A DESCRIPTIVE STUDY: TO UNDERSTAND LEAN READINESS THROUGH ASSESSMENT OF GRAIN ELEVATORS IN THE US CORN BELT REGION (INDIANA AND ILLINOIS)

by

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To my family

Thank you, mom, for always believing in me and standing by me in good and bad times

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GLOSSARY

Food security – In words of world health organization, food security refers to the situation where for everyone and at all times enough food is available (Maxwell, 1996).

Food safety – Refers to the regulations for attaining good quality of food and it's by products for safer consumer/customer consumption (Zhang & Seale, 2017).

Good manufacturing practices (GMPs) – Regulations approved and controlled by FDA for qualitied food and drug production through inspection of facilities setup (Center for Drug Evaluation and Research, 2018).

Grain Elevators – Storage facilities to store the grains before it can be moved to next level of post-harvest chain (Carney, 1995).

Lean – 'Lean' refers to organizational strategies of waste reduction with increasing output to optimize production systems (Dora et al., 2015, January, p. 1)

Lean readiness– Preparedness of an organization to undergo an organizational change of successfully adopting lean principles for operational excellence without any barriers and obstructions (Limère & Dora, 2016 & Catalanello & Redding, 1994)

Post-harvest loss (PHL) – De Lucia & Assennato, (1994), also cited by Kiaya, (2014), identifies PHL as measurable loss in quality and quantity of food loss in post-harvest activity.

LIST OF ABBREVIATIONS

AIB – American Institute of Baking

CR – Customer Relations

EM – Employees

FDA – Food and Drug Administration

GEAPS – The Grain Elevator and Processing Society

GMP – Good Manufacturing Practices

LD – Leadership

LR – Lean Readiness

PR – Process

SR – Supplier Relations

QMS – Quality management systems

WC – Willingness to change

ABSTRACT

Since its foundation, Lean practices have played crucial role in reduction of wastes in a given process to maximize efficiency. Adoption of Lean practices in several industries have opened wide scope to study its impact on many fields such as agricultural sector. Post-harvest stage within agricultural supply chain is known to have gaps in terms of assuring good storage practices. The losses at post-harvest level have significantly impacted the availability of sufficient food for global population. These losses occur due to lack of compliances with good management practices. The literature of this study identifies shortfalls in the management practices of the grain storage containers in United States. The grain elevators are most common technology in use which assures the security of the raw food grains after harvest stage and right before its transfer to next stage. Adoption of good management practices by grain elevators thus becomes crucial to secure the safety of the nutritional quality of the grains which is vital to ensure food security and keep food losses low.

The thesis considers the shortfalls associated with the management practices of grain elevators and propose to adopt Lean as a solution. The outcomes of this research present a descriptive analysis of the lean readiness survey completed by the superintendents of the grain elevators in corn belt region of United States (primarily in Illinois and Indiana). The lean readiness results reveal the extent to which the elevators are ready to adopt lean practices. The research also identifies the readiness level which indicates highest as well as lowest level of readiness levels towards lean adoption. The conclusion presents the summary of final outcomes of lean readiness level based on the surveyed elevator superintendents.

CHAPTER 1. INTRODUCTION

1.1 Introduction

Food security plays a major role in ensuring sufficient availability of food products to feed the growing population of the world (Kumar & Kalita, 2017). Kiaya (2014) & (Kumar & Kalita, 2017) states that while increasing food security remains a global initiative nearly one-third food losses occur during the post-harvest period. Food losses in a post-harvest period significantly decreases the availability of food products for the final consumers, which puts the concern of increasing food security at a higher risk (Kiaya, 2014). Studies by (Kumar & Kalita, 2017) reveals that food storage stage of a given post-harvest activity plays a vital role in ensuring security of the raw food products however faces a higher risk of losses owing to many factors driving its operational success. Study conducted by Velasquez (2007) revealed limited attention given towards security of raw food products during the storage stage which directly impacts food security.

Grain elevators are storage facilities operated to store grains during post-harvest period (Velasquez, 2007 & Carney, 1995). A report by United States department of agriculture (USDA) in 2000 had revealed that gaps in management practices at grain elevators to cause $500 million loss to the wheat industry that year (USDA ARS, 2000). Studies by Penn State Extension (2017) and Purdue Extension (2019) also identified gaps in elevator's management practices to be the cause behind inefficiencies in the elevator operations. The Penn State extension (2017) had reported that typically farmers lose about 10 percent of grain crop from the time between harvest and processing owing to poor management practices. This 10 percent in year 2017 nearly accounted to $31.4 million dollars in monetary value which was a significant loss to US economy. An article by University of Arkansas extension (2019) concluded that storing grains at elevators strongly requires a thorough monitoring of temperature and moisture control which ties back

to having effective management practices. Therefore, the studies conducted by Dora et al., (2015), Limère & Dora (2015) & Marcelis (2009) suggested about the need of adopting quality management strategies such as lean management to address the gaps explored in grain elevator management practices. Lean practices adoption in past has proven to show drastic improvements in organizations by improving management practices (Dora et al., 2015). The outcomes of the studies conducted by Simons & Zokaei (2005), Scott, Wilcock & Kanetkar (2009) and Kadjo, Ricker-Gilbert, Alexander & Tahirou (2013) had revealed positive impact of lean practice adoption in agricultural industries in terms of reducing food losses and ensuring organizational success. Same authors concluded lean to be an effective management and improvement tool which better manages an organization's business with limited resources.

Adoption of lean practices by grain elevators provides a scope to improve gaps in management practices which can further ensure the safety of raw food grains which is vital to ensure food security and keeping food losses low. Studies reveal that adoption of management practices by grain elevators as seen through lean lenses requires a thorough assessment of their preparedness levels (Al-Balushi et al., 2014 & Limère & Dora, 2015). The preparedness levels are crucial to assess as it provides current standing of grain elevators in going lean. This idea presents a scope to assess lean readiness of grain elevators.

1.2 Statement of Problem

Securing of raw food products during early stages of food supply chain is essential to ensure high food availability and food security (Velasquez, 2007). Limère & Dora (2015), discusses about gaps in managing resources in agricultural sector which cause high food losses. Dora, Lambrecht, Gellynck & Van Goubergen (2015) confirms gaps with management practices which fosters inefficiencies in securing the safety of raw food grains during post-harvest activity.

Kiaya (2014) reveals that food losses during storage stage in a post-harvest activity impacts food security at global level which shows an urgent need of adopting quality management practices. Limère & Dora (2015), strongly believes in adoption of management practices, such as lean, as an effective strategy to address management gaps in agricultural organizations. Most commonly used storage facilities such as grain elevators (Velasquez, 2007 & Carney, 1995), face gaps with management practices and challenges to manage operations with limited resources (Velasquez, 2007) and therefore are in need to adopt effective management system. Management practices such as Lean management system is an effective strategy of managing business with limited resources (Limère & Dora , 2015) which not all grain elevators follow (Velasquez, 2007). Adoption of lean practices has a scope to address gaps in the management practices of the grain elevator industry, which are SMEs bounded with limited resources (Velasquez, 2007). From the perspective of lean lenses, it becomes crucial to assess readiness level of organizations who are willing to adopt lean practices (Al-Balushi et al., 2014). From this perspective, Al-Balushi et al., (2014) & Limère & Dora (2015) explores and presents critical factors to assess an organization's preparedness level to adopt lean management system.

Therefore, the objective of this research leads to investigate the readiness levels of the grain elevators in terms of their preparedness to adopt lean as a management system. Lean adoption can greatly help grain elevators to ensure safety of grains and keep food losses minimum to ensure food security at global level.

1.3 Research Question

Based on the problem statement and literature the researcher attempted to answer following research questions.

- RQ1: What is the current Readiness level of the grain elevators as assessed through Lean Readiness factors towards adopting the Lean practices fostering efficiency in elevator operations?
- RQ2: Which Lean Readiness factor indicates the highest readiness level to adopt lean practices or lean implementation among independently owned grain elevators in the corn belt region of Indiana and Illinois?
- RQ3: Which Lean Readiness factor indicates the lowest readiness level to adopt lean practices or lean implementation among independently owned grain elevators in the corn belt region of Indiana and Illinois?

1.4 Scope

The scope of this study was to report the readiness level and the factors indicating the highest and lowest readiness levels of the grain elevators in corn belt region of US to adopt lean practices. This was done through assessment of Lean readiness framework developed by Limère & Dora (2015). Due to time constraints, the data was collected in the form of surveys distributed to the elevator superintendents through GEAPS (The Grain Elevator and Processing Society) chapter meetings. Based on literature and past case studies of assessing lean readiness levels of organizations, survey method was concluded to be the best strategy to collect data. The past case

studies by authors Limère & Dora, (2015), Al-Najem, Dhakal, Labib & Bennett (2013), Garza-Reyes, Ates & Kumar (2015) & Garza-Reyes et al., (2018) also concluded the studies by reporting readiness level results through survey analyses. The collected data from the surveys was analyzed descriptively to provide the level of lean readiness.

1.5 Significance

The assessment of readiness levels for grain elevators to adopt lean management is a research never done before. The outcomes of this study would assist researchers in assessing grain elevator's readiness to adopt lean practices. The results of this study can be used to study readiness factors critical to lean adoption for the management of the elevators. This also provides a future scope to research the strategies and methodologies that can help the managers/superintendents of grain elevators adopt lean practices. Additionally, as Garza-Reyes et al., (2018) believes, lean readiness scores can always be used as a reference to study certain quality aspects of operations such as leadership and effective management practices. Dora et al., (2015) discusses about lean readiness framework and its important quality aspects, such as: leadership, measurement and process and, people management. This study provides a good starting point for the practitioners who wishes to study lean practices adoption for grain elevators.

1.6 Assumptions

- It is assumed that a superintendent's knowledge, familiarity with the operations and work experience would be sufficient to understand post-harvest operations.
- It is assumed that the personnel completing the survey would do so with all honesty and with the best of their expertise.

- It is assumed that there will be no personal or any other sort of biasness involved in the study.
- It would be assumed that the personnel taking the survey belong to independent or co-operative owned grain elevators.
- Each survey was completed by one participant (superintendent)

1.7 Limitations

The limitations of the research study would be:

- This survey questions are based on the lean readiness questions developed for agricultural production systems and previous researches
- This study would be limited to the responses captured from the superintendents of the grain elevators.
- The Lean Readiness survey developed by Limère & Dora (2015) was adopted for this research.
- Interpretations are concluded based on the lower response rate of the surveys

1.8 Delimitations

The delimitations of the research study would be:

- The study does not incorporate any grain elevators outside corn belt region of state of Indiana and Illinois.
- The study does not consider any grain elevators other than independently owned or co-operatively owned.
- The study does not address the solutions to the gaps in the current organizational practices of the grain elevators.

- The study does not consider the operational performance of elevators based on lean readiness levels.

1.9 Summary

The purpose of the introduction section was to identify gaps in current grain storage practices at grain elevators. Lean adoption was reviewed to be a possible strategy to address these gaps for improving the efficiency of elevator businesses. However, it was deduced from literature that it is crucial to assess the preparedness level of an elevator businesses before lean adoption. Hence the purpose f this study aimed to assess current lean readiness levels of the grain elevators and identify factors critical to its successful implementation. The research gaps were identified through exhaustive literature review. The limitations, delimitations and assumptions placed the constraints over the limit and extent to which this study would attempt to address the readiness levels.

CHAPTER 2. LITERATURE REVIEW

2.1 Food Security/ Food Insecurity

Food security is defined as a situation where at all times and for everyone food is available to maintain an active and healthy lifestyle (Maxwell, 1996). Schmidhuber & Tubiello (2007), states four critical dimensions with regards to the food supply chain which includes – availability, stability, access and utilization. Based on a research by Barrett (2010), food insecurity refers to a situation when population doesn't have enough access and availability of food to fulfill their nutritious requirements. Gundersen & Ziliak (2015) discusses about the direct impact that food insecurity has to the health of the people who face situation of food insufficiencies. The authors Schmidhuber & Tubiello (2007) further segregates food availability dimension towards the efficiencies needed in the agricultural production systems to ensure enough availability of food products for the final consumers. Kendall, Olson & Frongillo Jr (1996) conducted studies to relate the issue of hunger and food insecurity to food availability. The authors deduced that enough food availability by the agricultural production systems is directly associated with ensuring food security. The literature suggests that for a population to be food secure it is essential to ensure that agricultural production systems are adopting relevant measures to ensure maximum food availability within their food value chain.

United states of America follow a highly regulated system to increase security of food items for its consumers and ensure high food availability (Velasquez, 2007). Swaminathan & Bhavani (2013) stresses on the fact that food availability and production forms the basis for the food security which is also accepted by FAO (Food and Agricultural organization). Based on the same article by Swaminathan & Bhavani (2013), the food availability refers to the situation where the food stocks are available in desired quantities with effective storage and transportation system. It can

therefore be understood from the literature that food security has a direct link to the effective farm management practices in terms of storage and transportation systems. An article by Laux & Sabharwal (2018), reviewed the limitations in the farm management practices among the small holder farmers to have a direct impact on the food security for the consumers. These practices are essential to ensure food availability by minimizing the food losses right at early stages of the farm supply chain level. In fact, research by (Parfitt, Barthel, & Macnaughton, 2010), discusses about the food losses to cause an impact on agricultural economies which further impacts the availability of enough food at the early stages of food supply chain. A study by Velasquez (2007) revealed about measures adopted to increase food security however pointed towards limited attention given towards securing of raw food grains during the early stages of the food supply chain. This leads to the fact that in order to ensure high food security it is essential to secure the raw food items in early stages and ensure sufficient food availability right from the initial stages.

It can therefore be deduced that keeping food losses low during the early stages of food supply chain is vital to ensure sufficient food availability for the consumer (Swaminathan & Bhavani, 2013). The next section of literature discusses about the food losses and the critical stage within food and farm supply chain which contribute maximum food losses to global numbers.

2.2 Food Losses

Food losses has been identified as a major issue behind fallen agricultural economies, which is deeply embedded within global food supply chain network (Parfitt, Barthel, & Macnaughton, 2010). From the previous section it was concluded that food security is impacted by the food losses occurring at various stages of the food supply chain. In fact, food losses occur at all stages of food supply chain (Gustafsson, Cederberg, Sonesson, & Emanuelsson, 2013 & Kiaya, 2014). Figure 2.1 represents a generic food supply chain model along with the nature of food wastes during each

stage of the food chain activity (Parfitt et al., 2010). According to a report by FAO, the food production would need to be raised by 70 percent by the year 2050 in order to feed the growing population (Kiaya, 2014). It is expected that by 2050 the world population would reach 10.50 billion which is a big concern owing to ensuring sufficient food availability. (Aulakh, & Regmi, 2013). Kiaya (2014), emphasizes on the need of adopting measures to control the food losses (or waste) right from the initial stages of the food supply chain where safety of food grains is at a higher risk. This is also confirmed by Bourne, (1977), Parfitt et al., (2010) and a report by FAO that due to increasing demand of food by growing population, it is crucial to assure that loses are being minimized right from the early stages of food supply chain.

Kiaya (2014) refers these food losses as a loss in quantity and quality which makes them unsuitable for human consumption. The same study discusses post-harvest losses (PHL) or the losses of food commodities after harvest to contribute most to the overall food loss numbers which results in less availability. These losses further increase the risks of less supply of food products to the final consumers (Kiaya, 2014). For instance, from Figure 2.1, it can be seen that during the storage stage of the food supply chain, the food losses occur due to pests' attacks, spillage and contamination by the external factors. The Figure 2.2 and Figure 2.3 further reflects upon the factors which drives the food losses during the stages of food supply chain. As discussed and seen from the figures the food storage stage has the greatest number of factors driving losses ranging from maintaining moisture, temperature, setup facilities and effective management system.

