottenstein, 1995)

The following important element is total preventive maintenance (White *et al*., 2010). Management of existing physical resources, including preventive maintenance is agreed to be viewed as important to JIT success (Kumar and Grewal, 2007; Spencer and Guide, 1993; Mehra and Inman, 1992; Stevenson, 1990 and Schonberger 1982). Because of JIT allows very little work-in-process inventory, machine breakdown can be seriously disruptive. Besides that, preventive maintenance is needed to provide smooth flow production (Zhiwei and Meredith, 1995). This involves by getting the machine operator actively participating in minor maintenance functions (White *et al*., 2010). Moreover, down-time can caused by poor maintenance and workers should be encouraged to fix problems before they start (Cheng, 1991). Total preventive maintenance can be measured by the steps plant management has taken to introduce preventive maintenance practices to workers daily routines, reserved a part of the shift for preventive maintenance and incorporated productive maintenance into manufacturing strategy (Sakakibara *et al*., 1993).

The next element is process and workers flexibility. Process flexibility is considered as one of the most flexible elements in implementing JIT (Kumar and Grewal, 2007; Chong *et al*., 2001; Stevenson, 1990; Shingo, 1988; Voss and Harrison, 1987 and Pegels, 1984). Flexibility might be considered as the ability of a manufacturing system to produce variety of products (Zhiwei and Meredith, 1995). It also means being able to respond quickly to customers' needs. Flexible workforce on the other hand refers to cross training, alternate work schedule, minimal non-process steps for operator together with usage of a system that is user friendly, adaptable and expandable (Prasad, 1995). Cross training is considered a must in order to produce flexible and multifunction workers (White *et al*., 2010). A firm that moving towards JIT need their work-force to be more flexible and the union should be supportive on job flexibility. This is because higher skills requirements may keep some companies from moving towards JIT (Ahmed *et al*., 1991). With a higher skill of workers and process flexibility, a firm or an organization can save a lot of costs in hiring new workers for different skills, and machines to do different process.

Another frequent elements that always appeared in literature as one of the important elements in implementing JIT is uniform workload. Uniform workload is defined by program that attempt to stabilize and smooth the production workload by level schedule (White *et al*., 2010). The product mix each day would be the same. Variations to the demand would be handled through varying frequency of product mix. Uniform workload able to minimize variations workload that then leads to smooth flow production that helps in obtaining the successful of JIT implementation in an organization (Kumar and Grewal, 2007; Chong, 2001; Hay, 1988 and Davy *et al*., 1982).

A JIT production requires high quality, small lot sizes, and frequent delivery of raw materials (Zhiwei and Meredith, 1995). A good relationship with suppliers is crucial to achieve this requirement (Sriparavastu and Gupta, 1997; Yasin and Wafa, 1994; Krafcik, 1989; Crawford *et al*., 1988 and Lee and Ebrahimpour, 1984). Because of this, vendor should be provided with clear information on specifications and delivery requirements as well as feedback and quality control problems (Cheng, 1991). Quality and delivery should be stressed to vendors as a long term commitment to the plant. On the other hand, a study conducted claimed that long-term partnership relationship is essential to the implementation of JIT (Sriparavastu and Gupta, 1997). Having suppliers located within close proximity will help to reduce lead-time for delivery (Ahmed *et al*., 1991). To measure the performances of JIT implementation via vendor or supplier relationship, vendors are measures by integrating vendors into production in term of using Kanban containers, making frequent or JIT delivery and quantity certification (Matsui, 2007). Above all, some study did argue this element in ensuring the successfulness of JIT implementation (Sohal *et al*., 1989). For the successful implementation of JIT, it is necessary to stabilize their own internal environment before extending the JIT philosophy to their supplier bases (White *et al*., 2010). JIT purchasing (between suppliers and vendors) also should be introduced toward the end of the JIT implementation process to support continuous development of cumulative capabilities.

Surprisingly, Kanban appeared as the eleventh element that is considered important in implementing JIT (Matsui, 2007; Aghazadeh, 2004; Flynn et al., 1995; White and Ruch, 1990 and Voss and Harrison, 1987). Some benefits of using Kanban instead of computerized systems include the reduction of cost processing information, rapid and precise acquisition of facts, and able to limits surplus capacity of preceding shops (Sugimori *et al*., 1977). Kanban attempts to eliminate the push system of material flows and develop a pull system which is dependent upon the operators at the downstream workstations to initiate material movement and control the pace of material flow for upstream work stations versus traditional management control of the initiation of material movements (White *et al*., 2010). Even Kanban is a powerful tool to achieve JIT environment, some study conducted found that

Kanban should be introduced toward the end of the JIT implementation process to support continuous development of cumulative capabilities (White et al., 2010).

Top management commitment is one of the essential ingredients for successful implementation of any new philosophy or technology, especially JIT system (Ahmed *et al*., 1991). Top management involves action and support for planning, implementation and follow-up of any major technological change (Ramarapu *et al*., 1993; Spencer and Guide, 1993; Dean and Snell, 1991; and Harber *et al*., 1990). Implementation of JIT cannot be successful without top management commitment (Zhiwei and Meredith, 1995). Management must be willing to devote the resources which are necessary to support an implementation such as JIT education and training. Besides that, management should be able to initiate and provide education training to workers while implementing JIT (Krafcik, 1989). Top management is urged to have formal means for listening and always investigate suggestions suggested by employees (Mehra and Inman, 1992). They also have to participate and keep track of quality circle in organization. Management commitment also is viewed as crucial to keep the process of JIT implementation to reach the level desired. This is because, even employee involvement plays central role in JIT implementation, management initiatives are beyond that (McLachlin, 1997). Strong support from four major management initiatives which are promotion of employees' responsibility, provision of training, promotion of teamwork and demonstration of visible commitment are each necessary condition for each of employee involvement, JIT flow, and JIT quality. Thus, managers planning to implement JIT should ensure that these four initiatives are undertaken.

JIT is claimed as a pull system (Ohno, 1988 and Ramarapu *et al*., 1995). Another element that is considered important in JIT implementation is pull system (White and Ruch, 1990; Hay 1988; Shingo, 1988; Suzaki, 1985 and Pegels, 1984). Pull system is defined as a production responds to customer orders immediately after an order is received (Prasad, 1995). It is different from push process which tries to move as much product as possible through the system, whether there are confirmed orders for the product. Some research has outlined the evidence of an organization if they used pull system (McLachlin, 1997). The characteristic of organization that applied pull system can clearly be seen by the usage of Kanban or similar signals that used to authorized workstation, the schedule or production rated are issued to final assembly operations only, a fixed number of standard containers are used for movement and storage of goods, and there is strict control of work-in-process inventory levels. The first requirement of just-in-time production is to enable all processes to quickly gain accurate knowledge of timing and quantity required (Sugimori *et al*., 1977). Because of that, Toyota adopted a reverse method of where the following process withdrawing the parts from the preceding process instead of the preceding process supplying the parts to the following process. The usage of pull system in successful JIT implementation is measured by the integration of plant has introduced supporting pull systems, such as stopping for quality problems, efficient floor layout, and workers directed production (Sakakibara *et al*., 1993).

Lastly, the elements that frequently mentioned by researchers in their study and research is eliminating waste (Biggart and Gargeya, 2002; Lawrence and Hottenstein, 1995; Cheng, 1991; Walton, 1985; Pegels, 1984 and Schonberger, 1982). All workers should be installed the concept of continuous improvement to eliminate waste (Cheng, 1991). Waste is considered any non-value added activities that requires cost but did not add any value to product produce. Waste has been classified into seven types of categories (Ohno, 1988). The types are, waste of transportation, waste of overproduction, waste of over process, waste of motions, waste of defects, waste of inventory and waste of waiting. To reduce waste, lean method such as the usage of Value Stream Mapping and 5S, look for and eliminate easy problems can be practiced (Hopp and Spearman, 2004). Reduction of lot sizes, reduction of lead time and automation are included in elimination of waste (Ramarapu *et al*., 1993). JIT teams should be always aimed to eliminate waste and workers should always been reminded on continuous improvement by eliminating waste in order to obtain the successful conditions of JIT implementation at an organization.

In a nutshell, referring to literature, by having and practicing these fourteen elements, an implemented company is able to increase their productivity and achieving JIT success in a long term.

CHAPTER 3

METHODOLOGY

3.0 INTRODUCTION

Methodology is an organized flow that functioned to guide a study to reach the objective desired. The progress and the flow of this study is all recorded and can be tracked in this chapter. In this study, questionnaires are primary data sources despite interviews, review on previous case study and journals. Before designing a questionnaire, a lot of factors have been taking of. This topic will be discussed further through this chapter.