Thus, it can be concluded that food losses occurring at the storage stage in the food supply chain is impacted by many factors and in fact post-harvest is confirmed to have maximum food losses at the global level. The next section researches more into the storage stage of the post-

harvest activity and takes a look into the existing gaps with the current storage practices mitigating losses in food supply chain

	stage	examples of food waste/loss characteristics
(1)	harvesting—handling at harvest	edible crops left in field, ploughed into soil, eaten by birds, rodents, timing of harvest not optimal: loss in food quality crop damaged during harvesting/poor harvesting technique out-grades at farm to improve quality of produce
(2)	threshing	loss through poor technique
(3)	drying—transport and distribution	poor transport infrastructure, loss owing to spoiling/ bruising
(4)	storage	pests, disease, spillage, contamination, natural drying out of food
	processing	
(5)	primary processing—cleaning, classification, de-hulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, milling	process losses contamination in process causing loss of quality
(6)	secondary processing—mixing, cooking, frying moulding, cutting, extrusion	process losses contamination in process causing loss of quality
(7)	product evaluation—quality control: standard recipes	product discarded/out-grades in supply chain
(8)	packaging—weighing, labelling, sealing	inappropriate packaging damages produce grain spillage from sacks attack by rodents
(9)	marketing—publicity, selling, distribution	damage during transport: spoilage poor handling in wet market losses caused by lack of cooling/cold storage
(10)	post-consumer—recipes elaboration: traditional dishes, new dishes product evaluation, consumer education, discards	plate scrapings poor storage/stock management in homes: discarded before serving poor food preparation technique: edible food discarded with inedible food discarded in packaging: confusion over 'best before' and 'use by' dates
(11)	end of life—disposal of food waste/loss at different stages of supply chain	food waste discarded may be separately treated, fed to livestock/poultry, mixed with other wastes and landfilled

Figure 2.1:Generic food supply chain and examples of food wastes
Source: Parfitt et al., 2010

	Factors affecting postharvest losses (PHL)								
	(Xj)								
Critical stages of food supply chain (Si)	***Moisture***	***Weather***	***Pests/disease***	***Infrastructure***	***Size of operation***	***Level of mechanization***	***Quality of management***	***Operator characteristics***	***Access to capital***
Harvesting	X	X	X		X	X	X	X	X
Food storage	X	X	X	X	X	X	X	X	X
Processing	X	X	X	X	X	X	X	X	X
Packaging				X	X	X	X	X	X
Sales				X	X		X	X	X

Note: Food waste at the consumer-level will not be covered in this study.

Figure 2.2 Factors affecting post-harvest losses at critical stages of food supply chain
Source: Aulakh, & Regmi (2013)

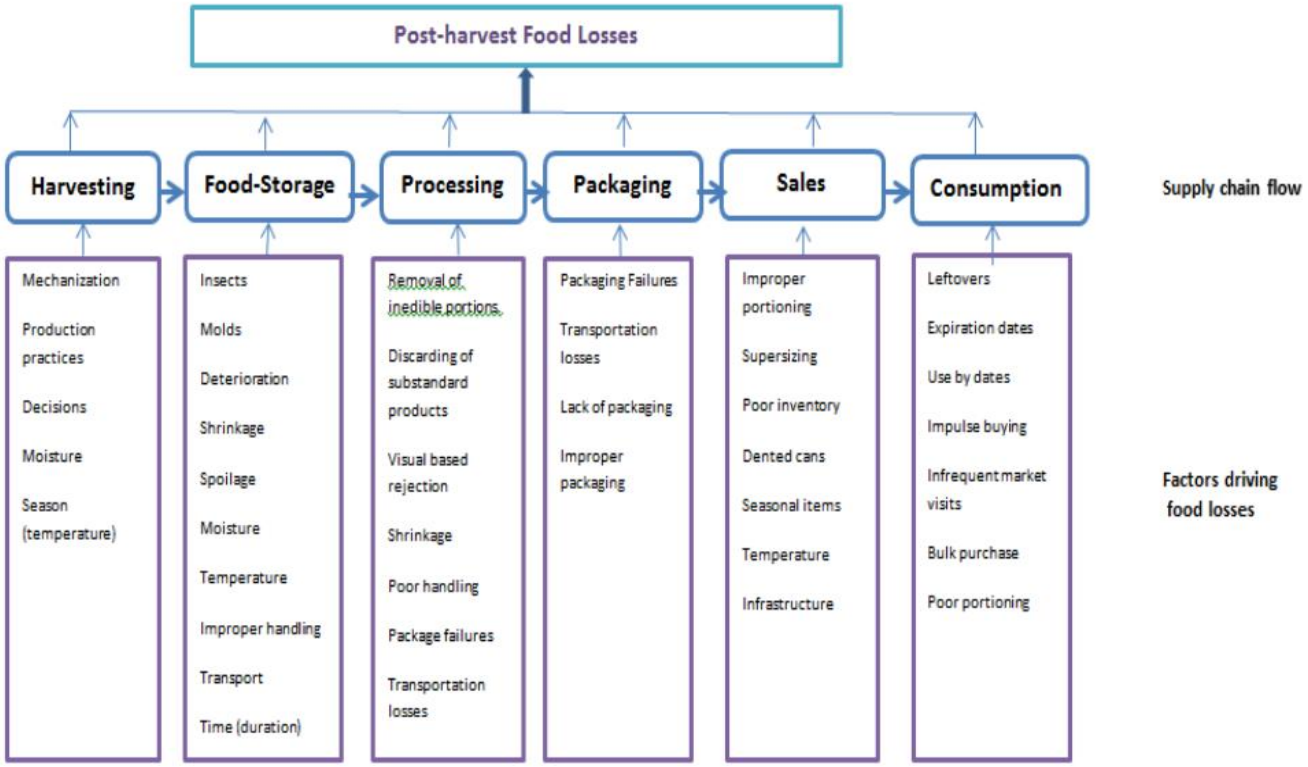

Figure 2.3 Conceptual framework for estimating post-harvest food losses
Source: Aulakh, Regmi, Fulton, & Alexander (2013)

2.3 Post-harvest

Prussia, & Shewfelt, (1993) refers post-harvest to be a set of activities or time period between the harvest of raw food from the agricultural land to the final food preparation. The frameworks in Figure 2.2 and Figure 2.3 depicts the stages within the post-harvest system which is crucial for its successful functioning. Kiaya (2014) discusses the term 'post-harvest losses' as the loss in quantity and quality of food commodities between the stages of harvest and final food production. Hodges et al. (2011) defines the loss in grain quantity as reduction in weight and volume, whereas loss in quality as decrement in nutritional value. Aulakh et al. (2013) discusses the quantitative losses at storage to occur as a result of infestation by pests, physical loss (spillage) and improper monitoring of moisture (or temperature) content, which reduces the amount of harvested of grain commodity. Based on the literature and from Figure 2.2 and Figure 2.3, it is observed storage stage of post-harvest activity has food losses driven by many factors such as moisture, temperature regulation, sanitary conditions, quality of facility, employee management and leadership involvement. This is also confirmed by authors Kiaya (2014), Velasquez (2007) & Aulakh, & Regmi (2013).

Studies conclude that both quality (qualitative) and quantity (quantitative) losses in a post-harvest activity hugely happens due to gaps in management practices of the storage operations (Velasquez, 2007 & Kiaya, 2014). The next section discusses about the storage and handling stages in context of the post-harvest activity. The gaps are identified in terms of the need of proper management system to ensure lower risks of food losses at storage facilities (Carney, 1995 & Velasquez, 2007).

2.3.1 Post-harvest losses: Storage and handling

The literature review unveils that post-harvest losses contributes maximum percentage in global food losses (Kiaya, 2014). This means that elimination of food losses in a post-harvest activity becomes an important issue to address. Kumar & Kalita (2017) believes that reducing post-harvest losses through sustainable means is essential to increase food availability. Brockamp (2016) and Kiaya (2014) discusses the impact of food losses during post-harvest to cause increasing food scarcities thus impacting the scope of food security.

Kumar & Kalita (2017) notes that storage stage in a post-harvest plays a vital role in determining the extent of food losses occurring within the food supply chain. Improper storage facilities and poor management leads to higher risks of food losses (Gustafsson et al., 2013). These gaps open up the gate for huge pest attacks and exposure to the open air thus degrading the food quality (Velasquez, 2007). Brockamp (2016) also questions the quality of the storage containers to hugely impact the security of grain quality. Based on the same context, Brockamp (2016) stresses on the on availability of education, technological advancements and proper management techniques to keep regular checks on handling practices during storage operations. The literature reveals that food losses during post-harvest normally occurs due to poor management. From figure 2.4 suggests that in developed nations food losses during post-harvest are managed when there is an intervention to regulate improvement in farm storage facilities.

Loss name	Definition	How computed	Possible interventions to avoid losses
Agricultural losses	Contains losses due to mechanical damage and/or spillage during harvest operation, crop sorting etc. Percentage varies from 2% for cereals in industrialised regions (EUR, NAO, INA) to 20% for roots & tubers (EUR, NAO, INA) and fruits & vegetable (EUR, NAO, LAM).	Calculated from the local production (FSC step (1) in Fig. 1A), derived from Food Balance Sheets (FAO, 2011d).	*In industrialised countries*: cooperation among farmers could reduce risk of overproduction that often leads to agricultural losses (Stuart, 2009). *In developing countries*: better organised small farmers, technology transfer, education (Gustavsson et al., 2011).
Postharvest losses	Contains losses due to storage and transportation between farm and distribution, and spillage and degradation during handling. Percentage varies from 0% for oilseeds & pulses in NAO to 19% for roots & tubers in SSEA.	Calculated from the harvested production (step 2 in Fig. 1A), i.e. the local production reported in Food Balance Sheets (FAO, 2011d).	*In industrialised countries*: Improved on-farm facilities. *In developing countries*: more reliable transportation network, energy and market systems; enhanced infrastructure during transportation and storage (Rolle, 2006; Stuart, 2009).
Processing losses	Includes losses during industrial or domestic processing. Percentage varies from 0.5% for cereal products in industrialised regions to 25% for fruits & vegetables in AFR and SSEA.	Calculated from the part of DFSQ that was processed (based on FAO, 2011d) before distribution and consumption (step 7 in Fig. 1A).	*In industrialised countries*: develop market for 'sub-standard' products that are eatable, enhanced production lines (Stuart, 2009). *In developing countries*: capacity building, more investments on food processing (Gustavsson et al., 2011).
Distribution waste	Includes losses and waste in the market system, including wholesale markets, supermarkets, retailers, and wet markets. Percentage varies from 1% for oilseeds & pulses in industrialised regions to 17% for fruits & vegetables in AFR.	Calculated from the total amount of processed and fresh food (step 8 in Fig. 1A) derived from DFSQ. For the processed fruits & vegetables and roots & tubers the waste percentages were 59% of the ones for the fresh food.	*In industrialised countries*: lower standards for size, weight, etc. (Gustavsson et al., 2011). *In developing countries*: marketing cooperatives and improved marketing facilities (Gustavsson et al., 2011).
Consumption waste	Includes all the losses and waste at the household level. Percentage varies from 1% for cereals in AFR and oilseeds & pulses in SSEA to 30% for roots & tubers in NAO.	Calculated from the total amount of consumed food (step 9 in Fig. 1A). For the processed fruits & vegetables and roots & tubers the waste percentages were 20% of the ones for the fresh food.	*In industrialised countries*: public awareness, smaller packages, better planning in restaurants and households (Gustavsson et al., 2011). *In developing countries*: not a big problems as consumption waste is already very low.

Figure 2.4 Food losses and Waste
Source: Kummu, De Moel, Porkka, Siebert, Varis & Ward (2012)

Based upon a storage point of view it can be concluded that several factors are responsible for both qualitative and quantitative food losses in a post-harvest activity. These factors range from infestation by to improper processing which further depends upon different regions and local weather conditions. The quantitative losses at storage is caused as a result of infestation by pests, physical loss (spillage) and improper monitoring of moisture (or temperature) content which reduces the amount of harvested grain commodities (Aulakh et al., 2013). The loss of harvested grain quantity therefore increases the risks of lower food security. The qualitative losses are mostly attributed to improper setting of the climate-controlled storage facilities. Additionally, the

contamination due to non-food material and improper processing causes the grains to lose its nutritional value (Aulakh et al., 2013). These losses in nutritional value also makes the grains unsuitable for human consumption.

Thus from the literature review it can be concluded post-harvest losses is an important issue which needs to be addressed in order to ensure sufficient food availability. From Figure 2.4 it was seen that storage operations needs to be checked and monitored on regular basis to ensure the security of raw grains. As Velasquez (2007) believes that simply taking measures to ensure food security is not enough. Instead steps are supposed to be taken to ensure security of raw food products. The qualitative and quantitative losses could be improved by ensuring proper checks and monitoring of the storage operations. The framework from Figure 2.2 also portrays proper people management, operator characteristics and size of operations to impact the smooth working of grain operations. This means that assuring an effective leadership, proper management and right knowledge are important to ensure right storage practices.

Gustafsson et al. (2013) suggests addressing management gaps in storage facilities and operations to ensure high security of raw food grains. From the framework in Figure 2.2, people management, operator characteristics and organization management are vital to ensure smooth working of grain operations (Aulakh, & Regmi 2013). It can be summed up that storage operations indeed requires a proper managerial leadership and effective management to ensure its successful working.

It can be concluded that a major chunk of food grain losses occurs during storage operations in a post-harvest activity. Gaps are identified in terms of poor management practices at storage facilities which puts the security of grains at risk. Though storage facilities in United States are highly optimized and mechanically operated, yet it isn't sufficient to ensure complete security

against environmental factors. These shortfalls increase the risks for the food losses and provides a scope to introduce practices which can eliminate the risks. The next sections discuss about the grain storage facilities and good quality management practices required for operational excellences.

2.3.2 Grain elevators – Organization

The purpose of this section is to discuss about gaps in management practices of storage facilities such as grain elevator's and how it impacts food losses. It is now established that there is a need for eliminating the risks for the grain damage caused due to pest infestation during post-harvest storage stage owing to poor management practices.

Hagstrum, Reed & Kenkel (1999) defines the grain elevators as large storage facilities, primarily used to store grains after harvest. Such elevators are present in every county within farms of United States (Hagstrum et al., 1999). Velasquez (2007,) & Hagstrum et al. (1999) identifies the ownership of the elevators to be either independent or co-operative or owned by big enterprises. These elevators play a crucial role to ensure safe storage of the grains after harvest (Ngwa, 2017). These facilities are expected to follow fixed quality management requirements such as Good manufacturing Practices (GMPs) regulations, to ensure organizational excellence. As Velasquez (2007) & Center for Drug Evaluation and Research (2018) discusses, these regulations establish standards for adequate facility setup and monitor the management practices for functional excellences. Compliances with such regulations ensures lower risks of the grain damage particularly caused due to pests. Based on the article by Hagstrum et al. (1999) the safety of stored grains in elevators against pest infestation is ensured by adopting good storage and organizational management practices.

The research by Purdue extension (2019) also lists improper grain cooling, inadequate insect control and lack of observations to cause grain damage. The same study identifies that

improper moisture control often leads to grain spoilage thus leading to losses. The migration of moisture within grain facilities are caused due to uneven temperature differences. Unmonitored grains due to lack of leadership involvement especially during winter seasons often causes uneven ambient temperatures which leads to moisture accumulation. Such accumulations cause the grains to get spoiled and lose its nutritional value. Figure 2.5 depicts the maximum allowable moisture contents for different grain commodities to prevent the grain spoilage.

Grain type & storage time	Maximum moisture content for safe storage, %
Shelled corn and sorghum	
Sold as #2 grain by spring	15 1/2
Stored 6-12 mo	14
Stored more than 1 yr	13
Soybeans	
Sold by spring	14
Stored up to 1 yr	12
Stored more than 1 yr	11
Wheat, oats, barley	
Stored up to 6 mo	14
Stored more than 6 mo	13
Sunflower	
Stored up to 6 mo	10
Stored more than 6 mo	8
Flaxseed	
Stored up to 6 mo	9
Stored more than 6 mo	7
Edible beans	
Stored up to 6 mo	16
Stored more than 6 mo	14

Figure 2.5 Maximum moisture content for safe grain storage
Source: Purdue Extension (2019)

Studies conducted by Jayas & White (2003) & Manandhar, Milindi & Shah (2018) discusses practices impacting the grain storage activities in most grain operations. The key aspects such as physical factors (temperature, moisture and oxygen), insect activity and mold formation leave significant scars on the quality of the stored grains (Manandhar et al., 2018). The study by Jayas & White (2003) addresses such factors to cause higher risks of having poor quality of stored grains. Both Penn State extension and Purdue extension published articles which highlighted the lack of leadership involvement and employee training to mitigate the factors (Penn State Extension, 2017 & Purdue extension, 2019). It can therefore be concluded that the major causes behind grain

spillages are mainly related to human based errors in terms of checks and examination which ties back to the gaps in management system.

Jayas & White (2003) recommends examination of stored grains in every two weeks. This is done to check for the infestation or unusual temperature variations. Additionally, the authors (Jayas & White, 2003) recommend checks for insect activities and levels of gases to ensure safe storage. Based on the losses calculated, the Penn State extension emphasizes on the need of easy monitoring and management techniques for the workers at elevators to conduct proper examinations. Among the list of good storage practices presented by Jayas & White (2003) it is also crucial for the facilities to install proper aeration systems to reduce temperature differences. Aeration systems, as discussed by Jayas & White (2003), controls such temperature differences to ensure moisture condensations. These systems regulate the moisture contents and reduces the risk of the grains exceeding the moisture level beyond their upper limits (upper limits presented in Figure 2.4). Such practices are termed as good storage practices listed under GMP management practices.

White (2000) & Jayas & White (2003) identifies several good storage practices to regulate effective storage management. These include leadership attention and employee knowledge towards preparation of the bins, managing grains and maintaining high level sanitation to keep pests away. The authors believe that compliance with such organizational management practices ensure safe and low-cost grain storage thus sustaining the efficiency. It can be concluded that lack of compliances with these practices therefore increases the risks of pest infestation and spoilage due to high moisture content. Grain elevators, whether independent or co-operative, face major challenges surrounding their organizational practices which puts the security of food grains at great risk (Velasquez, 2007). These challenges are due to lack of compliance with the quality

management practices, such as Good Manufacturing Practices (GMP) regulations, laid down by the Food and Drug administration in USA (Velasquez, 2007, & Center for Drug Evaluation and Research, 2018). The next sections discuss about good management practices of grain elevators as seen through GMP lenses.

2.4 Good manufacturing practices (GMPs)

The purpose of this section is to describe the management practices of grain elevators as seen through GMP lenses. GMPs provides an overview as to how one can see effective management practices of grain elevators based on GMP perspective. Sauer (2005) describes Good manufacturing practices as set of rules applied to regulate food production practices to ensure qualitied products suitable for human consumption. Sauer (2005) also states many problems such as, definite employee training, poor maintenance, poor setup, improper sanitation and lack of proper monitoring leads to major food safety problems. Referring to Sauer (2005) and other literature, Velasquez (2007) also identifies sanitation, preventive maintenance and food safety measures to regulate safe grain storage in grain elevators. Velasquez (2007) discusses, the failure of grain elevator compliances with GMP regulations to ensure ideal storage facilities setup. These gaps are related to outdated storage facilities, lack of updated machineries and improper monitoring of the storage facilities. These issues could potentially lead to loss of grain quality.

Velasquez (2007) believes that the grain losses occur due to errors and negligence by the employees in keeping proper checks at storage facilities. As discussed by Penn state extension (2017), the lack of commitment and knowledge of regular checks among the workers form the major cause of the damage to the grains at storage facilities. However, Velasquez (2007) believes that employee training and incorporating such programs (GMPs) can help reduce losses. As per Sauer (2005) and Velasquez (2007) implementation of such practices is essential to keep the

operator's knowledge updated and increase their involvement in proper monitoring of the food safety procedures.

Stark (2016) describes American Institute for baking (AIB) as set of regulated guidelines for food producing industries to ensure qualitied outputs. AIB inspects storage facilities based on five basic categories, such as, operations, preventive maintenance, sanitation, pest management and food safety programs as a part of the audit system (Stark, 2016). Velasquez (2007) discusses about the "AIB Consolidated Standards for Inspection of Grain Handling Facilities" which lays the guidelines for grain elevator facilities towards organizational excellence. The author discusses about aspects such as grain safety, pest control, sanitation and proper maintenance for the successful operation of storage facilities. These aspects are listed in the AIB standards document which can be adopted by elevator managers to study the quality functioning of their grain elevators.

Thus, it can be said that compliances with GMP practices can help grain elevators eliminate grain losses. Adoption of such practices can ensure smooth organizational working of grain elevators as per the AIB standards. The assessment developed by Velasquez (2007) provides a perfect insight of the critical quality aspects of a grain elevator facility setup. The GMP assessment was developed in compliance with the standards mentioned in AIB document. Since this assessment relates closely with the grain elevators, it provides a good foundation to study organizational practices of grain elevators. However, the primary concern relies on reducing the risks of grain losses. Higher risks of food losses would mean higher chances of food shortages which is not in compliance with ensuring food security. This gap clarifies the need for an effective management like lean management (or lean practices) to eliminate these losses and lower the risks.

The section thus concludes with looking organizational practices of grain elevators through GMP lenses. The next section introduces the concept of lean which is also based on the idea of managing resources and effective organizational practices.

2.5 Lean

The purpose of this section is to establish a foundation to view organizational practices of the grain elevators through lean lenses. Lean principles refer to the elimination of losses in a given process using suitable tools and techniques (Dora, Lambrecht, Gellynck & Van Goubergen, 2015). As per the same article, adoption of lean practices helps to lower the risks of losses in any given production system (Dora et al., 2015). Skill of workforce, in-house expertise and organizational culture are three important critical success factors towards successful lean implementation (Dora, Kumar, Van Goubergen, Molnar & Gellynck, 2013). Application of lean practices has been depicted to improve operational performances in a variety of industrial sectors in achieving effectiveness.

Based on a case study by Näslund, D. (2008), the lean approach is based on mapping and analyzing the activities of a given process. This activity is referred to as value stream mapping (VSM). VSM tool of lean is extensively applied by enterprises to identify and eliminate non-value-added steps (wastes) in a given process. The literature review shows that elimination of non-value steps without reducing the output forms the basic idea of lean. In context of improvement purposes, Dora, Van Goubergen, Kumar, Molnar & Gellynck (2014) and Näslund (2008), provides an overview of adopting lean practices to strive for perfection through improvement practices and managing with limited resources. This means that the new lean ideology is not merely limited on eliminating losses, but to achieve organizational change through continuous improvements (Näslund, 2008).

In a review by Dora et al. (2013) and Dora et al. (2015), the ultimate goal of implementing lean principles in an organization is to achieve operational efficiency and higher productivity. However, the literature review shows that the application of lean tools depends upon few organizational factors of size, suppliers, customers and quality requirements (Dora et al., 2013). The authors Dora et al. (2013) and Dora et al. (2015) identify lack of compliance with such factors to pose barriers for many enterprises to achieve successful lean implementation. Such factors sometimes limit the enterprises to adopt best quality management practices in an organization. However, these barriers haven't stopped the lean practices to move from its traditional manufacturing sector into other fields (Dora et al., 2015). Dora et al. (2015) also argues the limited availability of literature to study the impact of lean adoption in agricultural field. Another review by Dora et al. (2014) identifies the lack of knowledge and availability of simpler techniques to be responsible for limited lean adoption in food sector.

Several studies have been conducted to study lean adoption in food sector. Simons & Zokaei (2005), analyzed the adoption of VSM techniques to optimize the meat production facility in the UK red meat industry. A value stream map of the process revealed lack of standardizations, poor knowledge of workers and inadequate setup resulted in several non-value-added steps. Lean tools such as takt time, 5S work setup and work standardization greatly improved the working time of operators in performing the tasks (Simons & Zokaei, 2005). A study by Scott, Wilcock & Kanetkar (2009), concluded from a quantitative survey of 45 SME companies which practiced lean adoption faced fewer recalls of products as compared with the others. Additionally, the SMEs with lean ideology scored higher safety index and lower cost inputs (Scott, Wilcock & Kanetkar, 2009). Another case study, by Kadjo, Ricker-Gilbert, Alexander & Tahirou (2013), identified the gaps with producer's knowledge to adopt lean practices to sustain storage behavior. The observation

showed that poor storage adoption such as use of plastic bags and traditional methods to store maize grains, resulted in loss of both quality and quantity (Kadjo, Ricker-Gilbert, Alexander & Tahirou, 2013). This implies that operations systems in several agricultural sectors provides a broad scope to study lean adoption in agricultural sector. This idea provides a motivation to conduct further studies in expanding the idea of lean practices to other sectors of agriculture and study its impact.

Based on previous literature, a gap in grain elevators operations was identified in context of achieving improvements by lowering grain damage. Pest management and moisture control were identified to be major factors to impact grain safety. A need for the adequate work force management and easy quality management procedures were discussed in an article by Penn State extension (2017) to ensure grain safety. The literature review by White (2000), Jayas & White (2003), Sauer (2005) and Velasquez (2007), identified the importance of proper sanitation, preventive maintenance, temperature monitoring, pest control management and knowledge of the work.

The chart in Figure 2.7 by Dora et al. (2015) lists the wastes identified within a lean system in context of an agricultural setup. The wastes such as inventory, employees and non-value-added steps particularly relate to the gaps identified in grain elevators. For instance, the waste in terms of employees comes when there is lack of involvement and gaps in process knowledge as seen in Figure 2.7. Penn state extension (2017) and USDA (2000) reports indicate lack of employee awareness, proper monitoring and gaps in knowledge of the process to cause primary grain damages (Penn State Extension, 2017 & USDA ARS, 2000). The waste 'non-value-added processing discusses about inefficiencies in drying and grain conditioning processes which relates back to the literature by Velasquez (2007), Penn State Extension (2017) and Purdue Extension

(2019) about gaps in organizational and process factors. From a lean context, all such gaps are identified as wastes which needs to be addressed to assure management excellence. Therefore this implies a scope to assess adoption of lean practices in grain elevator industry to improve its organizational and management practices for operational excellence.

Wastes	Features	Example
Defect	Bad quality, short shelf-life, long delivery time	Wrong application of fertilizers, wrong mix of feed, bad seed quality
Overproduction	Excess production, poor product flow, resulting in discarding (very difficult to manage this as its largely nature dependent)	Possible due to favorable weather, or over-application of nutrients
Waiting	Long inactivity results in poor materials or information flow, long lead times and increased spoilage	Very typical in agriculture to wait for the last step to complete by the farmer
Non-value added processing	Incorrect and unnecessary procedures or systems lead to waste	Inefficiencies in the drying, grain conditioning and combining process
Transportation	Excessive movements of products or information	transport fertilizer for long distances before actually applying it
Inventory	Creates excessive delay, poor customer service, excessive spoilage	Stock of seeds and fertilizer
Motion	Poor design of workplace leads to lost or damaged items	Traditional agricultural practices don't give any importance to ergonomics
Employees	Lack of employees involvement and unused knowledge of employees	Family based farming often discount manpower use

Figure 2.6 Wastes in lean agriculture
Source: Dora et al. (2015)

Based on the scope of studying lean adoption, the framework in Figure 2.8 lists down three important segments of lean manufacturing ideology particularly adopted in production systems (Dora et al., 2015, p. 635). From a purely lean perspective, a grain elevator's first segment of 'lean' goal would be to achieve quality grains. The middle segment of 'lean' principles in Figure 2.8 would be to pursue perfection in operational functions. Lastly, for the bottom segment in Figure 2.8 of 'lean' practices, an organizationally efficient grain elevator would address stakeholder involvement, total product management and proper setup of the facility based on the quality management standards such as AIB (Stark, 2016) if seen from GMPs lenses or quality management practices if seen from lean lenses. The literature in section 2.4 discusses about the quality

management practices as seen from the GMPs lenses to adopt management practices to improve grain elevators at operational level. Also, from the bottom segment in Figure 2.8 the lean identifies customer and supplier involvement, employee involvement and internal related processes (issues) as critical factors toward lean practices adoption. This again relates back to the literature discussed in section 2.3.2 regarding gaps in elevators management practices as discussed by Velasquez (2007), Penn State Extension (2017) and Purdue Extension (2019). The idea of adopting management practices to improve grain elevators organizational practices based on lean practices provides a scope to assess lean adoption by grain elevators.

The next section discusses literature for adopting lean practices in SME's and establishing the idea of comparing grains elevators as SME's.

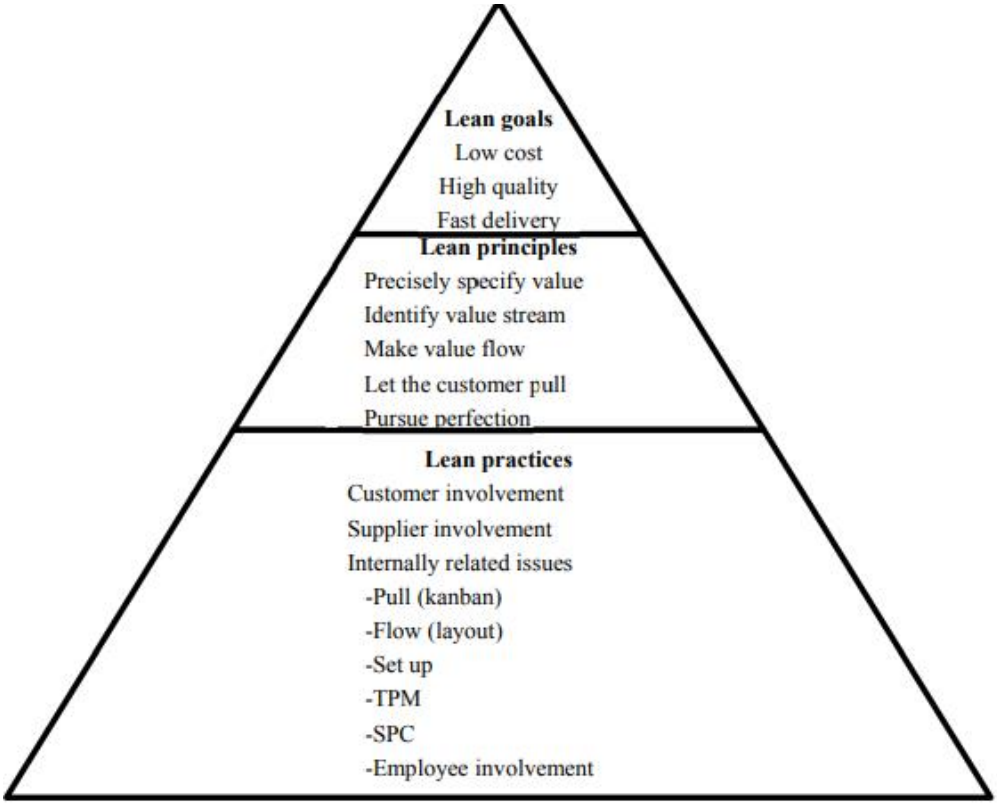

Figure 2.7 Lean goals, principles and practices
Source: Dora et al. (2015)

2.5.1 Grain Elevators as SME's and Lean adoption in SME's

The purpose of this sub-section is to discuss about importance of SME's and how lean adoption has helped SMEs improve the management practices. The objective is to link the adoption of lean in SMEs with lean adoption in grain elevators. The literature addresses the fact that grain elevators are SME's managed by small holder farmers.

Lean SME's

Aybar-Arias, Casino-Martinez & Lopez-Gracia, (2003) presented a structured view to describe the term SME or small to medium scale enterprises. An SME can be described as an organization operating on less than 200 employees (Aybar-Arias et al.,2003). The same article states different factors based on which an SME is defined. These factors relate to the size of an operating organization, availability of funds, number of employees and the extent of business operation (Aybar-Arias et al., 2003 & Aris, 2007). It can therefore be believed that an SME is an organization which operates on a smaller scale with limited workforce, area of operation and number of employees.

Aris (2007) stated that SME's forms important building block of a country's backbone economy due to its working structure and are important for a nation's growth. An article by Saad, Perera, Achanga, Shehab, Roy & Nelder (2006), revealed that SMEs in general face challenges due to its smaller size of operation, limited availability of resources and ineffective leadership. This means that SMEs which are limited on resources needs to have a management which can assist the business excellence by better managing the limited resources. The article by Saad et al., (2006) presents adoption of lean management practices as a possible solution to address the gaps of managing resources and improving efficiencies .The same article by Saad at al., (2006), confirms success factors critical to lean practices implementation in SME's. These success factors

include success in leadership, management, finances and employee management from lean lenses to ensure that an SME is prepared to undergo an organizational change to adopt lean management.

Several case studies were conducted by scholars to study the adoption of lean practices by SMEs and research its impact on the management of the organizations. A study conducted by Zhou (2016) involved assessing the lean practices adoption by various SMEs across USA. The objective of this study was to explore the knowledge of lean among SME's and how it relates to the successful working of the organizational management practices. The output of the exploratory study had revealed a good understanding of lean philosophy and concepts among SMEs. The SME's showed positive results of adopting lean as a management strategy to improve overall efficiencies of the organizations. Another study by Panizzolo, Garengo, Sharma, & Gore (2012), concluded with positive results of adopting lean practices in Indian SME's. The adoption of lean practices presented an increase in employment efficiency and improvement in the overall organizational management. In fact Panizzolo, Garengo, Sharma, & Gore (2012), asserted the improvement in terms of leadership and better top management improvement to be the key results In both studies the authors pointed out the fact that adoption of management practices from a lean perspective not only has a positive change in organizational culture and efficiency but also improves leadership, working environment and relations with the stakeholders. Based on the literature from section 2.5 lean practices are set of management practices which aims at managing an organization with limited resources. As it can be deduced from the literature that SMEs in fact operate on small scale level with limited resources and smaller employee numbers, it thus becomes crucial for SME's to adopt management practices that can assist the organization business by better managing the limited resources.

Thus, it can be concluded that Lean SME's thus provide a strong background of how lean adoption helps to improve management practices of SMEs. The next section discusses about grain elevators as SME's and leads to the idea of adopting lean management as set of practices to improve the organizational practices.