3.1 METHODOLOGY FLOW CHART

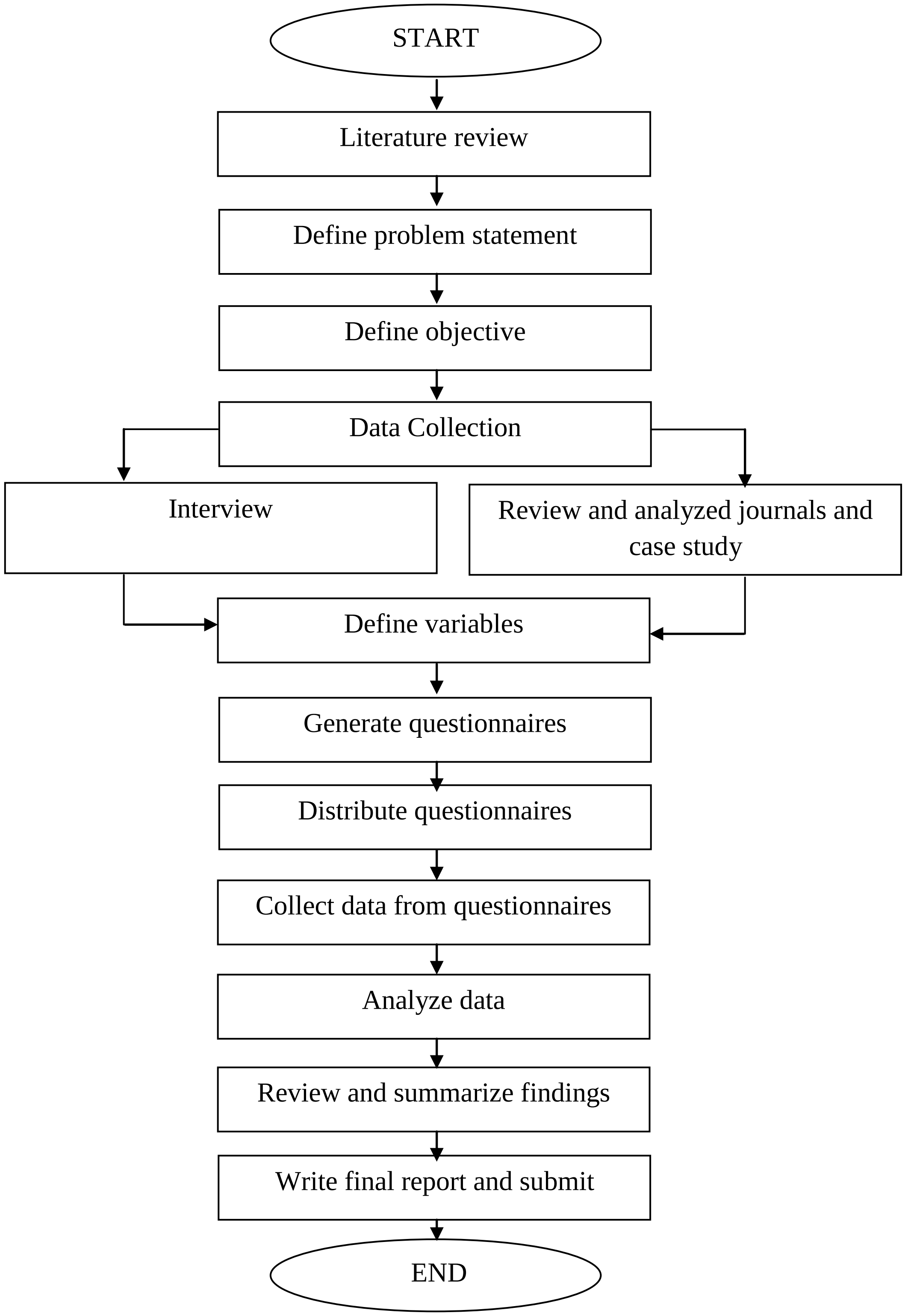

Figure 3.1 Methodology flow chart

The methodology for this study starts with literature review on related topic on studies, written journals, and books that has been established earlier. From the literature review, problem statement is generated and objective is defined. Problem statement and objective has been mentioned earlier in Chapter 1. Then, as this study used questionnaires as primary data collection method, a set of questionnaire is generated.

To develop a questionnaire, several interviews are conducted with some automotive players in Pekan, Pahang or Klang Valley. Appointment has been set-up, and few questions asked to the general managers, executives or production engineers. Some of interview is conducted through email. The purposed of this interview is to get general information and ideas on JIT environment in current Malaysian automotive industry. A part of that, previous case studies and journals have been reviewed to identify elements that are crucial in JIT implementation in automotive industry. All elements that been mentioned in case studies or journals have been noted. These elements and frequencies mentioned by researchers are represented in Table 2.1 and Table 2.2. Then, from those record, elements that being mentioned more than 10 times by researcher is considered crucial in JIT implementations. The data are recorded and summarized in Table 2.3. Fourteen elements recorded and these elements are considered crucial in JIT implementations in automotive industry. These fourteen elements are the variables used to further analyzed data gathered.

Based on these variables, the questionnaires were designed as given in Appendix A. The questionnaires comprise 3 sections, Section A focused on company profile, Section B focused on JIT implementation in a company, where Section C is only focused on general knowledge on JIT of company that not implement JIT in their company. For section A, 6 questions provided, for Section B, 20 questions and Section C, 10 questions. For Section B, there are five categories of responds according to Likert Scale, but doe to lack respondents of each scales to do Chi-Square test, scale 1 to 3 is grouped into *Disagree* responds while responds for scale 4 and 5 is grouped into *Agree* responds. While for Section C, there are two categories of responds provided either *Yes* or *No.* Section B comprised of 20 items spanning over the following kinds of variables as being presented in Table 3.

Table 3.1: Distribution of questions and variables for Section B

No	Variable	Question No.
1.	Setup time reduction	1, 2
2.	Total quality control or quality circle	3, 4, 5
3.	Smooth flow production	6
4.	Decrease lot size	7
5.	Education and training	8, 9
6.	Employee involvement	10
7.	Total preventive maintenance	11
8.	Process and workers flexibility	12
9.	Uniform workload	13
10.	Vendor/supplier relationship	14, 15
11.	Kanban	16
12.	Top management commitment	17
13.	Withdrawal by subsequent process (pull system)	18
14.	Eliminate waste	19, 20

These questionnaires are then being distributed randomly to automotive companies all over Malaysia either via email, mail or by hand. Then, data from gathered questionnaires are being reviewed and analyzed section by section. Section A will be analyzing company profile based on frequencies. Section B will be analyzed using Chi-square test. Section C will be analyzed based on frequencies. Analyzing data will be further discussed in details in next chapter.

After all data being reviewed and analyzed, a full report is write up upon findings, and submitted to fulfill the requirements of this course.

CHAPTER 4

RESULT AND DISCUSSION

4.0 INTRODUCTION

In this chapter, all data gathered from distributed questionnaires is recorded and analyzed. This chapter is divided into three sub-sections, where the first section, section 4.1 will be presenting all data gathered from Section A of questionnaires (Refer to Appendix A). All data of company profile are recorded in represent in section 4.1 in this chapter.

For companies that implements JIT, all data from Section B of questionnaires are analyzed and recorded in section 4.2 in this chapter. Total respondents for this section are 174. These respondents are from automotive companies that implement JIT from four types of industries either from electronic components, mechanical, metal or plastic types of industries. Types of industry are classified based on Question 4 in Section A of questionnaire. Main product produce by a company indicates types of industry of the organization. Chi-square test is computed to find the relatedness of variables with types of industry. A conclusion is stated for every test.

In section 4.3 of this chapter, all data from Section C questionnaires are recorded and analyzed on general knowledge of JIT of respondents from non-implemented JIT.

4.1 ANALYSIS OF SECTION A

Section A is a section in questionnaire is a section that records general information of respondents' company background. This section answered by respondents from both implemented and non-implemented JIT companies. Respondents were asked to answer six questions provided to gather company's background general information. Total respondents were 317 selected from thirty random automotive companies in Malaysia. All data from each question are recorded and represented in a bar graph or pie chart through this sub-section.

4.1.1 Analysis of Question 1

Question 1 indicates the approximate number of employees in respondents' company. Total respondents are 317.

Table 4.1: Respond of question 1

Employees (Workers)	Total Respondents
<100	32
101 to 300	190
500 to 1000	82
> 1000	13
Total	317

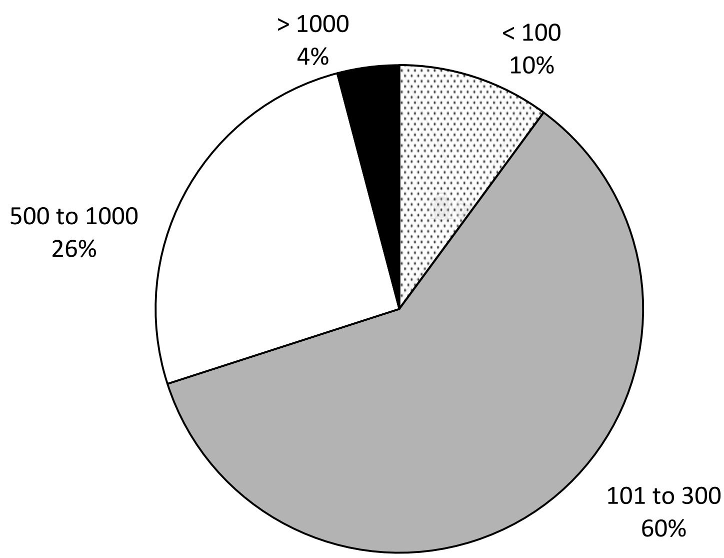

Figure 4.1: Percentage of respondents for question 1

From Table 4.1 and Figure 4.1, we can clearly see that 10% of respondents are from company that has less than 100 workers. Company that has less than 100 workers is considered small automotive plant. Small automotive plant usually paid up with less than 200k and a third tier company. 60% of respondents are from companies that have 101 to 301 employees. This company is classified as a medium automotive plant. The paid up capital is among 200k to 1 million per year, and these companies usually a second tier or third tier company. 26% of respondents are from companies with 500 to 1000 employees. These companies are considered a large automotive plant. This company usually a big metal stamper or assembler module part. They are usually a first tier supplier to Proton, Perodua or Honda. Only 4% of respondents are from companies that have more than 1000 employees. This company is considered a mega automotive plant. Usually mega company has more than 500 millions capital paid up per year and these respondents are usually from a car manufacturer or maker, including Proton, Perodua or Honda.

4.1.2 Analysis of Question 2

Question 2 indicates years of establishment of respondents' company. Below are the recorded data.

Table 4.2: Respond of question 2

Year of Establishment	Total Respondents
< 5	32
5 to 10	38
> 10 and < 15	155
> 15	92
Total	317

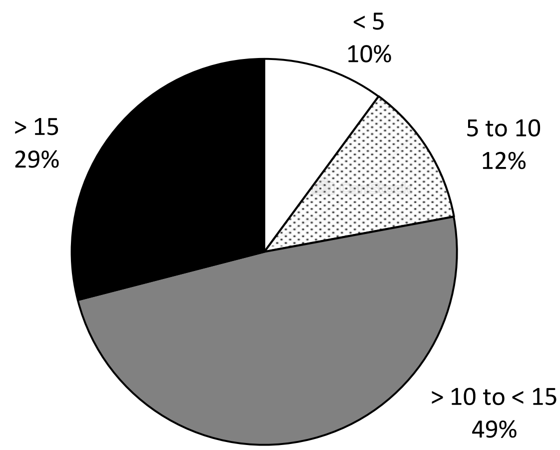

Figure 4.2: Percentage of respondents for question 2

From Table 4.2 and Figure 4.2, we can see that most of respondents which is 49% are from companies that have been establish between more than 10 years but less than 15 years. 29% of respondents are from companies that have been established for more than 15 years. 12% are from companies that have been established more than 5 years, and only 10% of respondents are from companies that established less than 5 years.

4.1.3 Analysis of Question 3

Question 3 indicates types of ownership of respondents' company. Result and data recorded as follow.

Table 4.3: Respond of question 3

Type of Ownership	Total Respondents
100% Local	250
100% Foreign	20
Mixed	47
Total	317

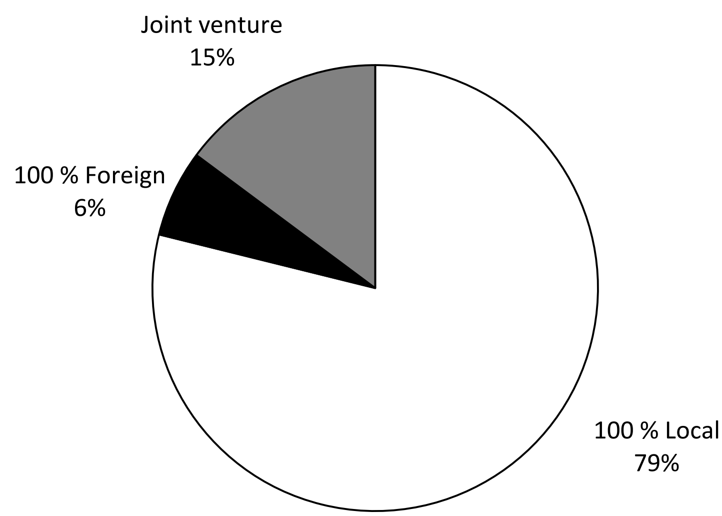

Figure 4.3: Percentage of respondents for question 3

From Table 4.3 and Figure 4.3, 79% of the respondents are from company that fully owned by local. 15% of respondents are from fully foreign ownership of a company. While only 6% of respondents are from mixed ownership of company. Type of ownership may influence a company to implement JIT since JIT is a production system that originates from foreign country.