Grain Elevators as SME's

Velasquez (2007) had stated that independently owned elevators fall short of complying with quality management practices which limits its capability to ensure the security of the raw food grains. These challenges discussed leads towards the gaps identified in the lower efficiency of an elevator's management as discussed in the previous literature. Velasquez (2007) also had stated that independently owned elevators operate with a small number of employees and limited resources. In fact, independently owned elevators are operated by small holder farmers at individual management level (Velasquez, 2007) who are basically the leaders and the owners of the facility. It can therefore be believed that independently owned elevators are a form of SMEs operating on limited amount of resources and are of smaller sizes. Review by Hagstrum, Reed & Kenkel (1999) & Velasquez (2007) discusses about the independently owned elevators and gaps in their management processes owing to their size, limited resources and scale of operation. This leads to the understanding that with SME's like grain elevators the management are bound to operate on a smaller scale and manage the operation with limited resources. And hence forth the conclusion from previous section leads to the idea of need of adopting management practices by grain elevators to operate by managing limited amount of resources.

The understanding from the literature review leads to the conclusion that adoption of lean management in SMEs provides a scope to improve its efficiency. An independently owned grain elevator is comparable to an SME which further supports the idea of adopting lean practices as a

means to address gaps and improve elevator efficiency. The lower block from Figure 2.8 discusses about leadership, relations with stakeholders (suppliers and customers), employee management and internal processes to be critical factors for lean practices adoption in an organization. However, it becomes crucial for an organization like independently owned grain elevator (SME) to assess the preparedness levels in terms of how ready they are to go lean. The next section therefore discusses about the idea of readiness and how crucial its assessment is in order to get an idea about an organization's current standing towards lean adoption.

2.5.2 Lean readiness

The objective of this section is to carry forward the idea of assessing the readiness of an organization to adopt lean practices. The section discusses about the readiness from a lean perspective and lays down the critical factors crucial to assess it.

In words of Al-Balushi et al., (2014) readiness factors are set of characteristics which foster an organizational change. It further eliminates the barriers which hinders a successful change in an organization. Readiness for a change refers to a state of preparedness by the organization to adopt a large-scale systematic change (Catalanello & Redding, 1994). Alnajem, Garza-Reyes & ElMelegy (2019) presents six factors of lean quality practices: process, planning and control, customer relations, supplier relations and leadership, which assess an enterprise's readiness level to adopt lean practices. The previous literature review shows the possibility of adopting lean practices to ensure effective management of the grain elevators. Another readiness assessment by Limère & Dora (2016) discusses about measuring readiness index for lean practices adoption in agriculture. The readiness index is measured based on leadership, processes, employees, supplier and customer relations and willingness to change. Dora et al., (2013), talks about success of lean implementation through effective leadership, strong relations and better management of the

processes. Thus, it can be concluded that strong leadership, good relations with suppliers and customers, and employee management are essential to assess readiness for lean practices adoption. In fact, an article by Lesecure, Hudson-Smith & Radnor (2010) concludes that lean management and adoption gets easier to attain when a thorough assessment of readiness factors is conducted. This led to the conclusion that in order to assess the preparedness of an organization for lean adoption it is crucial to assess the readiness levels through analyses of main readiness factors impacting that organization.

The concern of reducing grain damages by improving management practices of storage facilities along with limited applicability of lean in agriculture sector, provides a motivation to consider lean adoption by elevator managers. However, before adoption of lean practices it is first crucial to assess the extent to which an organization (such as SMEs) comply with the crucial aspects of lean adoption. Dora et al., (2015) and Garza-Reyes, Betsis, Kumar, & Radwan Al-Shboul (2018) strongly believes the need to check the lean readiness level of the organizations before getting into the thought of adopting lean practices. The barriers discussed by (Dora et al., 2013) in terms of facility size, quality requirements and nature of operations hugely impacts the scope of lean adoption in grain elevators. Hence, it becomes necessary to assess the readiness level of grain elevators to understand their standings in context of lean practices.

Literature reviews presents past case studies conducted by researchers to assess lean readiness level of the enterprises. An article by Al-Najem., Dhakal, Labib & Bennett (2013) studied the readiness level for Kuwaiti SMEs in context of various quality aspects. The mix-method analyses revealed that quality aspects of leadership, educational skills and people management did not comply well with the lean systems. The authors identified the gaps in Kuwaiti SMEs such as language barriers, government attention, lack of education and less quality standards

to impact the readiness index of the enterprises. Another case study by Garza-Reyes et al. (2018) deduced the inadequate level of lean readiness level of European pharmaceutical manufacturing industries. The gaps identified for the inadequacy were due to company size, poor relationships with suppliers and less compliances with the International organization for Standardization (ISO) standards. On a contrary note, Garza-Reyes, Ates & Kumar (2015) revealed higher lean readiness level for the Turkish automotive industries. Unlike the previous two case studies, the authors of this research showed higher compliance of Turkish SMEs based on six constricts of lean quality aspects. Excellence in leadership, top management and customer relations justified this higher readiness level. However, the authors identified no effect of company size to sustain lean readiness level. This implies that lean readiness level of a given enterprise depends hugely upon its compliance with six basic quality aspects presented by Alnajem et al. (2019). Leadership, top management involvement, quality standards, educational skills and relations to the stakeholders are critical factors to assess an enterprise's readiness to adopt lean practices.

Due to its conceptual applicability to the farms the chosen framework and survey by Limère & Dora (2016) is best suited for this study. The assessment developed by Velasquez (2007) provides a base to study a grain elevator's adoption of good quality practices as laid by AIB consolidated guidelines. The literature review revealed the gaps in terms of need for pest management, leadership and operator's knowledge to ensure operational excellence of a typical grain elevator. Hence the assessment developed Limère & Dora (2016) based on the lean readiness survey (Appendix A1) would encompass the lean aspects of leadership, process, employees, supplier relations, customer relation and willingness to change. The survey instrument aligns closely with the readiness assessment of lean adoption by the agricultural businesses. The framework developed by Dora et al., (2015, p. 639) also assesses the readiness of farms for lean

adoption. However, the survey by Limère & Dora (2016) encompasses the crucial aspects of agriculture business and hence is best suited for this research. The Figure 2.8 shows another lean readiness framework developed by Dora et al., (2015, p. 639) which can be deployed in a given farm activity to measure readiness for lean implementation.

Criteria to measure Readiness of farms for lean implementation	Measurement Scale				
	0	1	2	3	4
Leadership					
L1- Visible involvement and commitment (walk the farm, and give feedback)					
L2- Understanding and support for continuous improvement (appropriate resources)					
L3- Effective communication of long-term quality goals and objectives					
L4- Recognized and appreciated team effort					
Measurement and Processes					
M1- Major farming processes identified and documented (using flowcharts)					
M2- Key internal and external performance measures identified and defined					
M3- Basic tools of CI understood and used by employees for problem solving					
M4- Decisions based on fact and data					
M5- Performance indicators monitored, displayed and communicated					
People Management					
P1- Employees' knowledge and competencies linked to training					
P2- Employees respect accountability and discourage blame culture					
P3- Employees feel free to report information on errors and defects					
Systems & Control					
S1- Closed loop error prevention through the control of basic production					
S2- Effective communication system and timely information flow					
S3- Standardized procedures in a documented quality management system					
S4- Cross-functional team established as a way of working					
Customer Focus					
C1- Farm regularly seeks customer feedback to understand the key issues					
C2- Customer focus and satisfaction given priority					
C3- Understanding of value-added and non-value added activities					

Figure 2.8 Criteria for Readiness of farms for lean adoption
Source: Dora et al., (2015, p. 639)

The readiness assessment by Limère & Dora (2016), studies the readiness levels of a given agricultural business for operational excellence. The survey included in Appendix section provides a high-level picture of readiness levels which can assist an organization achieve operational change success. The next subsections discuss about each of the readiness factor presented in Limère & Dora (2016) model in terms of lean adoption at grain elevators.

Lean Leadership

Leadership plays a critical part in ensuring successful lean practices implementation (Al-Najem, Dhakal & Bennett, 2012). The authors, Al-Najem, Dhakal & Bennett (2012) concludes that good leaders often have vision and play a role model to drive employee motivation. Furthermore, for an organization (like SME) it is crucial to have a healthy organizational culture which can be achieved when there is a strong hold of leaders and senior management level over the business operations. In fact, an article by Dombrowski & Mielke (2013) discusses importance of lean leadership to drive improvement culture. Adding to the conclusion the authors Dombrowski & Mielke (2013) deduced that lean leadership is in fact the link between gaps and improvements in organization. The concept of having a strong vision, employee encouragement and investment in trainings and resources comes from a strong leadership. For an elevator to adopt practices to improve efficiency, the involvement of leadership is therefore crucial. Based on the literature review, the willingness to change, clear vision, defined objectives and effective employee engagement are dependent upon leadership (Limère & Dora, 2016). The instrument comprises of five questions based on leadership which attempts to understand the vision of an elevator superintendent. The vision includes willingness to accept change, ensure communication among employees and encourage new ideas. The Table 4.1 includes the list of the questions included under the leadership aspect. Resource allocation and managing the changes is essential to undergo changes in the organization. To understand lean and its tools, the leadership needs to have a vision, should be willing to accept ideas, ensure employee engagement and be open to new ideas.

Lean Processes

Process improvements are necessary to optimize the operations and improve efficiency in a lean culture (Dora et al., 2015). Based on the same article the processes could be related to and

external issues as seen in lower block of triangular representation in Figure 2.7. The processes include monitoring the lead time, 5S setup, cycle time & effective monitoring that impact the functioning of the organization's operation (Figure 2.7 & Figure 2.8). As an example, for the transportation of grains just when they arrive at an elevator, it is necessary to have the containers ready to transport the grains safely to the silos. To do this it is important to ensure that machinery/equipment are kept at right places. Having tools and equipment at wrong places can lead to loss in time and risk to quality of grains due to long exposure. Literature reveals that regular monitoring of the processes involving grain handling and transportation is important for maintaining the lead time. Task planning and allocation could be better understood when they are displayed visually on the boards (Limère & Dora, 2016). Based on same article by Limère & Dora (2016), employees should know critical functions of process and should always check on the proceedings. Limère & Dora (2016) describes this as the central medium information which ensures the visual display of process information. Such practices are important to ensure elimination of non-value-added steps. Based on the same article the authors Limère & Dora (2016) conclude that to ensure higher employee productivity and value-added steps, process management is important. This is required to assure that there is minimum number of non-value-added steps and employees are not spending much time on time consuming tasks. The Table 4.3 includes the list of questions included under the process aspect of the lean readiness survey.

Lean Employees

Dora et al., (2015) concludes that employee engagement and involvement are critical part of lean management. This means that the employees should be encouraged to be inclined towards understanding the importance of lean management. Willingness to change, reporting the error and defects and availability of resources and training is important to drive employee motivation

towards adopting organizational changes (Limère & Dora, 2016). The survey by Limère & Dora (2016) states that employees must have well defined job descriptions. Task allocation and identification of roles based on the employee capability is required to maintain efficiency. This will ensure that employees are not spending time on non-value-added tasks and all the required tasks are being performed appropriately and by right employee. The lower block of the triangular representation of lean adoption in Figure 2.7 states employee involvement to be a critical factor lean adoption. The questions for the employees' factor are included in Table 4.5.

Lean Customer Relations

Limère & Dora, (2016) states that customers play an important role in the product that an organization is suppling. The success of an organization is hugely dependent on the quality of products customers receive (Dora et al., 2015). The customers for the grain elevators expect the grains to retain the high nutritional quality and with minimum spoilage. The relationship with the customers' needs to be strong to understand customer needs and expectations. Lean philosophy states that a customer should be able to pull out maximum value and high-quality products from the supply chain of the organization (Dora et al., 2015). The models presented by Dora et al., (2015) in Figure 2.7 and Figure 2.8 also depicts that customer relations and customer focus are essential factors to ensure successful lean practice adoption. Based on the literature it is concluded that organization needs to maintain good relation from the customers by allowing them to pull out high value from the production supply chain. Moreover Limère & Dora (2016) suggests that customer identification and demands varies from market to market and therefore it becomes essential to correctly identify these factors. The questions for the customer relations factor are included in Table 4.7.

Lean Supplier relations

Relationship with the suppliers is crucial to sustain the benefits of having high quality materials for effective production. Wang & Taj (2005), states that this is indeed important for lean implementation. In fact, close relationship with local suppliers raises the chances of having materials at right time and with high quality (Limère & Dora, 2016). Based on same paper, regular feedback to the suppliers, quality checks, long term relationships and involving suppliers in product development is crucial to achieve correct lean implementation. Establishment of correct lean implementation would then provide the right level of readiness to the elevators towards adopting big organizational changes. The model presented by Dora et al., (2015) in Figure 2.7 (lower block of the triangular representation) also states the importance of maintaining healthy supplier relations for ensuring successful deployment of lean practices. The questions for the supplier relations factor are included in Table 4.9.

Lean Willingness to change

The overall success of lean implementation and adoption of its tools to improve efficiency depends upon the willingness of the organization to undergo the change (Limère & Dora, 2016). The change in an organization is crucial to attain sustainability in the production processes (Dombrowski & Mielke, 2013). This means that an organization should be prepared to undergo changes in culture if it is required to improve profitability. Al-Najem, Dhakal & Bennett (2012) states that an organization's willingness to change is necessary to transform culture from passive to open and pro-active status. The authors strongly believe that this change of culture brings in huge scope of continuous improvement. The survey model by Limère & Dora (2016) includes questions which checks what the elevator superintendents think about the new approach to manage the elevators. The question under this factor (Table 4.11) addresses as to what's the leadership

vision and goals are with regards to the organizational changes and to adopt practices for improving the efficiency of the elevator operations. Thus, from the literature it makes sense that an organizational change is successfully if it well aligned with the leadership vision and commitment by the employees. In fact, Al-Najem, Dhakal & Bennett (2012) also supports this idea of addressing the organizational change through understanding lean culture with both leadership and employee involvement.

2.6 Summary

The literature review section provides a background of the lean readiness framework and gaps in grain elevator management practices. It delivers an understanding of improving quality aspects of grain elevators to minimize grain damage and ensure food security. The outcomes of the lean readiness survey completed by elevator superintendents would reveal the current standing of the grain elevators in context of adopting lean practices. This would help elevator superintendents evaluate the quality practices of their respective elevators and identify areas of improvement. Finally, the study would determine the readiness level aspects and which aspects does the grain elevators are highly ready on and vice versa.

CHAPTER 3. METHODOLOGY

3.1 Introduction

This chapter provides an overview of the methodology and framework which was used to assess Lean readiness level of the grain elevators. A lean readiness review assessment was distributed to the grain elevator managers/superintendents in the form of surveys. The superintendents or the managers of the elevators were the leaders who understood the business operations of the elevators to the best. Their expertise with regards to elevator operations as well as their familiarity with processes and working experience with the stakeholders and employees provided sufficient knowledge to complete the survey. It was concluded that survey responses by the elevator managers or superintendents provided most relevant responses within the scope of this research. In fact, it was best to assess the responses from the mangers and superintendents who had the most knowledge about the elevators. The data was collected from the surveys and analyzed to generate scores of readiness factors and evaluate readiness levels. The process map in Figure 3.1 is an overview of how the methodology process was conducted.

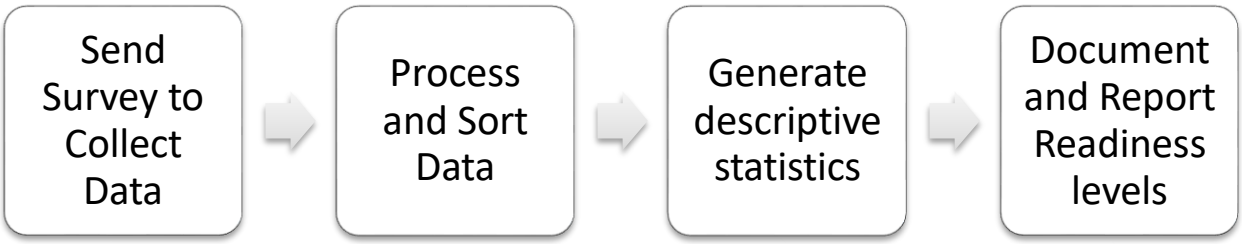

Figure 3.1 Process map for methodology Overview

3.2 Research type

Survey research was determined to be the right tool to collect data and report the results which aligned with the scope of this research. (Center for Innovation in Research and Teaching, 2019). The survey method was chosen due to researcher's time constraints and also surveys are easier to monitor, distribute and can be completed by the participants based on their convenience (Sekaran & Bougie, 2016). The past case studies by authors Limère & Dora, (2015), Al-Najem, Dhakal, Labib & Bennett (2013), Garza-Reyes, Ates & Kumar (2015) & Garza-Reyes et al., (2018) also concluded their studies by reporting lean readiness level results through survey analyses. Hence based on past researches and following a similar pattern, survey method was concluded to be right method. This study followed a quantitative method of analyzing the data. The data was captured through an assessment which was sent to the grain elevator managers in the form of surveys through Qualtrics. Sekaran & Bougie (2016) had stated that the structured surveys are good tools for collecting quantitative data. This research was based on capturing a participant's response score on a Likert scale ranging from 1 to 5 and analyzing through descriptive statistics. Henceforth a structured survey developed by Limère & Dora, (2015) was appropriate as per the research scope. The survey included the questions based on six factors of lean readiness framework presented by Limère & Dora (2016). These factors captured an elevator's operational characteristics based on these lean readiness factors. The lean readiness score was based on the scores of each of lean readiness factors. These Lean Readiness factors were Leadership, processes, Customer relations, Supplier relations and willingness to change. Based on this, the researcher interpreted the results and provided a rigorous discussion about the lean readiness of elevators.