4.1.4 Analysis of Question 4

Question 4 asked the respondents to indicate main product of their company. As one company may have more than one main product, the respondents are allowed to thick more than one from the options given. These main products that includes in option are plastic parts, metal parts, rubber parts, electronic components, mechanical devices, electrical components or others. Below are the data gathered from the respondent.

Table 4.4: Respond of question 4

Main Product	Total Respondents
Plastic Parts	82
Rubber Parts	3
Metal Parts	114
Electronic Components	29
Mechanical Devices	29
Electrical Components	25
Others	35

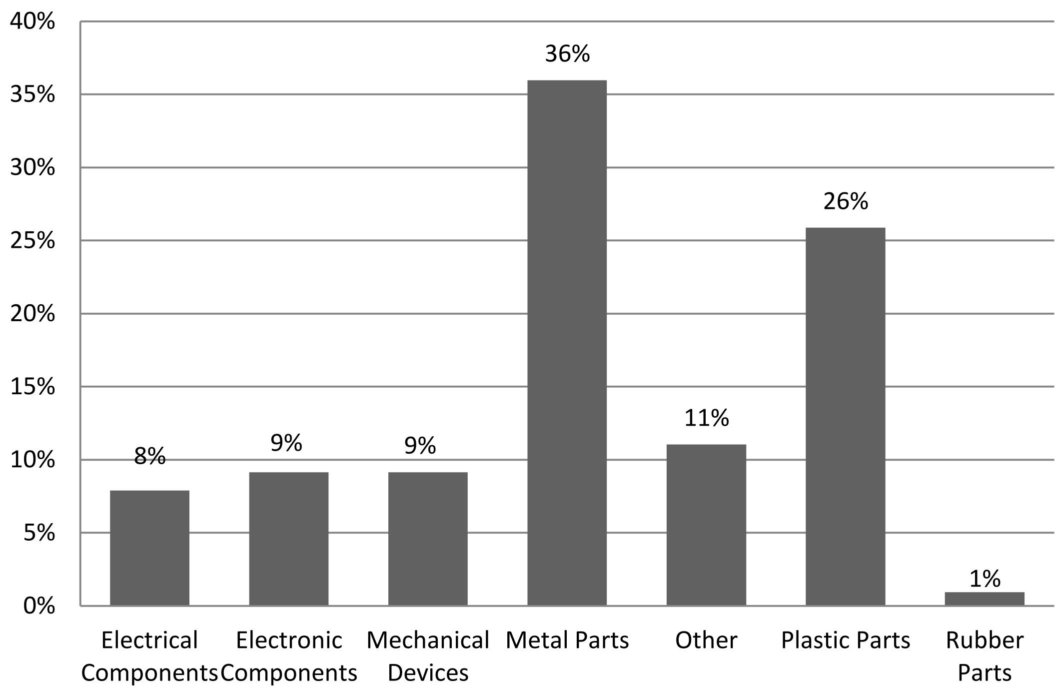

Figure 4.4: Percentage of respondents for question 4

In this study, main product of a company is considered types of industry. Based on Table 4.4 and Figure 4.4, 8% of respondents are from electrical components type of industry, 9% from electronic components, 9% from mechanical devices. Lots of respondents are from metal parts of industry which is 36%. 26% are from plastic part types of industry, and only 1% is from rubber parts of industry. 11% of respondents are from unlisted industry in questionnaire. Other industry is a part of miscellaneous types of industries includes polymer, chemical, cushion or spring as their main products. In this study, because of lack of respondents from certain types of industry, two categories are eliminated. These two categories are rubber part of industry, and other since it is the integration of many unclassified industry. Since electrical components and electronic components share same nature of production types and industry, total respondents of these two types of industry are combined. For this study, only respondents from Electrical and Electronic components, Mechanical devices, Metal parts, and Plastic are selected since their figure is valid in analysis. Further analysis is shown in sub-section 4.2.

4.1.5 Analysis of Question 5

Question 5 indicates the customers of respondents' companies. Data were recorded as follow.

Table 4.5: Respond of question 5

Main Customer	Total Respondents
100% Local	147
100 % Foreign	10
Mixed	160
Total	317

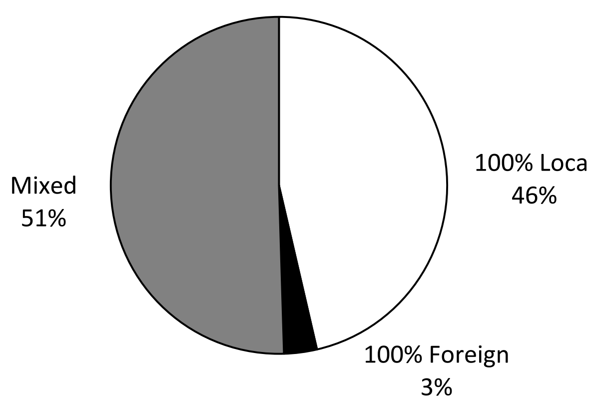

Figure 4.5: Percentage of respondents for question 5

From Table 4.5 and Figure 4.5, 51% of respondents are from companies that have 100% local customer, 46% of respondents are from companies that have mixed customer, local and foreign, while only 3% of respondents are from companies that have foreign customer. Sometimes, one of the factors that contribute to the JIT production system in a company is based on their customer requirement.

4.1.6 Analysis of Question 6

Question 6 asked the respondents either their company practiced Just-In-Time (JIT) or not. All responds were recorded as follow.

Table 4.6: Respond of question 6

Respond	Total Respondents
Yes	174
No	143
Total	317

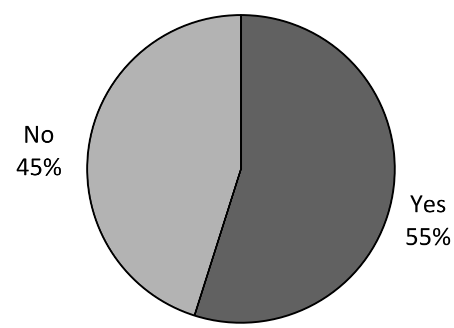

Figure 4.6: Percentage of respondents for question 6

Based on Table 4.6 and Figure 4.6, 55% of respondents claimed that their company implements JIT and 45% of respondents claimed that their company do not implement JIT. Respondents who answered *Yes* for this question were asked to proceed to Section B of questionnaires, while respondents who answered *No* were asked to proceed to Section C of questionnaires.

4.2 ANALYSIS OF SECTION B

Section B is a section in questionnaire that focused on implementation of JIT elements in an organization (Refer Appendix A). This section only answered by respondents from implemented JIT companies. Respondents were asked to answer twenty questions provided as reflecting fourteen JIT implementation elements in an organization.

The purpose of this section is to find the relationship between JIT implemented elements either it is independent or dependent on types of industry. To figure out the relatedness, Chi-square test used to conduct analysis in this section. This are the basic steps used in Chi-square test analysis:

(i) State the hypotheses and identify the claim.

(ii) Find the critical value. Refer Appendix B.

(iii) Compute test value, χ^2.

χ^2 can be calculated by finding the sum of the $\frac{(O-E)^2}{E}$ values. Refer Appendix C

(iv) Make the decision.

(v) Summarize the results.

In this section, null hypothesis and alternative hypothesis stated in every questions. Then through these analysis, it is found that critical value, $\chi^2_{0.05} = 7.815$. Finding critical value is presented in Appendix B. Calculation of test value, χ^2 is presented in Appendix C. Computation of test statistic of every question is presented in table form. After that, from computed test value, χ^2 decision is made and conclusion to summarize result is recorded for each question and each element analyzed through this section. Noted that all questions are being analyzed using the same methods mentioned above.

Total respondents for this section are 174. These respondents are selected randomly from automotive companies in Malaysia from four types of industries. These industries are electronic component, mechanical, metal or plastic industries. Types of industry are classified based on main product that company produce. Refer to Appendix A, Section A question number 4.

Table 4.7: Respondents from each type of industry

Type of Industry	Total Respondents
Electronic components	45
Mechanical	39
Metal	49
Plastic	41
Total	174

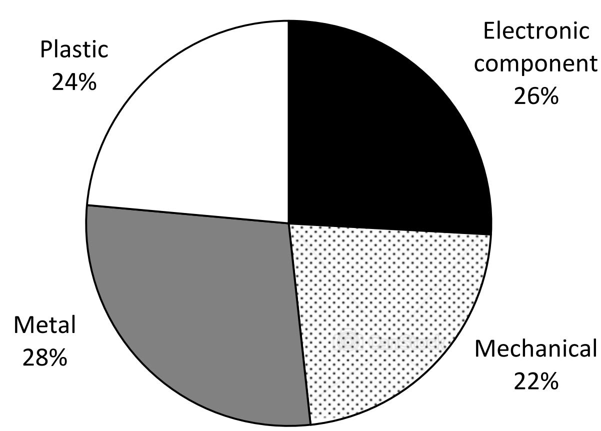

Figure 4.7: Percentage of Respondents from each types of Industry

As questionnaires were designed as given in Appendix A, the responds for section B is provided in a Likert Scale; 1 for strongly disagree, to 5 to strongly agree. In this analysis, answer for scale 1 and 2 is considered *Disagree*, answer for scale 3 is terminated while answer for scale 4 and 5 is considered as *Agree.* So, the responds for each respondent are analyzed based on their answer either *Agree* or *Disagree* on every question asked. Those data gathered from Section B is analyzed through this sub-chapter as follow.

4.2.1 Analysis on Element Setup Time Reduction

For this variable, there are two question tested either setup time reduction is dependant on types of industry. The first question asked to the respondent either their organization have reduced their lead time since implementing JIT. Setup time reduction is always proportional to lead time reduction. Second question view the effort of the company to reduce setup time in their plant since implementing JIT. Analyses of these 2 questions are provided as follow.

(i) Analysis of Question 1

Null hypothesis: Lead time reduction is independent on types of industry.

Alternative hypothesis: Lead time reduction is dependent on types of industry.

Table 4.8: Computation of Test Statistic of Analysis Question 1

Industry	**Responds**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	0	5.9483	5.9483
	Disagree	45	39.0517	0.9060
Mechanical	Agree	0	5.1552	5.1552
	Disagree	39	33.8448	0.7852
Metal	Agree	10	6.4770	1.9162
	Disagree	39	42.5230	0.2919
Plastic	Agree	13	5.4195	10.6030
	Disagree	28	35.5805	1.6150
Total				27.2208

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05,3} = 7.815$. Since the computed test statistics $\chi^2 = 27.2208$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, by implementing JIT, lead time reduction is depending on types of industry.

(iv) Analysis of Question 2

Null hypothesis: Effort towards lowering setup time is independent on types of industry.

Alternative hypothesis: Effort towards lowering setup time is dependent on types of industry.