3.3 Research question

- RQ1: What is the current Readiness level of the grain elevators as assessed through Lean Readiness factors towards adopting the Lean practices fostering efficiency in elevator operations?
- RQ2: Which Lean Readiness factor indicated the highest readiness level to adopt lean practices or lean implementation by grain elevators of Indiana and Illinois?
- RQ3: Which Lean Readiness factor indicated the lowest readiness level to adopt lean practices or lean implementation by grain elevators of Indiana and Illinois?

3.4 Variables

The average lean readiness score was determined by calculating the average of the mean scores of all six readiness factors. This average lean readiness score was the dependent variable of the study. The lean readiness factors included in the survey were leadership, process, employees, customer relations, supplier relations and willingness to change. These factors were the independent variables.

3.5 Population and Sample

The recruitment strategy for sample from the population was done through an organization known as GEAPS (The Grain Elevator and Processing Society). GEAPS is an active organization which includes managers/superintendents of grain elevators across USA. The members are classified based on the state where their grain elevator is located at. Each state is referred as a chapter which includes members from a particular state. The members of GEAPS served as the

overall population of the subjects which this research focused on. GEAPS proved to be an important link for this study since it provided a direct platform to reach out to the grain elevator superintendents/managers. GEAPS over the years have provided consistent support to the superintendents and managers of grain elevators with continuous provision of innovative ideas and technologies to improve elevator business operations. The members of the GEAPS chapters are the personnel who represent their respective grain elevator organization. Their work experience, knowledge about the processes and interaction with the stakeholders is strong. The knowledge of the superintendents and their survey responses reflected the standing of their elevator business. Hence it was concluded that the members of the GEAPS chapter meetings provided the best subject matter expertise with regards to the elevator operations and thus suitable to be included in the study. The responses of the elevator superintendents reflected the organizations preparedness for lean practices adoption.

The survey for lean readiness was distributed to the grain elevator managers/superintendents through GEAPS chapter meetings. The researcher also provided the access of the survey link to the GEAPS chapter meetings of Indiana and Illinois. The vice president of GEAPS chapter had forwarded the survey link to all the members of Indiana and Illinois chapter. Only completed surveys were included in the analyses. This was considered to be a specific sampling analyses with voluntary completion method. The readiness review was evaluated based on the responses captured from the survey responses. There was no maximum number of participants required. However, the researcher attempted to collect as much data as possible. A total of 29 sample responses were recorded at the end of the research time period which was then used for the analysis's purposes. There were approximately total of 1500 members included in the chapter meetings. Hence it was deduced that survey had a nearly 2% response rate.

3.6 Instrumentation

The study was conducted in the form of a lean readiness survey distributed to the grain elevator managers and superintendents through GEAPS chapter meeting. The assessment comprised of thirty questions. The instrument was prepared using the lean readiness framework by Limère & Dora (2016). The instrument addressed six main factors of an LR framework which were leadership, processes, employees, customer relations, supplier relations and willingness to change. The questions of the survey were modified in order to align it with the grain elevator operations without changing the intent of the questions. In simpler terms, only a few words of survey were changed to align with the grain elevator operations without changing the intent of the questions. The final survey was also face validated by the members of the committee who are experts in the field of the research. The seven wastes identified from the lean framework by Elnamrouty & Abushaaban (2013), included wastes from overproduction, defects, inventory, transportation, waiting, motion and over-processing. The survey questions attempted to get an idea from an elevator superintendent's vision to reduce these wastes from an elevator's operations process. Limère & Dora (2016) had concluded that for an effective lean implementation there should be vision and motivation to undergo organizational changes. From the literature review it was concluded that leadership and employee management played a critical role in shaping the efficiency of the elevator operation. Furthermore, the relationship with the stakeholders (customer and suppliers), willingness to change and internal processes were concluded to be crucial factors for the lean practices' adoption.

3.7 Assessment tool

The survey was distributed to the grain elevator managers and superintendents included in the GEAPS chapter who either operated an independent or co-operatively owned

grain elevators. The instrument passed the validation test since it was already used in previous researches. The assessment was based on a validated instrument used by Limère & Dora (2016) which credited its validity. The authors Limère & Dora (2016) had reviewed 45 papers on lean readiness and confirmed six factors to be crucial for the study. The factors such as leadership, processes, relations with stakeholders (supplier or customers) and willingness to change were also confirmed in the lean readiness studies conducted by Al-Najem, Dhakal, Labib & Bennett (2013), by Garza-Reyes et al. (2018) & Garza-Reyes et al., (2018). The survey was already deployed in previous researches for assessing the Lean readiness in agricultural sectors. The survey was also validated using face validity technique. The experts of the research area looked over the survey and validated the questions. The six factors critical to assess the lean readiness were emerged out of the exploratory studies and then confirmed by the previous authors Limère & Dora (2016). The reliability of the survey was also tested before by the authors which ensured the consistency of the results. However, the researcher took the initiative to run the reliability test in Minitab for the purpose of this study. Cronbach's alpha is most commonly used measures of the reliability test which ensure the internal consistency of the survey questions (Bonett, & Wright, 2015). The Cronbach's alpha for the results of this study was seen to be 0.8601 which is fairly more than 0.7. This concluded that the survey responses were consistent with respect to the questions. A Cronbach's alpha of more than 0.7 indicated the results to be reliable and thus establishing the internal validity (Nunnally, 1978). The outcomes of the Cronbach's alpha confirmed that the survey questions, just like previous studies had the consistency in the responses and confirmed the reliability of the instrument. The outcomes of this study provided the elevator managers/superintendents an opportunity to evaluate the quality aspects of elevator facility in context of being lean ready. This

assessment also formed a starting point for those elevators who in future wished to adopt lean practices for improving efficiency of their elevator operations.

3.8 Data Collection

The survey was completed electronically and through paper distributed at the GEAPS chapter meetings. The electronic version was developed on Qualtrics. The vice president of the GEAPS chapter for Indiana and Illinois had forwarded the survey link to members of Indiana and Illinois chapter. The members completed the survey online and the results were reported on the Qualtrics website. The paper surveys were distributed during the chapter meetings and collected back from the respondents towards the end of the meetings. There was absolutely not more than minimum day to day risk involved in the research and no identifiable question was asked to the participants. The identity of the participants was kept confidential and anonymity was maintained as per the Purdue's Institutional Review Board (IRB) standards. There were also no follow up procedures after completing the surveys by the participants. The participation in the survey was strictly voluntary and any participant was allowed to quit at any time. The participants were guided to not to include any identifiable information on any piece of paper, if the survey is being taken on paper.

The online surveys were completed by 22 participants whereas there were 7 paper surveys. There were approximately total of 1500 members included in the chapter meetings who received the link for the survey. Hence it was deduced that survey had a nearly 2% response rate. An article by Nulty (2008) had revealed that typically response rates should be higher (above 33%) to report results. However, the author also suggested that a lower percent score is acceptable as long as the data comes directly from the population of interest and there is no biasness involved. Based on the assumptions presented in section 1.6 and knowing that the survey was completed by the

superintendents of the grain elevator facility it was concluded that 2% rate was acceptable response rate for the study. Also, in order to increase the response, rate a gentle reminder was sent to the chapter members, about two weeks after the final visit to the first GEAPS chapter meeting. The researcher also attended two GEAPS chapter meetings to ensure a higher response rate.

3.9 Data Analyses

The purpose of the research was to report the survey results and present descriptive interpretations of the results. The researcher did not do any factor analyses or significance tests but only reported the results. The reporting of results was simply based on the method used by previous researches, such as by Limère & Dora (2016), where the results of lean readiness for SME farms were reported. The factors critical to assess lean readiness was adopted from previous studies by Limère & Dora (2016) where the reliability and validity was already proven. The data was recorded on a Likert scale which ranged from 1 to 5 on a positive integer scale. The integral value of '1' corresponded to a 'Strongly disagree' and '5' corresponded to 'Strongly agree' (Boone & Boone 2012). Being an interval scale test, the researcher exported the data into a desired statistical software like JMP and Microsoft excel. The statistical software (Microsoft Excel and JMP) generated descriptive statistics of the six factors of the lean readiness instrument. The descriptive statistics revealed the summary of the readiness level for surveyed elevators. The outcomes determined the extent of readiness and shortfalls of the elevators with respect to the Lean readiness factors. The results from the analyses provided the readiness levels of leadership readiness, customer and supplier relationship readiness, efficient process readiness, employee readiness and readiness of willingness to change. These readiness numbers were discussed descriptively to address the visible factors of Lean readiness for elevators on numerical scales. Based on the survey responses, the score of the LR factors determined the lean readiness score

for the grain elevators. The responses collected were enumerated to depict readiness level for each elevator. Data was also analyzed based on 'quantitative comparison', which indicated a through analyses of the key indicator's characteristics of the readiness factors for the elevators. As Reale (2014) had concluded that quantitative comparisons effectively use statistical stools to analyze and display the result outcomes in the form to identify rank order, graduating similarities and differentiations among the various categories of lean readiness factors with respect to distance between them. In simpler words the comparisons based on the variation of the scores (standard deviation) depicted the variation in the responses of the superintendents with respect to a particular question or factor or overall lean readiness. There were approximately total of 1500 members included in the chapter meetings to whom the survey was sent out. In total 29 surveys were completed. Hence it was deduced that survey had a nearly 2% response rate.

For the visualization purposes the researcher generated column charts and tables summarizing the descriptive statistics. The column charts were also populated with 95% confidence interval error bars. The error bars provided a range which contained the true mean of the aspect with 95% confidence. This meant that if the researcher in future captured more data then there would be a 95% confidence that the true mean would lie in that range. A box plot to compare the five-number summary of average of all six factors with grand lean readiness index was also included (Figure 4.7). The box plot was useful for the comparative analyses.

Thus, the overall interpretation of the descriptive statistics was to help the elevator managers/superintendents understand readiness levels of their elevator operations as seen through lean lenses. Since the total number of surveys completed was 29 and the response rate was 2%, the interpretations of this research were mostly restricted to being suggestive rather than conclusive. The outcomes and the results helped the managers/superintendents assess the current situation and

brainstorm the organizational changes to reduce cost and remain competitive. The outcomes also assisted the managers/superintendents in making statistical comparisons. The enumerated statistical figures and its conversion to percentages provided a scope to understand the readiness levels of LR factors thus better preparing the organizations to advance for competitive advantage.

3.10 Sequence of activities

The research was started in January of year 2019 with defining the problem and gaps in the current operations. The researcher spent time between January to August in developing the base for the research and finalize the survey instrument. The base of the research included developing chapters 1 to 3 of defining the problem statement, conducting exhaustive literature review and developing a crisp methodology for the research. The survey instrument was chosen towards the in April and sent out to the committee for review purposes. The IRB process was completed towards the end of April 2019. The researcher registered as a member of GEAPS in October 2019 and enrolled to attend chapter meetings on 19th November 2019 and on 11th December 2019. The paper surveys were distributed in both meetings towards the starting and collected back from the participants towards the end. The vice president of the chapter forwarded the survey link to all members included in the Indiana and Illinois chapters. A first and final reminder was sent two weeks after the first meeting of GEAPS. The research was strictly conducted based on the regulations laid by Purdue IRB office. The researcher conducted the study for the period of 6 months starting from August 2019 to January 2020. The researcher ensured not to obtain any identifiable information of the participants and keep the obtained surveys confidential. The researchers initiated the analyses after two weeks of the final reminder sent to the members. The researcher also consulted the Purdue statistics consulting club to obtain information on analyzing the survey results descriptively. The consulting was completed in a series of four meetings between

December 2019 to January 2020. For the analyses purposes the data was refined and displayed in a presentable form and presented to the committee. Lastly the refined data was analyzed based on appropriate statistical tools and techniques mainly restricting to descriptive analyses with a series of regular feedback from the committee members.

3.11 Conclusion

The descriptive statistics interpreted the readiness levels of the grain elevators to adopt lean practices to ensure efficiency of the elevator management practices. Analyses of the descriptive statistics was done to discuss the current standings of the elevators with respect to the lean readiness factors. The statistics depicted the shortfalls and gaps with respect to an average elevator's operational practices and LR factors. This study proved to be significant for those elevator superintendents who wishes to assess the gaps in current operational practices of their elevators. The assessment of the gaps can potentially reduce the grain losses at elevators. And reduction of these losses will be crucial to ensure lower post-harvest losses, cost, time and ensure safe food storage as concluded from the literature review.

CHAPTER 4. RESULTS AND DISCUSSIONS

4.1 Results

The purpose of the chapter is to describe the results of the lean readiness survey and provide a descriptive analysis of the data. The tables included in each section provides the overview of the descriptive statistics. Based on the results the interpretations are made to provide a better understanding of the captured responses. There were total of 29 responses captured. Based on the response rate of 2% the interpretations present more of a suggestive revelation rather than conclusive.

4.1.1 Leadership Results

The term LD stands as an abbreviation for Leadership. And LD1 refers to the first question and so on till LD5.

Table 4.1 Questions for the Leadership factor of Lean Readiness Survey

Question Acronym	Leadership Questions
LD1	As a leader/manager I clearly communicate my vision and objectives towards my employees
LD2	I am open to new ideas and provide resources when required
LD3	I provide support, direction and encouragement to my employees.
LD4	I fully understand that successful implementation of tools/techniques, which increases elevator operations efficiency, comes with investments and requires a long-term commitment
LD5	I do understand what the benefits of lean management consist of. (e.g. no compromise of grain quality, efficient transportation of grains, monitoring of right moisture and temperature content and ensure that grain storage standards are met)

Table 4.2 Leadership Scores for the superintendents (Leadership: LD)

Questions	MEAN	STDEV
LD1	*4.07*	*0.59*
LD2	*4.41*	*0.50*
LD3	*4.17*	*0.71*
LD4	*4.31*	*0.71*
LD5	*4.17*	*0.71*
Average	*4.23*	*0.42*

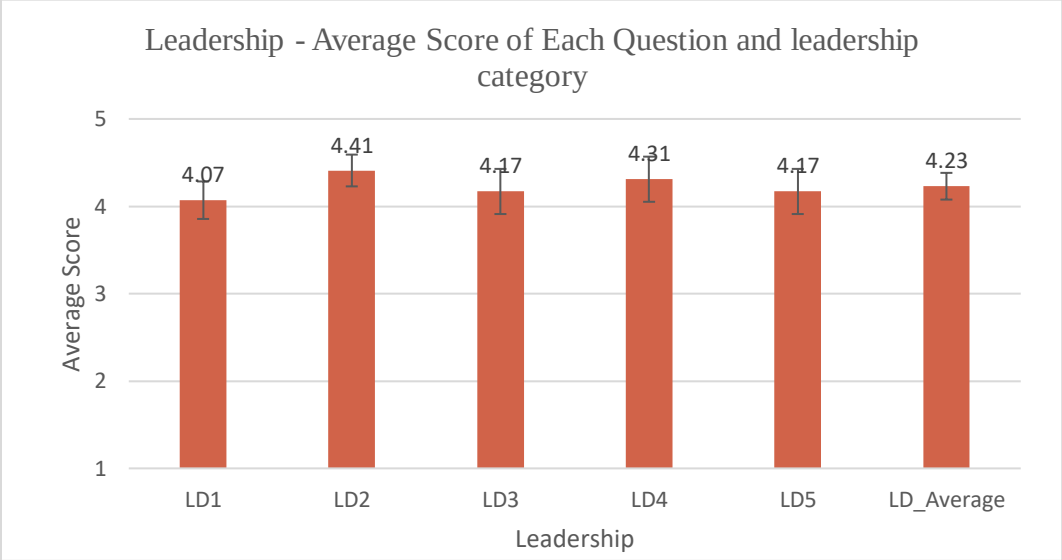

Figure 4.1 Leadership- Average score of each question vs Overall leadership Average

4.1.2 Process Results

The term PR stands as an abbreviation for Process. And PR1 refers to the first question and so on till PR5.