Table 4.9: Computation of Test Statistic of Analysis Question 2.

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	33	32.8448	0.0007
	Disagree	12	12.1552	0.0020
Mechanical	Agree	36	28.4655	1.9943
	Disagree	3	10.5345	5.3888
Metal	Agree	33	35.7644	0.2137
	Disagree	16	13.2356	0.5774
Plastic	Agree	25	29.9253	0.8106
	Disagree	16	11.0747	2.1904
Total				11.1779

(v) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05,3} = 7.815$. Since the computed test statistics $\chi^2 = 11.1779$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(vi) Conclusion

From the analysis, by implementing JIT, the effort towards lowering setup time is depending on types of industry.

(vii) CONCLUSION

For this element, setup time reduction, both hypotheses are rejected. It is found that lead time reduction and the effort towards lowering setup time are depending on types of industry.

4.2.2 Analysis on Element: Total Quality Control

For this variable, there are three question tested either total quality control is dependant on types of industry. The first question asked the respondent either operator perform 100% sources of inspection at time since implementing JIT. Second question asked the respondent to figure out either time to discover defects is minimized when implementing JIT. The third question focused on the usage of mistake-proof (poka-yoke) in production since implementing JIT. Analyses of these three questions represented as follow.

(i) Analysis of Question 3

Null hypothesis: 100% sources inspection performed by operators at workstation is independent on type of industry.

Alternative hypothesis: 100% sources inspection performed by operators at workstation is dependent on type of industry.

Table 4.10: Computation of Test Statistic of Analysis Question 3.

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	36	34.3966	0.0747
	Disagree	9	10.6034	0.2425
Mechanical	Agree	39	29.8103	2.8329
	Disagree	0	9.1897	9.1897
Metal	Agree	32	37.4540	0.7942
	Disagree	17	11.5460	2.5763
Plastic	Agree	26	31.3391	0.9096
	Disagree	15	9.6609	2.9506
Total				19.5705

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 19.5705$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, by implementing JIT, 100% sources inspection performed by operators at workstation is depending on types of industry.

(iv) Analysis of Question 4

Null hypothesis: Reducing of time to discover defects is independent on types of industry.

Alternative hypothesis: Reducing of time to discover defects is dependent on types of industry.

Table 4.11: Computation of Test Statistic of Analysis Question 4

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	23	25.3448	0.2169
	Disagree	22	19.6552	0.2797
Mechanical	Agree	23	21.9655	0.0487
	Disagree	16	17.0345	0.0628
Metal	Agree	31	27.5977	0.4194
	Disagree	18	21.4023	0.5409
Plastic	Agree	21	23.0920	0.1895
	Disagree	20	17.9080	0.2444
Total				2.0024

(v) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 2.0024$ has not exceeded the critical value, or:

$$\chi^2 < \chi^2_{0.05}$$

So, the null hypothesis is accepted.

(vi) Conclusion

From the analysis, by implementing JIT, reducing time to discover defects is independent on types of industry.

(vii) Analysis of Question 5

Null hypothesis: The usage of mistake-proof (poka-yoke) is independent on types of industry.

Alternative hypothesis: The usage of mistake-proof (poka-yoke) is dependent on types of industry.

Table 4.12: Computation of Test Statistic of Analysis Question 5

Industry	**Respond**	**Observed Frequency, *O***	**Expected Frequency, *E***	$\frac{(O-E)^2}{E}$
Electronic component	Agree	33	34.6552	0.0791
	Disagree	12	10.3448	0.2648
Mechanical	Agree	31	30.0345	0.0310
	Disagree	8	8.9655	0.1040
Metal	Agree	45	37.7356	1.3984
	Disagree	4	11.2644	4.6848
Plastic	Agree	25	31.5747	1.3690
	Disagree	16	9.4253	4.5863
Total				12.5174

(viii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 12.5174$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(ix) Conclusion

From the analysis, by implementing JIT, the usage of mistake-proof (poka-yoke*)* is depending on types of industry.

(x) CONCLUSION

From the analysis computed, it is found that only null hypothesis of Analysis of Question 4 is accepted while null hypotheses of Analysis of Question 3 and Analysis of Question 5 are rejected. These mean, reducing time to discover defects is independent on types of industry. But in the other hand, by implementing JIT, 100% sources inspection performed by operators at workstation and the usage of mistake-proof (poka-yoke*)* is depending on types of industry.

4.2.3 Analysis on Element: Smooth Flow Production

To ensure smooth flow production is applied in JIT environment, respondents were asked either machines or process are laid out in close proximity to each other. Analysis is represented as follow.

(i) Analysis of Question 6

Null hypothesis: The layout of machine and process is independent on type of industry.

Alternative hypothesis: The layout of machine and process is dependent on type of industry.

Table 4.13: Computation of Test Statistic of Analysis Question 6

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	20	24.8276	0.9387
	Disagree	25	20.1724	1.1553
Mechanical	Agree	20	21.5172	0.1070
	Disagree	19	17.4828	0.1317
Metal	Agree	33	27.0345	1.3164
	Disagree	16	21.9655	1.6201
Plastic	Agree	23	22.6207	0.0064
	Disagree	18	18.3793	0.0078
Total				5.2834

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 5.2834$ has not exceeded the critical value, or:

$$\chi^2 < \chi^2_{0.05}$$

So, the null hypothesis is accepted.

(iii) Conclusion

From the analysis, to ensure smooth flow production, machines or process are laid out in close proximity to each other are independent on types of industry.

4.2.4 Analysis on Element: Decrease Lot Size

One of the factors that contribute to JIT success is by decreasing lot size in production. Because that, respondents were asked either their plant has moved towards producing in small batches. The responds is then analyzed to test either their action is dependent or independent based on types of industry.

(i) Analysis of Question 7

Null hypothesis: Small batches production is independent on types of industry.

Alternative hypothesis: Small batches production is dependent on types of industry.

Table 4.14: Computation of Test Statistic of Analysis Question7

Industry	**Responds**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	14	20.9483	2.3047
	Disagree	31	24.0517	2.0073
Mechanical	Agree	12	18.1552	2.0868
	Disagree	27	20.8448	1.8175
Metal	Agree	33	22.8103	4.5518
	Disagree	16	26.1897	3.9645
Plastic	Agree	22	19.0862	0.4448
	Disagree	19	21.9138	0.3874
Total				17.5649

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05,3} = 7.815$. Since the computed test statistics $\chi^2 = 17.5649$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that small batches production is dependent on types of industry.

4.2.5 Analysis on Element: Education and Training

To ensure there is training provided by organizations that implement JIT, two questions asked to the respondents. First, is there any training provided to all employees. Second question is training provided is aiming at more than purely technical skills. All responds are then analyzed as follows.

(i) Analysis of Question 8

Null hypothesis: Training provided to all employees is independent on types of industry.

Alternative hypothesis: Training provided to all employees dependent on types of industry.

Table 4.15: Computation of Test Statistic of Analysis Question 8

Industry	**Responds**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	45	35.9483	2.2792
	Disagree	0	6.4655	6.4655
Mechanical	Agree	33	31.1552	0.1092
	Disagree	6	5.6034	0.0281
Metal	Agree	37	39.1437	0.1174
	Disagree	12	7.0402	3.4941
Plastic	Agree	34	32.7529	0.0475
	Disagree	7	5.8908	0.2089
Total				12.7499

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 12.7499$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that training provided to all employees is dependant on types of industry.

(iv) Analysis of Question 9

Null hypothesis: Training focused on more than technical skill is independent on types of industry.

Alternative hypothesis: Training focused on more than technical skill is dependent on types of industry.

Table 4.16: Computation of Test Statistic of Analysis Question 9

Industry	**Responds**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	45	34.6552	3.0880
	Disagree	0	10.3448	10.3448
Mechanical	Agree	21	30.0345	2.7176
	Disagree	18	8.9655	9.1040
Metal	Agree	37	37.7356	0.0143
	Disagree	12	11.2644	0.0480
Plastic	Agree	31	31.5747	0.0105
	Disagree	10	9.4253	0.0350
Total				25.3623

(v) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 25.3623$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(vi) Conclusion

From the analysis, it is found that training focused on more than technical skill is not depending on types of industry.

(vii) CONCLUSION

For this element, education and training, both hypotheses are rejected. It is found that training provided to all employees and training that focused on more than technical skill is dependent on types of industry.

4.2.6 Analysis on Element: Employee Involvement

As employee involvement is one of the elements that consider crucial in JIT implementation, a question asked to the respondents which companies implement JIT either employee participate in improvement activities and problem solving. All responds are then analyzed as follows.

(i) Analysis of Question 10

Null hypothesis: Employees participation in activities is independent on types of industry.

Alternative hypothesis: Employees participation in activities is dependent on type of industry.

Table 4.17: Computation of Test Statistic of Analysis Question 10

Industry	**Respond**	**Observed Frequency, O**	**Expected Frequency, E**	$\frac{(O-E)^2}{E}$
Electronic component	Agree	24	29.2241	0.9339
	Disagree	21	15.7759	1.7300
Mechanical	Agree	25	25.3276	0.0042
	Disagree	14	13.6724	0.0078
Metal	Agree	39	31.8218	1.6192
	Disagree	10	17.1782	2.9995
Plastic	Agree	25	26.6264	0.0993
	Disagree	16	14.3736	0.1840
Total				7.5780

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 2.0823$ has not exceeded the critical value, or:

$$\chi^2 < \chi^2_{0.05}$$

So, the null hypothesis is accepted.

(iii) Conclusion

From the analysis, it is found that employees participation in activities is independent on types of industry.

4.2.7 Analysis on Element: Total Preventive Maintenance

One question asked under the element of total preventive maintenance to figure out either it is being practices in workers daily routine. All responds are analyzed as follows.

(i) Analysis of Question 11

Null hypothesis: Preventive maintenance practices are independent on type of industry.

Alternative hypothesis: Preventive maintenance practices are dependent on type of industry.

Table 4.18: Computation of Test Statistic of Analysis Question 11

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	26	30.2586	0.5994
	Disagree	19	14.7414	1.2303
Mechanical	Agree	37	26.2241	4.4280
	Disagree	2	12.7759	9.0890
Metal	Agree	27	32.9483	1.0739
	Disagree	22	16.0517	2.2042
Plastic	Agree	27	27.5690	0.0117
	Disagree	14	13.4310	0.0241
Total				18.6605

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 18.6605$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that total preventive maintenance practices are dependent on type of industry.

4.2.8 Analysis on Element: Process and Workers Flexibility

To figure out if the organization that implements JIT practicing process and workers flexibility, the respondents were asked is there any cross-training provided for multiple skills workers. Data is then analyzed as follow.

(i) Analysis of Question 12

Null hypothesis: Cross training is independent on type of industry.

Alternative hypothesis: Cross training is dependent on type of industry.

Table 4.19: Computation of Test Statistic of Analysis Question 12

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	33	32.3276	0.0140
	Disagree	12	12.6724	0.0357
Mechanical	Agree	36	28.0172	2.2745
	Disagree	3	10.9828	5.8022
Metal	Agree	33	35.2011	0.1376
	Disagree	16	13.7989	0.3511
Plastic	Agree	23	29.4540	1.4142
	Disagree	18	11.5460	3.6077
Total				13.6370

(ii) Discussion and conclusion

From *Chi-Square Distribution Table*, level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 13.6370$ has not exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that cross training is dependent on type of industry.

4.2.9 Analysis on Element: Uniform Workload

Under the element of uniform workload, a question asked to the respondents which is either mixed modeling production is being practiced to the companies that implement JIT. Data then is analyzed as follows.

(i) Analysis of Question 13

Null hypothesis: Mixed modeling is independent on type of industry.

Alternative hypothesis: Mixed modeling is dependent on type of industry.

Table 4.20: Computation of Test Statistic of Analysis Question 13

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	19	28.7069	3.2823
	Disagree	26	16.2931	5.7831
Mechanical	Agree	20	24.8793	0.9569
	Disagree	19	14.1207	1.6860
Metal	Agree	49	31.2586	10.0694
	Disagree	0	17.7414	17.7414
Plastic	Agree	23	26.1552	0.3806
	Disagree	18	14.8448	0.6706
Total				40.5703

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 40.5703$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that the practices of mixed modeling production are dependent on type of industry.

4.2.10 Analysis on Element: Vendor and Supplier Relationship

For the elements of vendor and supplier relationship, two questions asked to the respondents. The first question is either supplier makes frequent, reliable deliveries of high quality parts, or the second question is either supplier participates in improvement activities since the companies implement JIT. The data then gathered and analyzed as follow.

(i) Analysis 14

Null hypothesis: Supplier makes frequent, reliable delivery of high quality parts is independent on type of industry.

Alternative hypothesis: Supplier makes frequent, reliable delivery of high quality parts is dependent on type of industry.

Table 4.21: Computation of Test Statistic of Analysis Question 14

Industry	**Respond**	**Observed Frequency, *O***	**Expected Frequency, *E***	$\frac{(O-E)^2}{E}$
Electronic component	Agree	23	25.0862	0.1735
	Disagree	22	19.9138	0.2186
Mechanical	Agree	28	21.7414	1.8016
	Disagree	11	17.2586	2.2696
Metal	Agree	37	27.3161	3.4331
	Disagree	12	21.6839	4.3248
Plastic	Agree	9	22.8563	8.4002
	Disagree	32	18.1437	10.5821
Total				31.2034

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 31.2034$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that supplier makes frequent, reliable delivery of high quality parts is dependent on type of industry.

(iv) Analysis of Question 15

Null hypothesis: Participation of supplier in improvement activities is independent on type of industry.

Alternative hypothesis: Participation of supplier in improvement activities is dependent on type of industry.

Table 4.22: Computation of Test Statistic of Analysis Question 15

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	20	24.0517	0.6825
	Disagree	25	20.9483	0.7837
Mechanical	Agree	24	20.8448	0.4776
	Disagree	15	18.1552	0.5483
Metal	Agree	31	26.1897	0.8835
	Disagree	18	22.8103	1.0144
Plastic	Agree	18	21.9138	0.6990
	Disagree	23	19.0862	0.8026
Total				5.8917

(v) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 5.8917$. Since the computed test statistics $\chi^2 = 7.6505$ has not exceeded the critical value, or:

$$\chi^2 < \chi^2_{0.05}$$

So, the null hypothesis is accepted.

(vi) Conclusion

From the analysis, it is found that the participation of supplier in improvement activities is independent on type of industry.

(vii) CONCLUSION

For this element, vendor and supplier relationship it is found that one hypothesis is rejected and one hypothesis is accepted. Where, supplier makes frequent, reliable delivery of high quality parts is dependent on type of industry. But, in the other hand, supplier participation in improvement activities is independent on types of industry.

4.2.11 Data Analysis on Element: Kanban

Kanban is another element that is crucial in JIT implementations. A question asked to respondents to figure out is Kanban used for production control in order to achieve JIT environment. All responds are then analyzed as follows.

(i) Analysis of Question 16

Null hypothesis: The usage of Kanban is independent on type of industry.

Alternative hypothesis: The usage of Kanban is dependent on type of industry.

Table 4.23: Computation of Test Statistic of Analysis Question 16

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	28	26.8966	0.0453
	Disagree	17	18.1034	0.0673
Mechanical	Agree	21	23.3103	0.2290
	Disagree	18	15.6897	0.3402
Metal	Agree	33	29.2874	0.4706
	Disagree	16	19.7126	0.6992
Plastic	Agree	22	24.5057	0.2562
	Disagree	19	16.4943	0.3807
Total				2.4885

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 2.8445$ has not exceeded the critical value, or:

$$\chi^2 < \chi^2_{0.05}$$

So, the null hypothesis is accepted.

(iii) Conclusion

From the analysis, it is found that the usage of Kanban is independent on types of industry.

4.2.12 Analysis on Element 12: Top Management Commitment

Top management commitment is identified as one of the crucial elements in implementing JIT. To find the relatedness of this element with types of industry, all the respondents asked to answer a question. The question is either top management demonstrate commitment to JIT, keep track all JIT activities in the company. All responds are then analyzed as follows.

(i) Analysis of Question 17

Null hypothesis: Top management commitment is independent on types of industry.

Alternative hypothesis: Top management commitment is dependent on types of industry.

Table 4.24: Computation of Test Statistic of Analysis Question 17

Industry	**Respond**	**Observed Frequency, *O***	**Expected Frequency, *E***	$\frac{(O-E)^2}{E}$
Electronic component	Agree	45	33.1034	4.2753
	Disagree	0	11.8966	11.8966
Mechanical	Agree	39	28.6897	3.7053
	Disagree	0	10.3103	10.3103
Metal	Agree	30	36.0460	1.0141
	Disagree	19	12.9540	2.8218
Plastic	Agree	14	30.1609	8.6594
	Disagree	27	10.8391	24.0957
Total				66.7785

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 66.7785$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that top management commitment is dependent on types of industry.

4.2.13 Analysis on Element: Pull System

A question, schedule or production rate are only issued to final assembly operations being asked to respondents to figure out either pull system is related to types of industry or not. All respondents for this question are analyzed as follows.

(i) Analysis of Question 18

Null hypothesis: Pull system is independent on type of industry.

Alternative hypothesis: Pull system is dependent on type of industry.

Table 4.25: Computation of Test Statistic of Analysis Question 18

Industry	**Respond**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	19	24.5690	1.2623
	Disagree	26	20.4310	1.5180
Mechanical	Agree	20	21.2931	0.0785
	Disagree	19	17.7069	0.0944
Metal	Agree	39	26.7529	5.6066
	Disagree	10	22.2471	6.7421
Plastic	Agree	17	22.3851	1.2955
	Disagree	24	18.6149	1.5578
Total				18.1552

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 18.1552$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(iii) Conclusion

From the analysis, it is found that pull system is dependant on types of industry.

4.2.14 Analysis on Element: Eliminate Waste

Two questions asked to find the relatedness of JIT element; eliminate waste with types of industry. The effort towards seeking and reduce waste in production line is being asked to respondents in the first question. For the second question, the respondents are being asked on the establishment of small group activities to do continuous improvement in the organization since they are implementing JIT. All responds are being analyzed as follows.

(i) Analysis of Question 19

Null hypothesis: Effort towards reducing waste is independent on type of industry.

Alternative hypothesis: Effort towards reducing waste is dependent on type of industry.

Table 4.26: Computation of Test Statistic of Analysis Question 19

Industry	**Respond**	**Observed Frequency,** *O*	**Expected Frequency,** *E*	$\frac{(O-E)^2}{E}$
Electronic component	Agree	27	32.5862	0.9576
	Disagree	18	12.4138	2.5138
Mechanical	Agree	25	28.2414	0.3720
	Disagree	14	10.7586	0.9766
Metal	Agree	37	35.4828	0.0649
	Disagree	12	13.5172	0.1703
Plastic	Agree	37	29.6897	1.8000
	Disagree	4	11.3103	4.7250
Total				11.5802

(ii) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 11.5802$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected

(iii) Conclusion

From the analysis, it is found that effort towards reducing waste is dependent on type of industry.

(iv) Analysis of Question 20

Null hypothesis: The establishment of small group activities is independent on type of industry.

Alternative hypothesis: The establishment of small group activities is dependent on type of industry.

Table 4.27: Computation of Test Statistic of Analysis Question 20

Industry	**Respond**	**Observed Frequency,** *O*	**Expected Frequency,** *E*	$\frac{(O-E)^2}{E}$
Electronic component	Agree	21	32.0690	3.8206
	Disagree	24	12.9310	9.4750
Mechanical	Agree	39	27.7931	4.5189
	Disagree	0	11.2069	11.2069
Metal	Agree	37	34.9195	0.1240
	Disagree	12	14.0805	0.3074
Plastic	Agree	27	29.2184	0.1684
	Disagree	14	11.7816	0.4177
Total				30.0389

(v) Discussion and conclusion

From *Chi-Square Distribution Table,* level of significance, $\alpha = 0.05$ and the degree of freedom (df) = 3, the critical value obtained is $\chi^2_{0.05} = 7.815$. Since the computed test statistics $\chi^2 = 30.0389$ has exceeded the critical value, or:

$$\chi^2 > \chi^2_{0.05}$$

So, the null hypothesis is rejected.

(vi) Conclusion

From the analysis, it is found that the establishment of small group activities is dependent on type of industry.

(vii) CONCLUSION

For eliminate waste element, both hypotheses are rejected. It is found that effort towards reducing waste and the establishment of small group activities to do continuous improvement is dependent on type of industry.

4.2.15 Result Summary of Section B

A Chi-square test is computed for every question in section B to find either elements stated are independent or dependent on types of industry. Below is a table that summarize the result of all questions that being tested in this section.

Table 4.28: Result summary of Section B

No.	Elements	Decision
1.	Setup time reduction	
	(1) Lead time reduction	Dependent
	(2) Efforts towards lowering setup time	Dependent
2.	Total quality control	
	(3) 100% sources inspection performed by operators at workstation	Dependent
	(4) Time to discover defects is reduced	Independent
	(5) Usage of mistake-proof (poka-yoke)	Dependent
3.	Smooth flow production	
	(6) Layout of machine and process	Independent
4.	Decrease lot size	
	(7) Small batches production	Dependent
5.	Education and training	
	(8) Training provided to all employees	Dependent
	(9) Training focused on more than technical skill	Dependent
6.	Employee involvement	
	(10) Employees participation in activities	Independent

Table 4.28: Continued

No.	Elements	Decision
7.	Total preventive maintenance	
	(11) Preventive maintenance practices	Dependent
8.	Process and workers flexibility	
	(12) Cross training	Dependent
9.	Uniform Workload	
	(13) Mixed modeling	Dependent
10.	Vendor and supplier relationship	
	(14) Supplier makes frequent, reliable delivery of high quality Parts	Dependent
	(15) Participation of supplier in improvement activities	Independent
11.	Kanban	
	(16) Usage of Kanban	Independent
12.	Top Management Commitment	
	(17) Top management commitment towards JIT effort	Dependent
13.	Pull system	
	(18) Pull system production	Dependent
14.	Eliminate waste	
	(19) Effort towards reducing waste	Dependent
	(20) Establishment of small group activities	Dependent

Table 4.28 summarizes the result of Chi-square test on hypothesis testing. It is found that only 5 elements or activities that are independent on types of industry. The other 15 elements are dependent on types of industry. From Table 4.28, column *No.* indicates the number of elements in JIT implementations. Number in bracket in second column of the table indicates number of question in questionnaire.