Table 4.3 Questions for the Process factor of Lean Readiness Survey

Question Acronym	Process Questions
PR1	We use visual boards or representations to track the moisture, temperature and logistics of the grain storage at the elevators?
PR2	Tools and equipment are always stored in the right location
PR3	We use a schedule for maintenance of equipment so that machines are maintained on a regular basis by skilled people
PR4	Occasionally time is lost due to forgetting equipment as it is kept at wrong location.
PR5	Everybody in the organization helps to identify wastes and solve problems by generating new ideas and solutions. (See description of wastes below)

Table 4.4 Process scores for the Superintendents (Process: PR)

Questions	MEAN	STDEV
PR1	*3.59*	*0.82*
PR2	*3.28*	*0.88*
PR3	*3.97*	*0.87*
PR4	*3.43*	*0.88*
PR5	*3.59*	*1.15*
Average	*3.57*	*0.59*

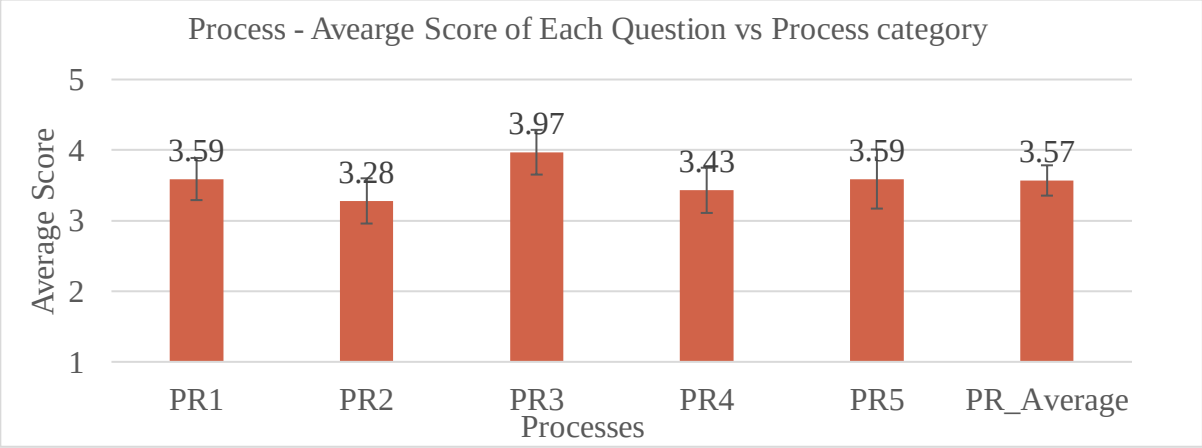

Figure 4.2 Process – Average score of each question vs Overall process Average

4.1.3 Employees Results

The term EM stands as an abbreviation for Leadership. And EM1 refers to the first question and so on till EM5.

Table 4.5 Questions for the Employees factor of Lean Readiness Survey

Question Acronym	**Employees Questions**
EM1	My employees feel free to report information on errors and defects
EM2	We promote the involvement of all our employees in providing suggestions to improve system and the process at the elevator
EM3	Each employee has a clear understanding of his/her roles and responsibilities while at the elevator facility
EM4	Suggestions and ideas from employees are actively used by the superintendents/elevator managers and management
EM5	We support training and employee development

Table 4.6 Employees scores for the superintendents (Employees: EM)

Questions	**MEAN**	**STDEV**
EM1	*4.03*	*0.82*
EM2	*4.24*	*0.64*
EM3	*3.69*	*0.76*
EM4	*3.83*	*0.71*
EM5	*4.31*	*0.66*
Average	***4.02***	***0.44***

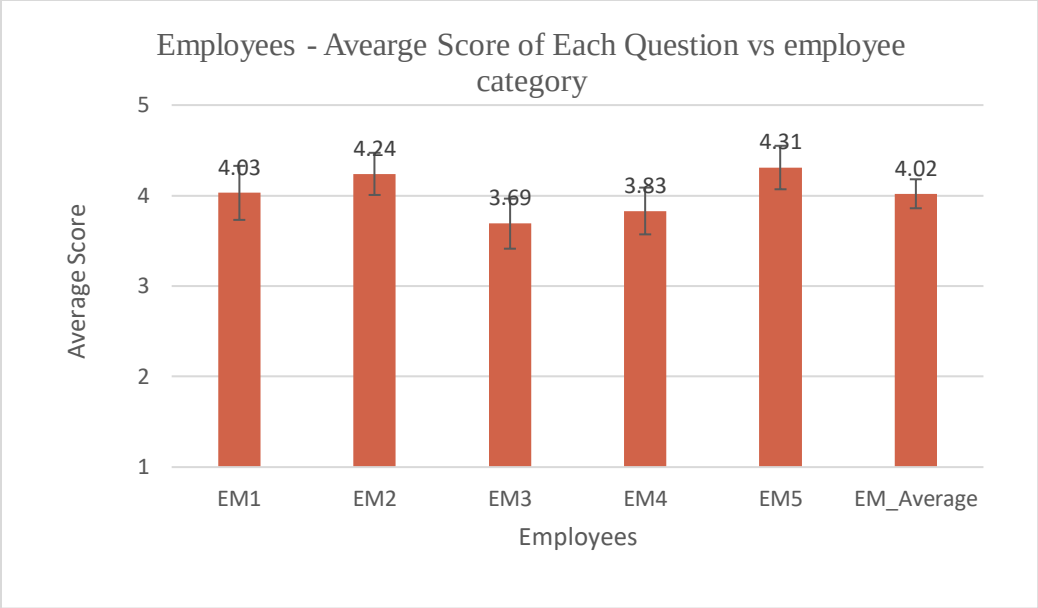

Figure 4.3 Employees - Average score of each question vs Overall employees Average

4.1.4 Customer Relations Results

The term CR stands as an abbreviation for Leadership. And CR1 refers to the first question and so on till CR5.

Table 4.7 Questions for the Customer Relations factor of Lean Readiness Survey

Question Acronym	**Customer Relation Questions**
CR1	We question our customers about their satisfaction levels on a regular basis
CR2	We frequently seek customer feedback on delivery performance and the quality of the products
CR3	We understand our customers' requirements
CR4	We understand that our grain elevators have multiple customers (Consumers, Retailers, Government, etc.)
CR5	We collect customer complaints so that problems can be avoided in the future

Table 4.8 Customer Relation scores (Customer Relations: CR)

Questions	MEAN	STDEV
CR1	*3.69*	*0.89*
CR2	*3.62*	*0.78*
CR3	*3.76*	*0.83*
CR4	*4.34*	*0.55*
CR5	*3.72*	*0.96*
Average	*3.83*	*0.57*

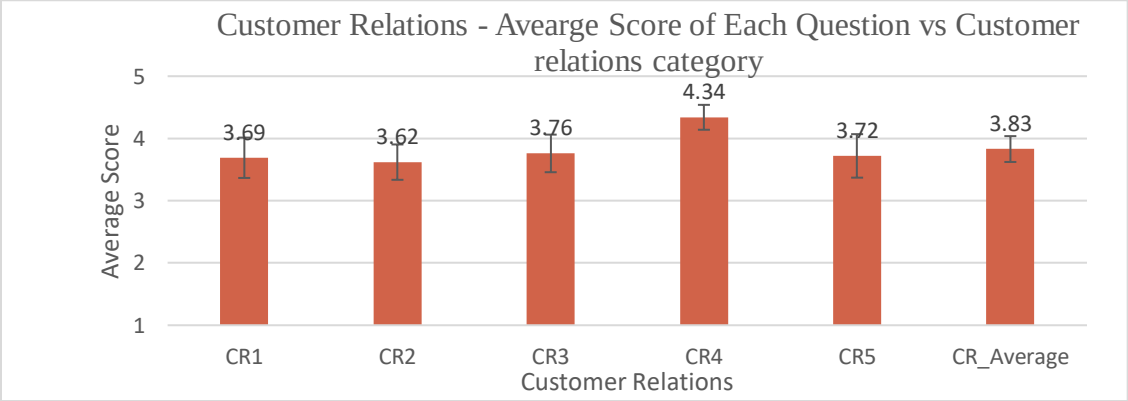

Figure 4.4 Customer Relations- Average score of each question vs Overall CR Average

4.1.5 Supplier relations Results

The term SR stands as an abbreviation for Leadership. And SR1 refers to the first question and so on till SR5.

Table 4.9 Questions for the Supplier Relations factor of Lean Readiness Survey

Question Acronym	Supplier Relation Questions
SR1	We have a good and close relationship with our suppliers who provide us Equipment and services for running of our grain elevator facility
SR2	We utilize a clear strategy by which we evaluate supplier performance in terms of quality, delivery and prices
SR3	Local suppliers are used. This to avoid shipment delays.
SR4	We keep the number of suppliers deliberately as low as possible
SR5	We give suppliers regular feedback on quality and delivery performance

Table 4.10 Supplier Relations Scores (Supplier Relations: SR)

Questions	MEAN	STDEV
SR1	*3.90*	*0.67*
SR2	*3.72*	*0.84*
SR3	*3.90*	*0.82*
SR4	*3.72*	*1.03*
SR5	*3.64*	*0.91*
Average	*3.78*	*0.60*

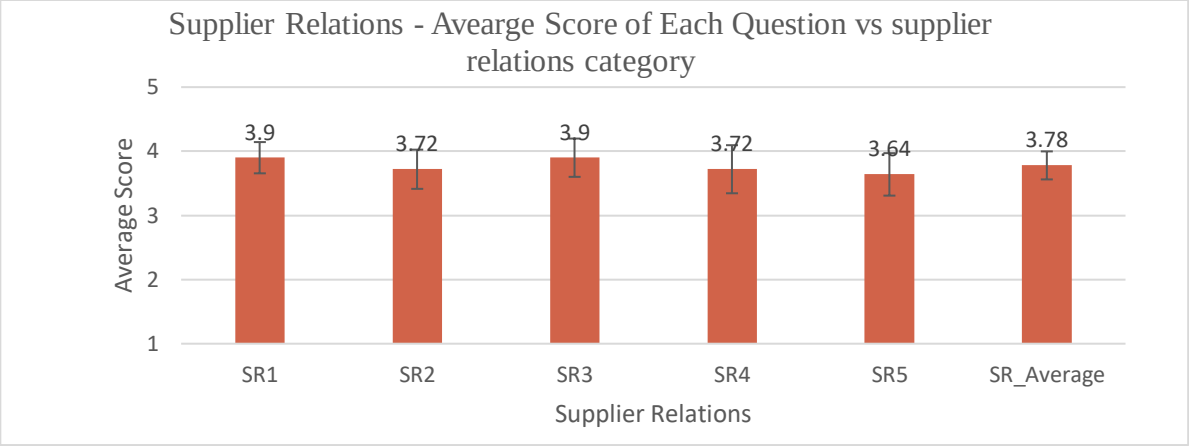

Figure 4.5 Supplier Relations- Average score of each question vs Overall SR Average

4.1.6 Willingness to change Results

The term WC stands as an abbreviation for Leadership. And WC1 refers to the first question and so on till WC5.

Table 4.11 Questions for the Willingness to Change factor of Lean Readiness Survey

Question Acronym	**Willingness to Change Questions**
WC1	I am interested in implementing changes at my elevator's working environment to improve efficiency and reduce non-value steps Efficiency: Reduce costs of running the grain elevator operations
WC2	I want to be further informed concerning lean management
WC3	I will focus on reducing the grain losses and deterioration to improve profitability.
WC4	I will start using visual boards and representations on the elevator site to communicate clearly with the employees
WC5	I will organize regular meetings to discuss the processes and solve problems

Table 4.12 Willingness to Change scores for the Superintendents (Willingness to change: WC)

Questions	MEAN	STDEV
WC1	*4.17*	*0.60*
WC2	*3.72*	*0.70*
WC3	*4.17*	*0.66*
WC4	*3.86*	*0.69*
WC5	*3.90*	*0.82*
Average	*3.97*	*0.50*

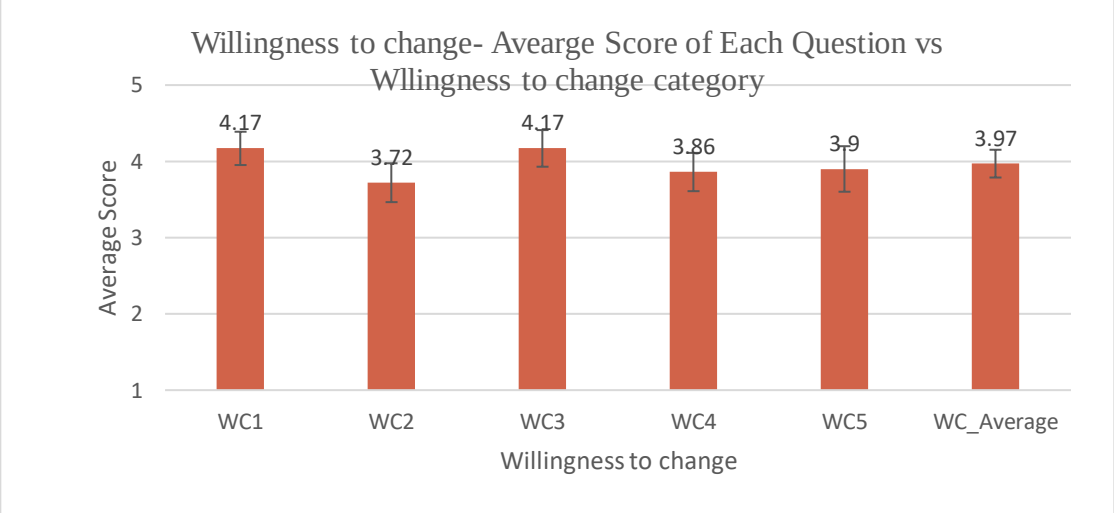

Figure 4.6 Willingness to Change- Average score of each question vs Overall WC Average

4.1.7 Lean Readiness Results

Table 4.13 Grand averages for the LR factors

Factor	MEAN	STDEV
Leadership	*4.23*	*0.42*
Processes	*3.57*	*0.59*
Employees	*4.02*	*0.44*
Customer Relations	*3.83*	*0.57*
Supplier Relations	*3.78*	*0.60*
Willingness to Change	*3.97*	*0.50*
Lean Readiness	*3.90*	*0.36*