4.3 ANALYSIS OF SECTION C

Section C is answered by respondents from company that is not implemented JIT. 10 questions asked to the respondents about their knowledge and understanding on JIT production system. Total respondents for this section are 143.

4.3.1 Analysis of Question 1

Respondents were asked on their understanding of JIT. It is stated that JIT is a pull system. Results are recorded as follow.

Table 4.29: Responds of question 1

Answer	**Total Respondents**
Yes	134
No	9
Total	143

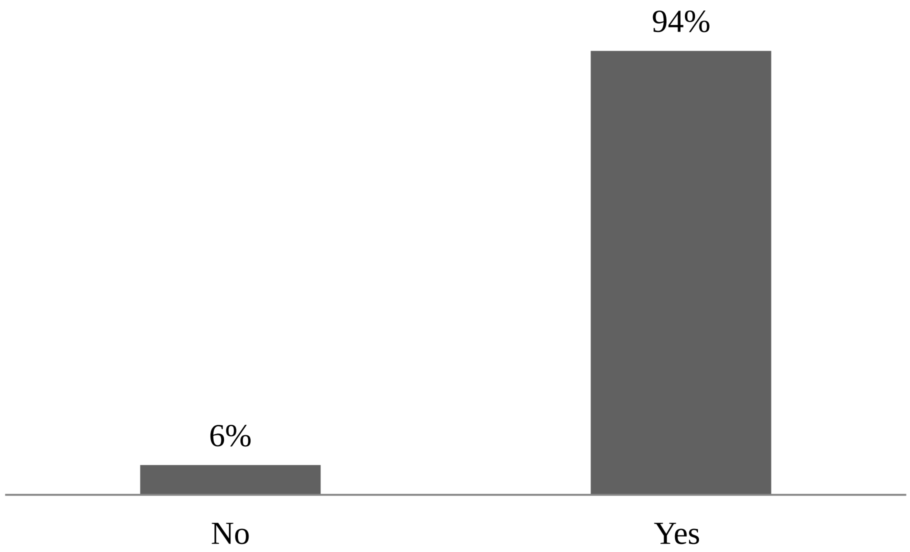

Figure 4.8: Percentage of respondents for question 1

Majority of respondents believe JIT is a pull system with 96% of responds, while only 6% said JIT is not a pull system.

4.3.2 Analysis of Question 2

Question 2 asked on their understanding on definition of JIT. It is claimed that JIT makes and delivers what is needed, just when it needed, and just in the amount needed.

Table 4.30: Responds of question 2

Answer	Total Respondents
Yes	134
No	9
Total	143

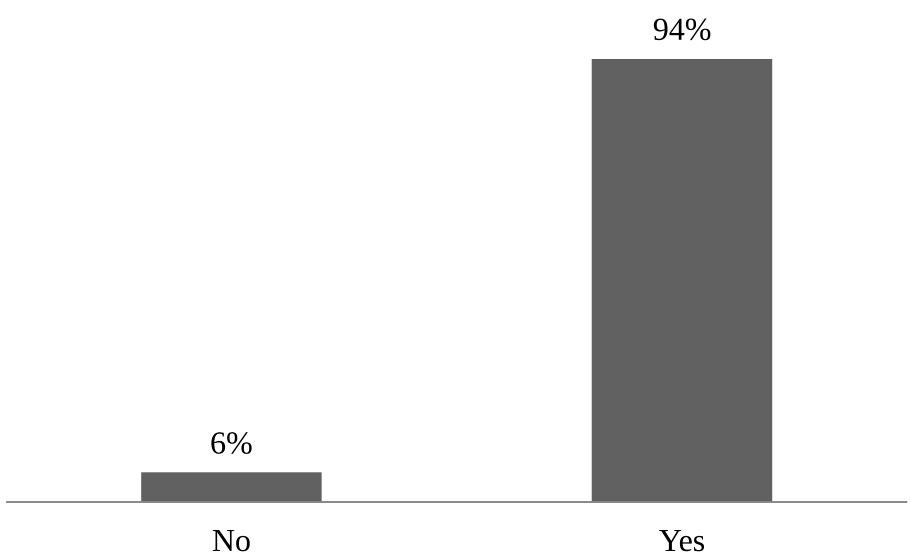

Figure 4.9: Percentage of respondents for question 2

94% of respondents agree with the definition of JIT that is JIT makes and delivers what is needed, just when it needed, and just in the amount needed .While 4% of respondents did not agree with the definition.

4.3.3 Analysis of Question 3

Question 3 asked on respondents' opinion on a statement where JIT provides cost-effective of production and delivery.

Table 4.31: Responds of question 3

Answer	Total Respondents
Yes	122
No	21
Total	143

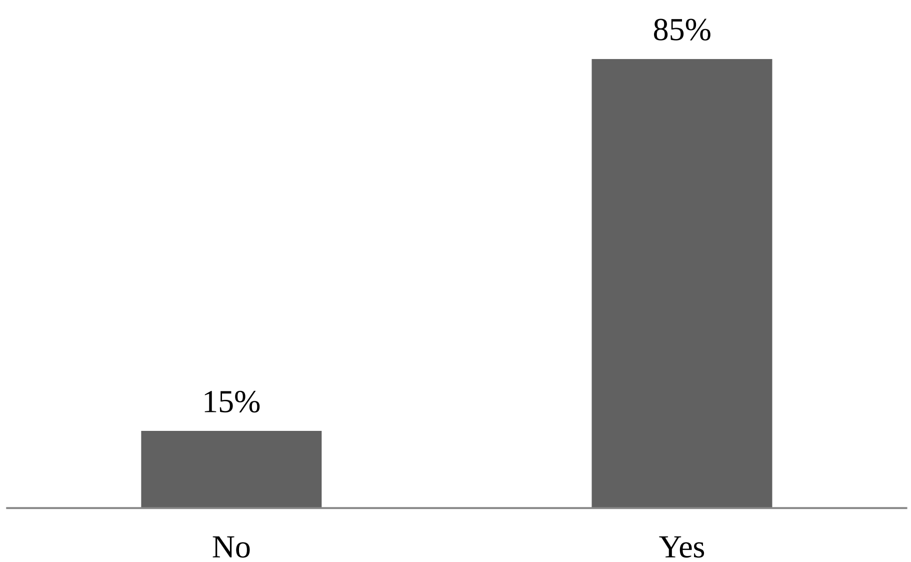

Figure 4.10: Percentage of respondents for question 3

15% of the respondents did not agree with the statement of JIT provides cost-effective of production and delivery. On the other hand, 85% of respondents agree with the statement.

4.3.4 Analysis of Question 4

Question 4 asked on respondents' opinion on a key philosophy of JIT that is simplification.

Table 4.32: Responds of question 4

Answer	Total Respondents
Yes	122
No	21
Total	143

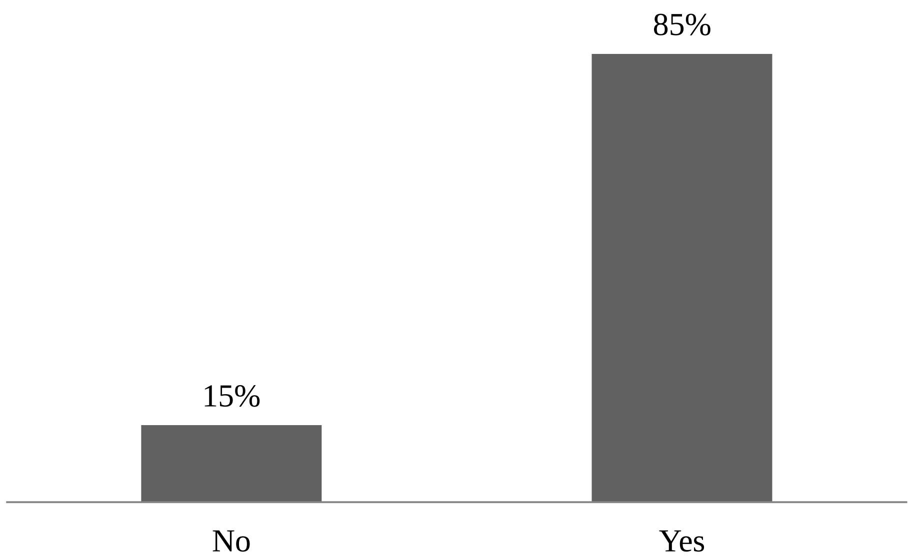

Figure 4.11: Percentage of respondents for question 4

85% of respondents agree that key philosophy of JIT is simplification while 15% of respondents did not agree with the statement.

4.3.5 Analysis of Question 5

Question 5 asked on respondents' understanding on JIT as a production system.

Table 4.33: Responds of question 5

Answer	Total Respondents
Yes	122
No	21
Total	143

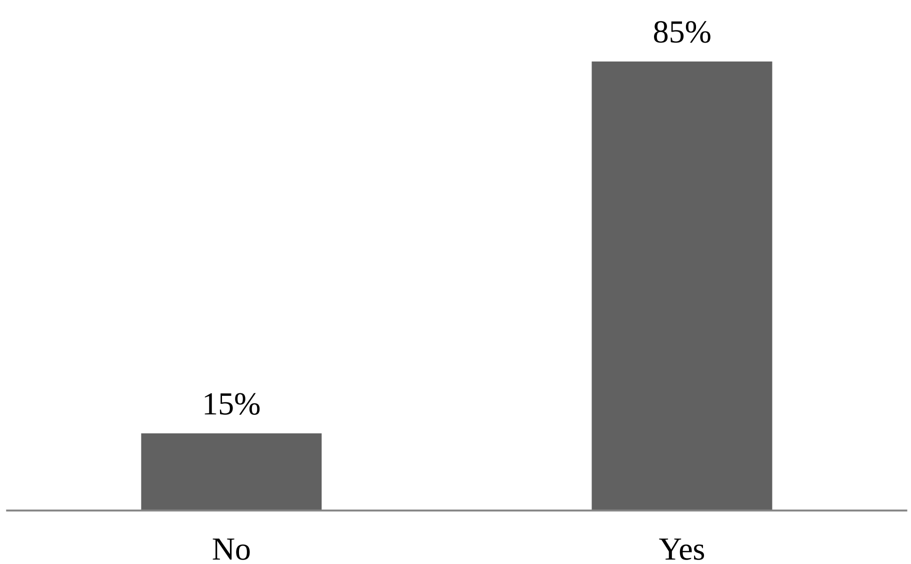

Figure 4.12: Percentage of respondents for question 5

85% of respondents agree that JIT is production system while 15% of respondents did not agree with the statement.