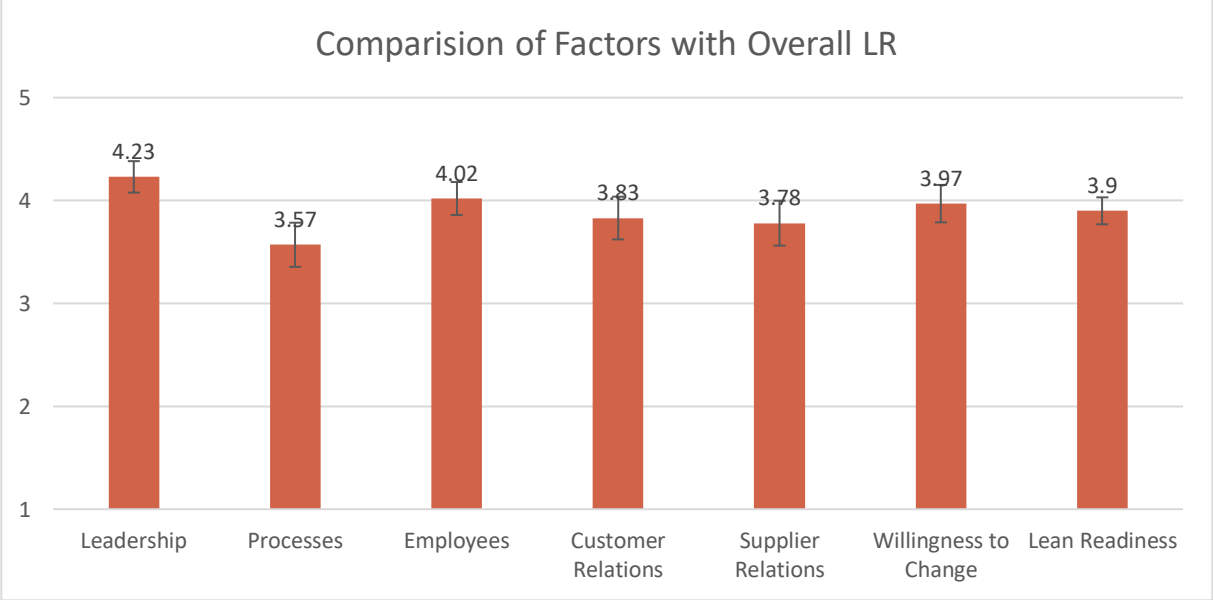

Figure 4.7 Comparison of Factors with Overall LR

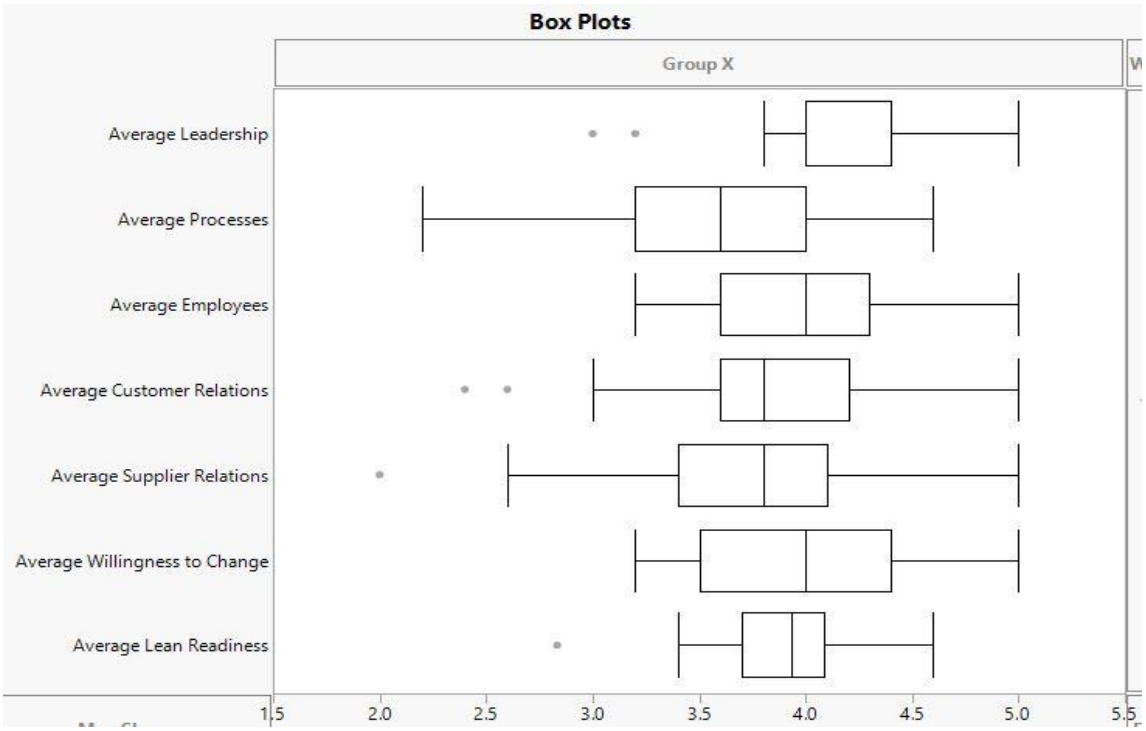

Figure 4.8 Box plots for the Factor and overall LR comparison

4.2 Discussion

The following section discusses the results presented in section 4.1 of chapter 4. The discussion is based on the descriptive analyses of the scores. The analyses are a representation of the scores supported with the literature review. The discussion presents a high-level view of the grain elevator as an organization.

4.2.1 Leadership Discussion

It can be seen from Table 4.1 and Figure 4.1 that the elevator superintendents tend to convey their vision and objectives clearly towards their employees. Questions for the leadership aspect are included in Table 4.1. The scores for question LD 1 (mean = 4.07 and standard deviation = 0.59) revealed that superintendents are highly ready when it comes to talking to their employee on regular basis to convey their ideas. These ideas and visions could be related to improvement

of the elevator operations and/or improving the business. Moreover, the superintendents showed a higher readiness when it comes to being open to new ideas and allocating the resources when needed. The scores of LD2 (mean = 4.41 and standard deviation = 0.50) stated that managers and superintendents are generally more open to listening of new ideas from the employees and stakeholders. The scores for question LD3 (mean = 4.31 & standard deviation = 0.71) showed high readiness in supporting, coordinating and providing encouragement to the employees. It can therefore be interpreted from this information that generally managers are highly ready to understand the need of the employees.

The average score for question LD4 (mean = 4.31 and standard deviation = 0.71) depicted that elevator superintendents were generally well aware of the tools and techniques which are essential to run the elevator business. Superintendents also showed readiness to be well aware about technological developments which pertains to the elevator operations. The scores suggested higher readiness of elevator superintendents based on knowledge and strong commitment. They showed higher readiness towards commitment and knowledge for improvement and successful functioning of the elevators as suggested by Sauer (2005) and Velasquez (2007). This meant that as superintendents of an elevator facility, they expected the operations to be smooth and comply to technological standards for smooth functioning which is also confirmed by Velasquez (2007) as important factors for smooth running of an elevator's operational success. In fact, the score of LD5 (mean = 4.17 & standard deviation = 0.71) depicted the strong readiness among the superintendents about lean management. This meant that superintendents are generally ready and aware of the wastes within their elevator operations and tend to deploy techniques to encompass them. The overall score of the leadership (mean = 4.23 & standard deviation = 0.42) leads to the interpretation that generally managers felt well prepared on the leadership scale. This supports the

conclusions made by Al-Najem, Dhakal & Bennett (2012) & Garza-Reyes, Ates & Kumar (2015), that leadership involvement is crucial to assess lean adoption in an organization. The error bars in Figure 4.1 shows a possible range which contains true mean with 95% confidence. Ranging from sharing the vision of ideas and improvement to being open to new ideas and from committing to the work to being aware about lean management techniques, the superintendents are highly ready towards being good leaders.. The results scores suggest a higher possibility of communication, management and running the elevator operation from the superintendent's end. As discussed in population and sample section that a superintendent's response reflects the preparedness of an organization owing to the knowledge and expertise level of superintendents. This reveals that on the leadership factor the grain elevators are highly ready towards lean adoption.

4.2.2 Process Discussion

The scores from the process showed a different trend as compared with the leadership. The process factor of lean readiness depicts the lowest average scores among all the other factors. Table 4.2 and Figure 4.2 summarizes the findings of the process aspect and Table 4.1 lists the questions included in the process aspect. The average score of PR1 (mean = 3.59 & standard deviation = 0.82) suggested a different readiness of elevators towards use of visual boards and representations to track for the logistic of the grains and maintaining the moisture and temperature content of the grains. The scores for question PR2 (mean = 3.28) revealed that tools and equipment are not always stored at the right locations. In fact, under the process factor the location of tools and equipment had the least average score. One of the interpretations that can be made is that less attention is given to the location of the tools as long as the operation is running smooth. From the literature it was concluded that grain elevators are SMEs operating on smaller scales with limited resources. Hence it makes sense that elevators are less ready to invest in improving operations. The

superintendents are highly ready when it came to the scheduling of the maintenances for the machines which is also discussed by Velasquez (2007) as an important aspect to ensure smooth running of elevators. The scores however revealed that it may not be the case for all the superintendents. Few of the superintendents were less ready towards the adoption of regular maintenance. The scores depicted that typically superintendents of the grain elevators are not highly ready towards spending resources on keeping visual boards or store equipment at right locations. This could either possibly be due to lack of resources or availability of funds among the elevator facilities. This makes sense since the leadership factor showed that superintendents in their viewpoint are readier to grow the business, however they are very limited on the process side. This could be possibly due to the limited availability of the resources or elevator management. This can also be well supported from the literature which shows that SMEs are bounded by financial constraints and resources.

The scores of PR 4 (mean = 3.43) pointed out the fact that occasionally time is lost when the equipment is kept at wrong location. Based on the scores of PR2 (mean = 3.28) the managers are typically less ready to spend time in ensuring that tools and equipment are stored at right locations. It means that superintendents do realize that time is lost whenever equipment are not stored at right location. Based on lean principles, loss of time due to wrong storage of the equipment does contribute to the adding of additional unwanted steps in the processes. Based on the literature review the 5S setup strategy therefore needs to be deployed to optimize the process and save the time for efficiency purposes. The scores from PR5 (mean = 3.59) revealed that following a similar trend, there is medium level of readiness among the organization about what they identify as ‘wastes’. Knowledge about wastes and generating ideas to mitigate them is crucial to ensure that an elevator is following lean principles of identifying and eliminating wastes to

increase efficiency of the process. This makes sense as Kadjo, Ricker-Gilbert, Alexander & Tahirou (2013) discusses about a farmer's limited knowledge about lean practices as a gap to identify 'wastes' in an organization. The average score from the process factor of the LR (mean = 3.57) survey revealed that elevators are less ready in process factor when compared with leadership factor. The setup of storing tools and equipment being at right location (PR2) scored the minimum average score as seen from Figure 4.2. However, the superintendents felt higher readiness towards maintaining the machines (PR 3, mean 3.97) which was highest in the process factor as seen in Figure 4.2. The elevator organization hence are least ready in terms of the process factor.

4.2.3 Employee Leadership

The outcomes of the employee scores suggested about stronger employee involvement in terms of reporting errors and defects. The data outcomes of the employee factor are listed in table 4.6 and Figure 4.3 and the questions about employee aspect in table 4.5. The average score of question EM5 (mean = 4.31) showed that elevators had higher readiness to invest in training of the employees for the overall development. The superintendents also felt higher readiness of the employees in terms of providing suggestions to improve systems and processes at the elevator facilities as seen from scores of EM1 (mean = 4.03) and EM2 (mean = 4.24). It can therefore be interpreted from the scores that superintendents are highly ready to provide adequate training to the employees which leads to their development. From the leadership factor it was observed from the scores that superintendents are highly ready to encourage employees to provide suggestions for improvement. This is further clarified in the employee factor since scores revealed higher readiness of employees to recommend suggestions for improvements. The score of question EM4 (mean = 3.83) depicted that to some extent the managers do incorporate the suggestions from the employees into the elevator management. This means that generally employees at elevator actively

participate in discussions involving improvements and their suggestion do get considered if they add value to the business. The scores of EM3 (mean = 3.83) also pinpointed less readiness among the superintendents to believe that their employees understand roles and responsibilities all the times. This completely made sense since work at elevator facilities often requires specific knowledge and time to get familiarize with the processes. Agricultural sector generally requires the employees to be flexible and open ended while performing the tasks (Limère & Dora, 2016). It makes sense that superintendents do need to invest in training in order to assist the employees in familiarizing themselves with the tasks and responsibilities. The outcomes of the employees scores revealed that superintendents highly ready in investing resources in employee training and development. However, more is required to be done in order to ensure that employees understand their tasks better. The average score of employees' factor (mean = 4.02) suggested with some more improvement on the employee aspects the elevator facilities can become more lean ready. The literature also supported the conclusion that leadership and management of the employees are crucial aspects when it comes to lean adoption. This leads to the idea that after leadership the elevators are highly ready on employee factor.

4.2.4 Customer Relations Discussion

Customer satisfaction is considered to be an important aspect when it comes to the lean management of a business (Limère & Dora, 2016). Table 4.8 and Figure 4.4 summarizes the scores of the customer relations aspect of the lean readiness survey. The questions for the 'employee' aspect is presented in Table 4.7. Based on the same article, the authors suggest that customers feel satisfied when the products are of high quality and fulfill their requirements. The scores of customer relations revealed the level of readiness the superintendents of the elevators have when it comes to maintaining relations customers. Superintendents showed higher readiness towards

dealing with variety of customers on day to day basis (CR4, mean = 4.34). However, they rated their experience with customers to be somewhat on a medium level. This meant that superintendents were not highly ready to invest resources in capturing of customer feedback and satisfaction levels on regular basis. This can be seen in the average scores of CR1 and CR2 (mean = 3.69 and mean = 3.62). On the other scale the superintendents had higher readiness levels to spend time and efforts towards understanding of the customer requirement and collect the customer complaints on time to time basis. The average scores of these two questions CR3 (mean = 3.76) & CR5 (mean = 3.72) was observed to be nearly same .

The scores therefore revealed that in the viewpoint of an average superintendent's readiness levels, the customer feedback, satisfaction, requirements and collection of complaints are not highly important. One of the possibilities behind this could be the close relationships with the clients. This means that elevator superintendents probably know the customers personally and therefore through means of personal conversations have an idea of their satisfaction levels. Being on a small-scale level and independently owned (SME), the superintendents have a better understanding of the requirements through word of mouth. This is just an interpretation of what could be a possibility behind the obtained scores. The total average score of customer relations (mean = 3.83) was observed to be lower than 'leadership' (mean = 4.23) and 'employees' (mean = 4.02) but little higher than the 'processes' (mean = 3.57). Limère & Dora (2016), also suggested that generally in agricultural sector customer feedback is not done actively owing to the open-ended nature of the work. Similarly, for the grain elevators it makes sense to have medium level average scores which points towards similar logic.

4.2.5 Supplier Relations

The scores from the supplier side revealed a somewhat similar trend as customer relations. Table 4.10 and Figure 4.5 summarizes the scores for this factor and table 4.9 shows the questions for the supplier relations. Scores depicted higher readiness of the to do business with the local suppliers with whom they shared a strong relationship. The average scores of SR1 (mean = 3.90) and SR3 (mean = 3.90) was observed to be same. It simply meant that superintendents are readier to use local suppliers in order to save time and cost. The superintendents however showed less readiness in order to evaluate the suppliers and provide feedback. A possibility behind this could be due to maintaining personal relationship with the suppliers. Similar to what was observed with the scores of customer relations. The average score of SR2 (mean =3.72) and SR 5 (mean = 3.64) pointed towards same understanding.

Scores also pin-pointed that superintendents looked to keep number of suppliers as low as possible. Though not many superintendents had the same opinion. This was seen to be a general trend. The average score for SR4 (mean = 3.72) simply meant that maintaining the number of suppliers is something which superintendents consider but does not give a higher importance.

The overall supplier relations score (mean = 3.78) revealed that superintendents had similar trend as compared to customer relations. Superintendents showed less readiness towards evaluating and collecting regular feedback from suppliers. This could mean that superintendents didn't considered collecting feedback and evaluation as an important task. However, the superintendents had higher readiness when it came to maintain strong relations. This meant that superintendents are readier to stay local and maintain close relationships to avoid shipment delays. However, the higher magnitude of standard deviations showed a variety of readiness levels among the superintendents. This could mean that it hugely depends upon the nature of superintendent as to how effectively they communicate with the suppliers and maintain the healthy relationships.

4.2.6 Willingness to Change Discussion

The elevator superintendents showed higher readiness to adopt a change if it improved the efficiency of their organization. The scores are summarized in Table 4.12 and Figure 4.6 with the list of questions included in Table 4.11. The score of 4.17 for WC1 (mean = 4.17 & standard deviation = 0.60) showed that there is not much difference of readiness with regards to bringing a change. The results also stated that the superintendents are readier towards reducing the grain losses and deterioration in order to improve their probability. The score of WC3 (mean = 4.17 & standard deviation = 0.66) suggested a somewhat similar trend as compared to WC1. It can therefore be revealed that superintendents of the elevators are lean ready when it comes to realizing the importance of adopting changes and assess its impact over improving profitability of the elevator facility. However, the scores for the questions concerning lean management goes down (WC2, mean = 3.72). Superintendents showed readiness in knowing about the lean management but not as strong as for the concern of improving profitability. This makes sense since being independently owned and operating over smaller scale (SME), the superintendents focused more on reducing the loss of grains and improving the overall profits. In other words, there seems to be less readiness among the superintendent to know about lean as compared with reducing losses and willingness to bring a change.

The scores of WC4 (mean = 3.86, standard deviation = 0.66) also show that managers have interest to use visual boards and visual representations to communicate clearly with the employees. This means that there is not much variation among the opinions and overall the superintendents do consider going for a change if needed. The scores of WC5 (mean = 3.90 & standard deviation = 0.82) suggests that though in general the superintendents agreed to organization meetings to discuss and solve problems however the deviation showed a huge variety of opinion. Based on a similar logic of being a small holder elevator, it does makes sense that organizing more meetings

would not make sense owing to the knowledge of the superintendent. Smaller elevator facilities involve fewer complex structures and more of an open-ended culture. The superintendents are typically aware of the operations and the tasks being performed. Therefore, based on scores even though with a variety of opinions among the superintendents generally they prefer to keep a greater number of meetings to discuss about the business problems and address them.

The overall score for the willingness to change shows nearly positive results. The average score of willingness to change (mean = 3.97 & standard deviation = 3.97) shows that superintendents are positive about bringing a change if provided with right knowledge and awareness. This factor mainly addresses the willingness factor among the elevators organizational practices to change the business environment in order to improve the profitability.

4.2.7 Lean Readiness Discussion

The scores in table 4.13 shows the averages for all six factors of the LR framework and the grand average for the lean readiness of the grain elevators. These numbers show a high-level picture of the lean readiness of grain elevators. The Figure 4.7 presents a column chart of average scores of all six aspects of LR survey framework. The leadership factor received the highest average score while the lowest score was seen on the process factor. The employee aspect had the next highest score. This demonstrated that superintendents generally had similar readiness when it came to describing their leadership and employee engagement. In fact, the LD2 and EM5 had the highest averages within their respective aspects. Superintendents showed high readiness in being open to new ideas and innovation and supporting the training of the employees. It can therefore be said from literature and scores that superintendents in general see the leadership and employee management as important aspects for the running of the elevator business. The scores also revealed superintendent's readiness towards adopting a change for improving the profits. The

scores depicted that superintendents were highly ready to know about techniques that can reduce the losses and increase efficiency of the elevators. They also showed positive readiness towards organizing regular meetings to discuss processes and solve problems (WC5). Superintendents generally had a similar readiness with regards to willingness to change (standard deviation = 0.50) This means that scores of superintendents for willingness to change were precisely close.