4.3.6 Analysis of Question 6

Question 6 asked on statement JIT is a discipline approach to improving overall productivity and eliminating waste

Table 4.34: Responds of question 6

Answer	Total Respondents
Yes	122
No	21
Total	143

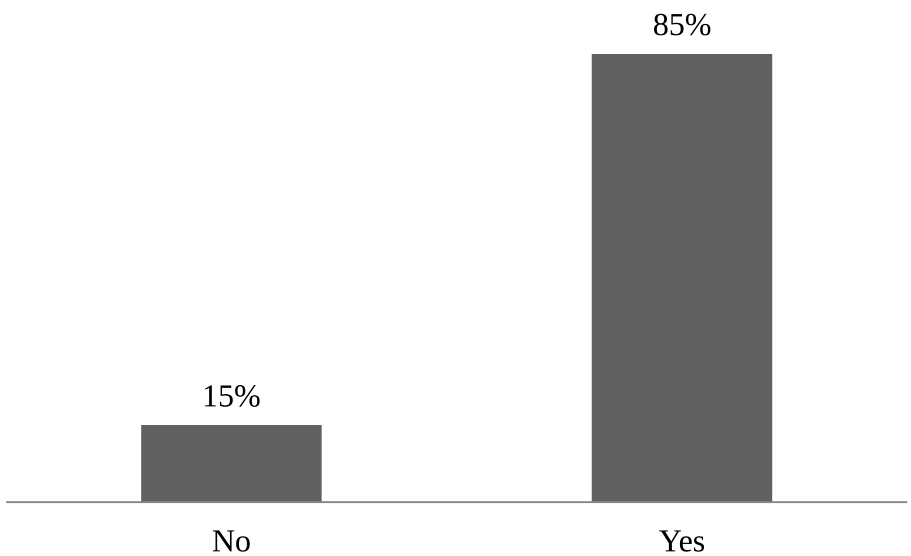

Figure 4.13: Percentage of respondents for question 6

85% of respondents agree with that statement while 15% of respondents did not agree with the statement.

4.3.7 Analysis of Question 7

Question 7 asked on respondents on statement; JIT is a manufacturing philosophy that seeks to eliminate waste and strive for on going improvement.

Table 4.35: Responds of question 7

Answer	Total Respondents
Yes	126
No	17
Total	143

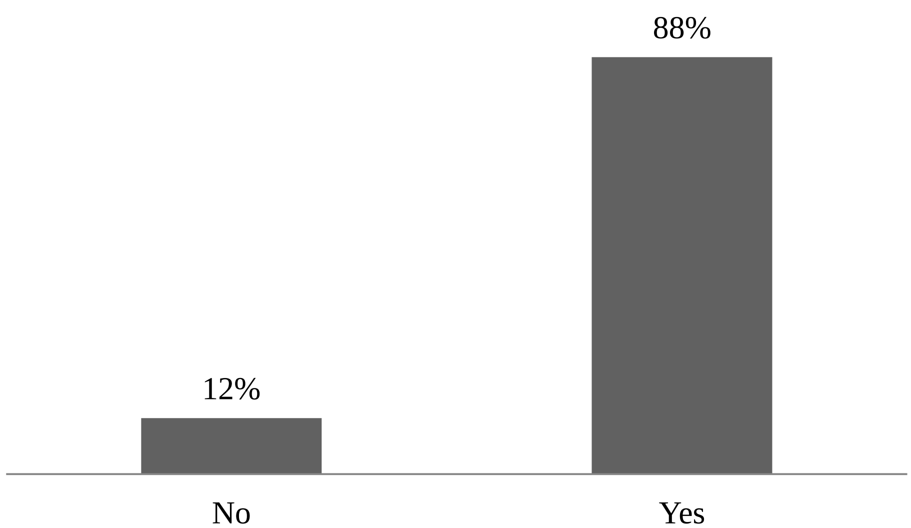

Figure 4.14: Percentage of respondents for question 7

88% of respondents agree with that statement while 15% of respondents did not agree with the statement.

4.3.8 Analysis of Question 8

Question 8 asked on respondents on statement; JIT encourages regular and explicit identification of problems and subsequent resolution.

Table 4.36: Responds of question 8

Answer	Total Respondents
Yes	117
No	26
Total	143

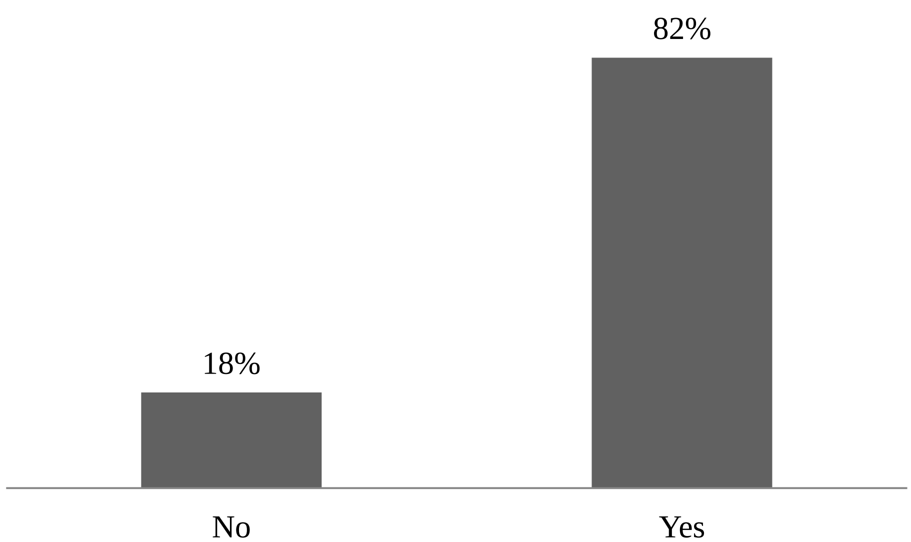

Figure 4.15: Percentage of respondents for question 8

82% of respondents agree with that statement while 18% of respondents did not agree with the statement.

4.3.9 Analysis of Question 9

Question 9 asked on respondents on statement; JIT is a 'mighty weapon' for improving delivery performance and reducing it manufacturing cost with highest quality of product.

Table 4.37: Responds of question 9

Answer	Total Respondents
Yes	109
No	34
Total	143

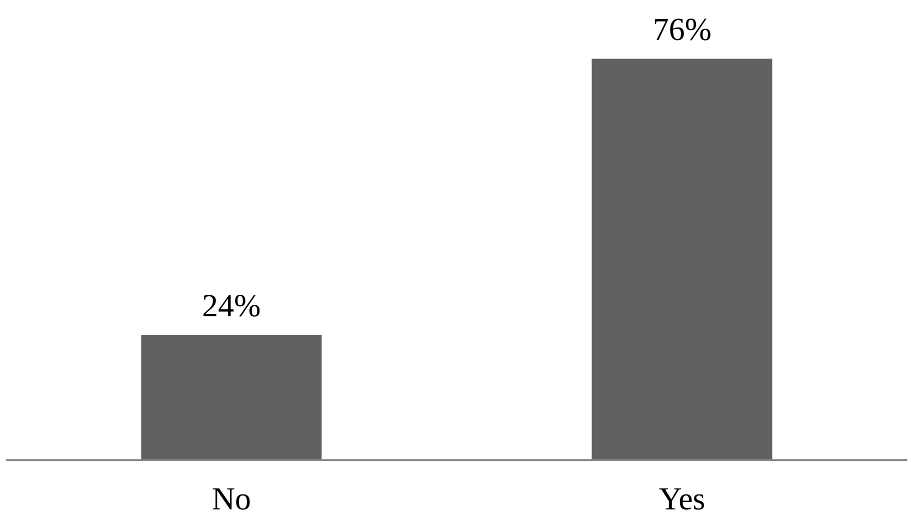

Figure 4.16: Percentage of respondents for question 9

76% of respondents agree with that statement while 24% of respondents did not agree with the statement.

4.3.10 Analysis of Question 10

Question 10 asked on respondents either their company wants to implement JIT or not in the future.

Table 4.38: Responds of question 10

Answer	Total Respondents
Yes	122
No	21
Total	143

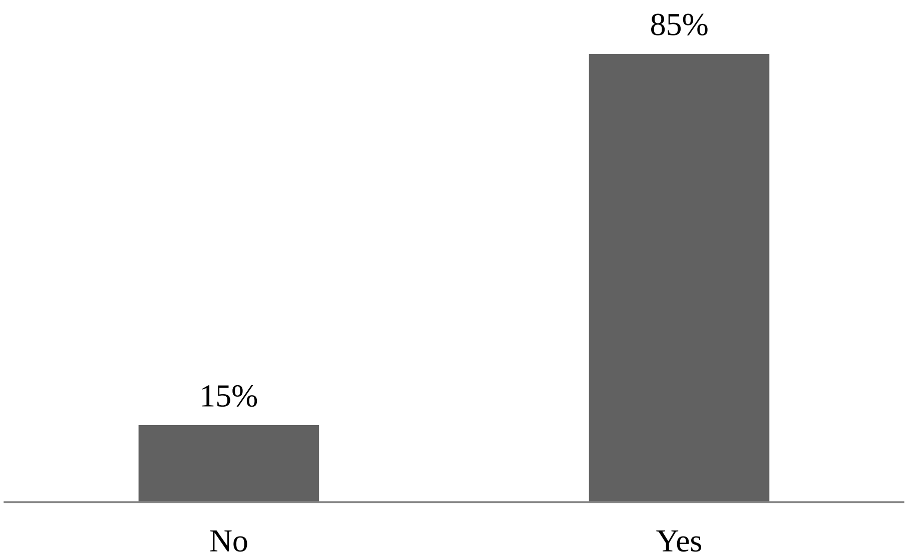

Figure 4.17: Percentage of respondents for question 10

85% said their company is looking forward in implementing JIT in the future, but 15% of respondents said their company does not want to implement JIT in the future.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 INTRODUCTION

This chapter will summarize findings from the analysis done in Chapter 4. In this study, since the objective to find the relationship between elements and types of industry, only result and analysis from Section 4.2 is explored and further discuss.

5.1 SUMMARY

Based on analysis done in Section 4.2, it is found that only 5 elements and 15 activities that are independent in JIT implementation. This elements and activities are summarized in Table 5.1 as follow.

Table 5.1: Elements and activities that are independent on types of industry

No	Elements	Activity
1.	Total quality control	Time to discover defects is reduced
2.	Smooth flow production	Layout of machine and process
3.	Employee involvement	Employees participation in activities
4.	Vendor and supplier relationship	Participation of supplier in improvement activities
5.	Kanban	Usage of Kanban

Based on Table 5.1 above, all the activities and elements listed are independent on type of industry. This mean, these elements and activities can be practiced and implemented in any company without considering type of industry.

In total quality control, a company that implements JIT will found time to discover defects is reduced. Smooth flow production that is required in JIT environment also can be achieved by having a good layout of machine and process regardless types of industry practiced. Employees, vendor and supplier participation in improvement activities are crucial in JIT implementation success, and can be practiced in any types of industries. Last but not least, the usage of Kanban to ensure the successfulness of JIT environment can be practiced in any types of industries regardless its own nature.

In analysis conducted, it is also found that 11 elements and 15 activities practiced are dependent on types of industries. Table 5.2 summarized the elements and activities as follow.

Table 5.2: Elements and activities that are dependent on types of industry

No	Elements	Activity
1.	Setup time reduction	Lead time reduction
		Efforts towards lowering setup time
2.	Total quality control	100% sources inspection at workstation
		Usage of mistake-proof (poka-yoke)
3.	Decrease lot size	Small batches production
4.	Education and training	Training provided to all employees
		Training focused on more than technical skill
5.	Total preventive maintenance	Preventive maintenance practices
6.	Process and workers flexibility	Cross training
7.	Uniform Workload	Mixed modeling
8.	Vendor and supplier relationship	Supplier makes frequent, reliable delivery of high quality parts
9.	Top Management Commitment	Top management commitment towards JIT effort
10.	Pull system	Pull system production
11.	Eliminate waste	Effort towards reducing waste
		Establishment of small group activities

Based on Table 5.2 above, analysis found that these 11 elements together with 15 activities listed in study are dependent on types of industries. These activities can not be easily practiced on all industries since the requirements of industry are different from each other.

Through this study, it is found that not all fourteen elements suggested by literature in the past 33 years are applicable in all types of industry. As this study revealing elements that are dependent and independent on types of industry, it may explain why we have various different elements that have been suggested by researchers in order to implement and achieve JIT success in a company or an organization.

5.2 RECOMMENDATIONS

It is suggested for any company from any industry that wants to achieve JIT environment in their organization to practice all the elements and activities listed in Table 5.1. But, if a company wants to practice elements from Table 5.2, it is suggested the company take a very deep observation in every activities taken since these activities only can be success and suits to only certain types of industry.

For future study, it is recommends to focus on one element, and zooming into all activities related to the element selected. Further investigation may be proceed through statistical analysis to find any related activities with the elements and industry.

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APPENDIX A

Serial No:_______

SECTION A: GENERAL INFORMATION – *Company background*

1. What is the approximate **number of employees** in your company?

☐ < 100 workers ☐ 101 to 300 workers ☐ 500 to 1000 workers ☐ > 1000 workers

2. How many **years** have your company been established?

☐ < 5 years ☐ 5 to 10 years ☐ > 10 and < 15 years ☐ > 15 years

3. What is the **type ownership** of your company?

☐ 100% Local ☐ 100% Foreign ☐ Joint Venture: ___% Local ___% Foreign

4. What are the **main products** that your company produces? You may tick more than one.

☐ Plastic Parts ☐ Rubber Parts ☐ Metal Parts ☐ Electronic Components

☐ Mechanical Devices ☐ Electrical Components ☐ OTHERS. Please specify ________________

5. Who is your main **customer**?

☐ 100% Local ☐ 100% Foreign ☐ Mixed ___% Local ___% Foreign

6. Is your company **practice** Just-In-Time production system?

☐ Yes If **YES**, Please proceed to **SECTION B**

☐ No If **NO**, Please proceed to **SECTION C**

SECTION B: JUST-IN-TIME (JIT) IMPLEMENTATION PERFORMANCES

This section attempts to determine the **level of production performances** of organization after implementation of JIT.

Please **tick (✓)** or **circle (◯)** the number of the response which best represents the **level of production performances** in your organization, according to given scale;

Perception

[1]	**[2]**	**[3]**	**[4]**	**[5]**
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Since implementing JIT;

NO	ITEMS	SCALE				
1.	Lead time has been reduced	1	2	3	4	5
2.	We aggressively working to lower setup time in our plant	1	2	3	4	5
3.	Operator perform 100% sources inspection at workstation	1	2	3	4	5
4.	Time to discover defects is minimized	1	2	3	4	5
5.	Usage of mistake-proof (poka-yoke)	1	2	3	4	5
6.	Machines and process are laid out in close proximity to each other	1	2	3	4	5
7.	The plant has moved towards producing in small batches	1	2	3	4	5
8.	Training is provided to all employees	1	2	3	4	5
9.	Training is aimed at more than purely technical skills	1	2	3	4	5
10.	Employees participate in improvement activities and problem solving	1	2	3	4	5
11.	Preventive maintenance is practices in workers daily routine	1	2	3	4	5
12.	Cross-training provided for multiple skills workers	1	2	3	4	5
13.	Mixed modeling production practiced	1	2	3	4	5
14.	Supplier make frequent, reliable deliveries of high quality parts	1	2	3	4	5

15.	Supplier participate in improvement activities	1	2	3	4	5
16.	Kanban is used for production control	1	2	3	4	5
17.	Top management demonstrate commitment to JIT, keep track all JIT activities	1	2	3	4	5
18.	Schedule / production rate are issued to final assembly operations only	1	2	3	4	5
19.	We aggressively seek and reduce waste in production line	1	2	3	4	5
20.	Small group activities establish to do continuous improvement	1	2	3	4	5

Is there any comment you want to add/share? (if necessary).

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Thank you for participating in this study. All responses will be treated with highly confidential and no single set of responses will be identifiable.

SECTION C: KNOWLEDGE OF JUST-IN-TIME (JIT)

This section attempts to determine the **level of knowledge on JIT** of the company.
Please **tick** (✓) the response which best represents the degree of agreement of your company on JIT statement.

NO	STATEMENTS		
1	JIT is a pull system	☐ Yes	☐ No
2	JIT makes and delivers what is needed, just when it needed, and just in the amount needed.	☐ Yes	☐ No
3	JIT provides cost-effective of production and delivery.	☐ Yes	☐ No
4	A key philosophy of JIT is simplification.	☐ Yes	☐ No
5	JIT is a production system.	☐ Yes	☐ No
6	JIT is a discipline approach to improving overall productivity and eliminating waste	☐ Yes	☐ No
7	JIT is a manufacturing philosophy that seeks to eliminate waste and strive for on going improvement.	☐ Yes	☐ No
8	JIT encourages regular and explicit identification of problems and subsequent resolution.	☐ Yes	☐ No
9	JIT is a 'mighty weapon' for improving delivery performance and reducing it manufacturing cost with highest quality of product	☐ Yes	☐ No
10	.Will your company implement JIT in future?	☐ Yes	☐ No

Is there any comment you want to add/share? (if necessary).

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Thank you for participating in this study. All responses will be treated with highly confidential and no single set of responses will be identifiable.

APPENDIX B

This is a step to find critical value for each question. Data for Question 1 in Section B is used to demonstrate steps taken.

First, to find critical value, all data needs to be transferred into contingency table as follow;

Table I: Contingency table of Question 1

	Agree	**Disagree**
Electronics Components	0	45
Mechanical	0	39
Metal	10	39
Plastic	13	28

To find critical value, first, we must find the degree of freedom (d.f). This value can be find through this contingency table. That is;

$$\begin{aligned} d.f &= (Row-1)(Column-1) \\ &= (4-1)(2-1) \\ &= 3 \end{aligned}$$

So, the value of d.f is 3. In this study, we choose $\alpha = 0.05$. Referring to Critical Value of Chi-square distribution table, we found that the critical value, $\chi^2 = 7.815$.

Critical Values of the χ^2 Distribution

df	0.995	0.975	0.9	0.5	0.1	0.05	0.025	0.01	0.005	df
1	.000	.000	0.016	0.455	2.706	3.841	5.024	6.635	7.879	1
2	0.010	0.051	0.211	1.386	4.605	5.991	7.378	9.210	10.597	2
3	0.072	0.216	0.584	2.366	6.251	7.815	9.348	11.345	12.838	3
4	0.207	0.484	1.064	3.357	7.779	9.488	11.143	13.277	14.860	4
5	0.412	0.831	1.610	4.351	9.236	11.070	12.832	15.086	16.750	5
6	0.676	1.237	2.204	5.348	10.645	12.592	14.449	16.812	18.548	6
7	0.989	1.690	2.833	6.346	12.017	14.067	16.013	18.475	20.278	7
8	1.344	2.180	3.490	7.344	13.362	15.507	17.535	20.090	21.955	8
9	1.735	2.700	4.168	8.343	14.684	16.919	19.023	21.666	23.589	9
10	2.156	3.247	4.865	9.342	15.987	18.307	20.483	23.209	25.188	10
11	2.603	3.816	5.578	10.341	17.275	19.675	21.920	24.725	26.757	11
12	3.074	4.404	6.304	11.340	18.549	21.026	23.337	26.217	28.300	12
13	3.565	5.009	7.042	12.340	19.812	22.362	24.736	27.688	29.819	13
14	4.075	5.629	7.790	13.339	21.064	23.685	26.119	29.141	31.319	14
15	4.601	6.262	8.547	14.339	22.307	24.996	27.488	30.578	32.801	15

With d.f = 3, and $\alpha = 0.05$, the critical value from table $\chi^2 = 7.815$

This critical value that we obtain from Chi-Square distribution table is used to compare with critical value that we computed for every 20 questions in section B.

APPENDIX C

This is a step that used to compute test value. First, to compute test value, expected frequencies is calculated from contingency table that we construct from Appendix B. Again, Question 1 of Section B questionnaires data is used to demonstrate this step.

Table I: Contingency table of Question 1

	Agree	**Disagree**	Total
Electronics Components	0	45	45
Mechanical	0	39	39
Metal	10	39	49
Plastic	13	28	41
Total	23	151	174

Expected value = $\frac{RowsumxColumnSum}{GrandTotal}$

To find the expected for agree respondents of electronic components type of industry, the calculation is as follow.

Expected value = $\frac{23x45}{174}$

= 5.9483

To find the expected for disagree respondents of electronic components type of industry, the calculation is as follow.

Expected value = $\frac{151x45}{174}$

= 39.8276

The step is repeated to find expected frequencies for every responds of types of industries.

Then, after we calculated the expected frequencies, the data is transferred into table below;

Industry	**Responds**	**Observed Frequency,** O	**Expected Frequency,** E	$\frac{(O-E)^2}{E}$
Electronic component	Agree	0	5.9483	5.9483
	Disagree	45	39.0517	0.9060
Mechanical	Agree	0	5.1552	5.1552
	Disagree	39	33.8448	0.7852
Metal	Agree	10	6.4770	1.9162
	Disagree	39	42.5230	0.2919
Plastic	Agree	13	5.4195	10.6030
	Disagree	28	35.5805	1.6150
Total				27.2208

To find test value for every responds the calculation is as follow;

Test value, $\chi^2 = \frac{(ObservedFrequency - ExpectedFr\,equency)^2}{ExpectedFr\,equency}$

So, to find Test value of agree responds of electronic component types of industry,

$$\chi^2 = \frac{(0 - 5.9483)^2}{5.9483}$$

We get the test value, $\chi^2 = 5.9483$

We find all test values of every responds of every type of industries through the same step. So, the total test value we get is 27.2208. This test value is compared to the test value that we get from table (Refer Appendix B) to make a conclusion.