Superintendents showed lower readiness for providing and capturing regular feedback or check satisfaction levels on regular basis for their customers and suppliers. However, the scores did suggest that superintendents kept knowledge of who their customers were and what they need. On the supplier side, the superintendents had higher readiness towards using local resources. This leads to the understanding that superintendents understand the importance of time and logistics and prefers to go the simpler way. This make sense since most independently owned elevators operate on a smaller scale and are limited on the resources. The average standard deviation of both CR and SR (0.57 & 0.60) lie pretty close to each other. This means that superintendents on a general note have similar readiness towards maintaining the relations. Another interpretation of this could mean that owing to the small-scale business, elevator superintendents have a more close and simple relationships with their suppliers and customers. Henceforth they don't consider capturing and providing feedback of complaints on regular basis. In simpler words the relationships are more of a word to mouth and the maintaining highly professional standards is not considered necessary.

The lower processes average score could mean that superintendents could be falling short of resources, ideas and right knowledge to optimize their business operations. The standard deviation for processes (standard deviation = 0.59) suggest similar readiness among the superintendents. It can be interpreted from the scores that though superintendents have limited and

less motivation to know more about lean management, however they are ready to adopt a change for improving efficiency. It makes sense to have lower scores for the processes owing to the fact that small scale elevators may not be technologically advanced and could be functioning on limited resources. From the literature it is concluded that just like SMEs, the elevator is limited on the amount of resources and finances.

It can be seen in figure 4.7 and figure 4.8 that 'Leadership' factor indicated the highest readiness level among the elevator superintendents. The average score for leadership was seen to be highest when compared to all other factors. In fact, all five questions in the 'Leadership' factor scored numbers above four (Figure 4.1). Hence it can be concluded that 'Leadership' turned out to be the highest readiness level factor among all the factors of LR framework. The scores revealed that superintendents showed higher readiness in communicating their vision and objectives, supporting the employees and being open to new ideas. Scores also showed that superintendents understand the importance of strong commitment to ensure successful elevator operation. However, the scores revealed less readiness of superintendents towards showing a strong interest to learn more about lean. In fact, scores depicted higher focus on reducing wastes at elevator facility and improve profitability. The scores showed elevator superintendents do possessed strong vision and will to adapt a change to improve elevator business but limited with resources to achieve the targets. However, despite the limitations, the superintendents had a higher readiness in terms of leadership and employee management. Based on the understanding from the literature review, Brockamp (2016, p. 54) & Velasquez (2007, p. 9) stresses on the availability of training programs and education about proper monitoring techniques to manage the grain handling operations at the elevator facilities. White (2000) & Jayas & White (2003, p. 259) discusses that awareness about good storage practices and regulations are crucial to ensure that grain safety is maintained. On the

other the reports by Penn State Extension (2017) & Purdue extension (2019), stated that grain damages primarily occur when there is insect infestation due to poor storage practices. In such cases lack monitoring and attention by the leadership and employees causes the grains to get infected. Awareness and knowledge among the employees thus become an important aspect to avoid such infestations. The literature thus leads to the revelation that involvement and attention by the leadership is crucial to ensure commitment by employees and that everyone understand the processes.

In addition, from Figure 2.2 it can be seen that quality of management, operators' characteristics and access to capital are essential during the food storage stage. Information from the scores reveals that employee management is considered as an important factor by the surveyed superintendents. This leads to the conclusion that employee management and leadership involvement are critical to ensure the smooth running of elevator operation. Articles by Garza-Reyes et al. (2018, p. 20), Al-Najem., Dhakal, Labib & Bennett (2013, p. 280), & Garza-Reyes, Ates & Kumar (2015, p. 1092) summarizes findings of lean readiness assessment, which each author did in a different field. The outcomes of the research discussed about the importance of leadership, educational training, relations with the stakeholders and management of the employees to be crucial aspects for an organization to be lean ready. The literature from all these studies combines to an idea that in order for the grain elevators to be lean ready leadership, involvement and employee management are two crucial factors. The scores of the lean readiness survey also revealed the same conclusions. Leadership and employee management scored the highest numbers whereas the processes scored the lowest. Relations with the suppliers and customers ranged in between the leadership and process factors. The next section summarizes the conclusion of this research and provides answers to the research questions.

CHAPTER 5. CONCLUSION AND FUTURE RECOMMENDATIONS

The final chapter includes the conclusion of this research and future recommendations. The conclusion would include a short and crisp overview of the findings and the interpretations made based on the scores. The future recommendations include possible steps which a future researcher can adopt to extract more findings out of this research.

5.1 Research Questions

Based on the results the readiness levels were calculated for each one of the six factors in presented in the lean readiness survey. Results determined the level of readiness for the grain elevators to adopt lean management practices. Thus, based on the literature review and findings of the research following are answers to the research questions, generated for this research:

RQ1: What is the current Readiness level of the grain elevators as assessed through Lean Readiness factors towards adopting the Lean practices fostering efficiency in elevator operations?

The readiness levels revealed that grain elevators superintendents had a higher readiness for leadership and better employee management. Leadership and employee management contributed maximum percentage to this score. The results along with literature also indicated that typically farmers (superintendents) are ready towards maintaining high process standards including process knowledge, awareness and investment in training programs are necessary to improve the efficiency of the business. Operating on a small-scale level and being small holder farmers does pose a challenge in terms of resources and investments.

The literature review had revealed that gaps with process knowledge, technology and awareness among the employees are the crucial reasons fostering losses at the grain elevator facilities. Therefore, it is important to understand that improvements and investments should be done at right places. For this purpose, process knowledge is necessary. And process knowledge is strong and accurate when the leadership is actively involved in every business aspect of an elevator operation as also confirmed from literature. Results suggested that even elevators were strongly ready towards the leadership and employee management being important indicators for high lean readiness. This further supported the revelations from the literature that active involvement of the top-level management is crucial aspect of lean readiness. Commitment by the employees, employee training and process knowledge are other crucial aspects which are required to be high and effective in order for an organization to go lean.

Lean readiness levels of the surveyed grain elevators thus indicated a higher leadership and employee management importance. The process levels were revealed to be lowest preceded by supplier and customer relations and willingness to change aspects. The revelations thus serve the purpose of the first research question of understanding the lean reediness levels of the grain elevators towards adopting best management practice of lean.

RQ2: Which Lean Readiness factor indicated the highest readiness level to adopt lean practices or lean implementation among independently owned grain elevators in the corn belt region of Indiana and Illinois?

Leadership readiness factor indicated the highest readiness level among the surveyed elevator superintendents to adopt lean practices. As discussed before and from the literature it is

well understood that leadership plays a crucial role when implementing lean practices in a given organization. The results deduced that managers at the elevators were highly ready on having strong vision and will to adopt new ideas to improve the business of the elevator operation. Moreover, their scores revealed the high level of readiness to have a strong will to learn about lean management tools and techniques. Under leadership aspect the superintendents were ready to be open to new ideas which can foster the development of the elevator business. Based on the literature, a strong leadership would provide encouragement, motivation and resources to the employees in order to improve the working of the elevator business. This was also seen from the scores of leadership aspect where scores of superintendents showed high readiness towards providing support, encouragement and direction to the employees when needed.

Hence it can be concluded from the literature as well as from the scores of the survey that leadership readiness factor has indicated the highest readiness level to adopt lean practices or lean implementation among the independently owned grain elevators. The revelation of the scores and the literature thus serves the propose of the question and presents the aspect with higher readiness level of the grain elevators.

RQ3: Which Lean Readiness factor indicated the lowest readiness level to adopt lean practices or lean implementation among independently owned grain elevators in the corn belt region of Indiana and Illinois?

Process readiness factor indicated the lowest readiness level for the lean implementation of the grain elevators. The scores revealed that superintendents were less ready towards the use of visual boards or storing the equipment at the right locations. In fact, the superintendents had lowest

score when it came towards storing the equipment at the right spot. Moreover, superintendents also showed less readiness towards storing of equipment at right location which meant that occasionally the time was lost due to incorrect storage of the equipment. The literature revealed that losses at grain elevators particular happen whenever there is negligence in maintaining the moisture or temperature control. This monitoring is based on the knowledge and understanding of the processes by the employees. The lower process scores were expected owing to the fact that leadership and employee management are critical to ensure lean operations. The limitation with the process scores tends to happen due to awareness factors. In other words, there is limited availability of process knowledge and compliance with the good storage practices as discussed by Velasquez (2007). The other conclusion that can be deduced from the scores points towards the fact that superintendents considers leadership readiness to be most important factor. This makes sense since it is understood from literature that in order to go lean, leadership and management are critical factors to improve before one can move to other factors.

The revelation of the scores and the literature thus serves the propose of the question and presents the aspect with lowest readiness level of the grain elevators.

5.2 Conclusion

The readiness was seen to be highest to be on ‘leadership’ factor followed by ‘employees’ which had average scores greater than four out of five on Likert scale. The ‘customer relations’, ‘supplier relations’ and ‘willingness to change’ factors trended closely and right after ‘employee’. The lowest average score was seen on the ‘process’ side. The findings revealed a high level of readiness on the leadership side and a comparatively lower readiness for the process side.

The results aligned with the survey results reported by Limère & Dora (2016), in their research where the authors had concluded high leadership scores and lower process scores. Similar

trend was seen with regards to other four factors of lean readiness survey. The factors of lean readiness survey emerged from the exploratory and then confirmatory analyses done by Limère & Dora (2016) in their research study. The purpose of this descriptive study was to adopt the instrument developed by Limère & Dora (2016) and deploy in same field of agriculture and confirm the survey results. The authors Limère & Dora (2016) had reviewed 45 papers on lean readiness and confirmed six factors to be crucial for the study. The factors such as leadership, processes, relations with stakeholders (supplier or customers) and willingness to change were also confirmed in the lean readiness studies conducted by Al-Najem, Dhakal, Labib & Bennett (2013), by Garza-Reyes et al. (2018) & Garza-Reyes et al., (2018). The outcomes of the researches and from the literature concluded that elevator organizations are highly ready on the leadership factor.

In order to be lean ready, it is important to have a strong leadership involvement and constant commitment by the employees. The grain elevator management needs to look for strategies and investments to improve their operation on the process side. The conclusion showed that superintendents are highly ready in terms of leadership and employees management, which are critical for lean adoption. This leads to the conclusion that in order to score high on lean readiness the next steps would be to improve the process scores and continue maintaining strong relations with the suppliers and customers.

The research thus concludes with recommendations for the future researchers who wishes to carry forward the findings and make results more effective. The recommendations simply provide an extension of this research and as to what additional steps can be done to provide a deeper insight about the gaps in the current readiness levels of the grain elevators.

5.3 Future Recommendations

The following are the set of future recommendations that the researcher would recommend:

- The research can reveal more descriptive results if information about demographics (location, type of farming, crops etc.) is obtained. The additional information of demographics can be used for the correlation studies to generate more useful results.
- The survey used for this research can be deployed in grain elevators of other regions and results can be generated to check for the comparisons of same instrument in different regions. The research can be taken a step forward by conducting the same research in different farming regions of United States. This Lean Readiness survey could be further developed into a generalized framework for grain elevator operations through means of replicability and reproducibility.
- Analyses of variance could be done between the demographic's information and lean readiness aspects of the LR framework. This can reveal the possible impact each readiness aspect can have on the readiness based on location and nature of food harvest the elevator superintendents store at the facility.
- Studies relating to the lean implementation on particular aspect of LR framework could be adopted in order to foster the lean adoption from the ground root level of the elevator operation. One such example of this can be the deployment of a lean tool PDCA (Plan, Do, Control, Act) cycle in one of the processes.
- Regular readiness review assessments could be performed on regular basis at elevator sites on regular basis to monitor the variation in scores on regular basis.
- The future researchers are encouraged to ensure maximum participation by the elevator managers in order to ensure that data complies with normality and present close results.

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APPENDIX

Elevator Participation

My name is Rohit Sabharwal and I am pursuing my Master's degree in Technology Leadership and Innovation from Purdue University. This survey addresses the major points to assess Lean Readiness among grain elevator operations. Lean is defined as a set of tools and techniques aimed at reducing 'wastes', or customer non-value-added activities, in an operation and increasing efficiency by maximizing outputs and minimizing the inputs. The survey will take about 10 minutes to complete. The survey is confidential, and the name and location of a facility, and any personnel taking the survey, will not be disclosed. There is no more than minimal risk involved and has minimal chances of breach of confidentiality and risks are lesser than someone faces on day to day basis. The survey complies with the Purdue IRB (Institutional review board) guidelines. However, all measures and steps shall be taken to protect the data and information. By agreeing to participate in the survey, you will be helping support this research which could benefit elevator operations in the future. If you wish to complete the survey over the phone, online or in person, have any questions or comments please feel free to contact me at rsabharw@purdue.edu or cell 513-602-5739.

Thank you so much in helping me with my research and participating.

Survey Link: https://purdue.ca1.qualtrics.com/jfe/form/SV_74yPBwBr4UnaV5r

Lean Readiness Questionnaire for Indiana Grain Elevators

To what extent do you agree with the following statements regarding the use of Lean management practices when considering your grain elevator facilities current operations?

Please use the following scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

	Criteria of Lean Readiness	**Measurement Scale**				
	Leadership	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	As a leader/manager I clearly communicate my vision and objectives towards my employees	1	2	3	4	5
2	I am open to new ideas and provide resources when required	1	2	3	4	5
3	I provide support, direction and encouragement to my employees.	1	2	3	4	5
4	I fully understand that successful implementation of tools/techniques, which increases elevator operations efficiency, comes with investments and requires a long-term commitment	1	2	3	4	5
5	I do understand what the benefits of lean management consist of. (e.g. no compromise of grain quality, efficient transportation of grains, monitoring of right moisture and temperature content and ensure that grain storage standards are met)	1	2	3	4	5

	Processes	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
6	We use visual boards or representations to track the moisture, temperature and logistics of the grain storage at the elevators?	1	2	3	4	5
7	Tools and equipment are always stored in the right location	1	2	3	4	5
8	We use a schedule for maintenance of equipment so that machines are maintained on a regular basis by skilled people.	1	2	3	4	5
9	Occasionally time is lost due to forgetting equipment as it is kept at wrong location?	1	2	3	4	5
10	Everybody in the organization helps to identify wastes and solve problems by generating new ideas and solutions. (See description of wastes below). Waste = Improper moisture and temperature control, machinery breakdowns force employees to wait, a fault in elevator's operation requires extra labor and a larger proportion of grains are rejected/replaced/mixed with similar grains due to poor quality. These are all wastes that can be eliminated to smoothen the process and augment efficiency.	1	2	3	4	5

	Employees	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
11	My employees feel free to report information on errors and defects.	1	2	3	4	5
12	We promote the involvement of all our employees in providing suggestions to improve system and the process at the elevator.	1	2	3	4	5
13	Each employee has a clear understanding of his/her roles and responsibilities while at the elevator facility.	1	2	3	4	5
14	Suggestions and ideas from employees are actively used by the superintendents/elevator managers and management.	1	2	3	4	5
15	We support training and employee development.	1	2	3	4	5
	Customer Relations	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
16	We question our customers about their satisfaction levels on a regular basis.	1	2	3	4	5
17	We frequently seek customer feedback on delivery performance and the quality of the products.	1	2	3	4	5
18	We understand our customers' requirements.	1	2	3	4	5
19	We understand that our grain elevators have multiple customers (Consumers, Retailers, Government, etc.)	1	2	3	4	5
20	We collect customer complaints so that problems can be avoided in the future.	1	2	3	4	5

	Supplier Relations	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
21	We have a good and close relationship with our suppliers who provide us Equipment and services for running of our grain elevator facility.	1	2	3	4	5
22	We utilize a clear strategy by which we evaluate supplier performance in terms of quality, delivery and prices.	1	2	3	4	5
23	Local suppliers are used. This to avoid shipment delays.	1	2	3	4	5
24	We keep the number of suppliers deliberately as low as possible.	1	2	3	4	5
25	We give suppliers regular feedback on quality and delivery performance.	1	2	3	4	5
	Willingness to change	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
26	I am interested in implementing changes at my elevator's working environment to improve efficiency and reduce non-value steps Efficiency: Reduce costs of running the grain elevator operations	1	2	3	4	5
27	I want to be further informed concerning lean management.	1	2	3	4	5
28	I will focus on reducing the grain losses and deterioration to improve profitability.	1	2	3	4	5
29	I will start using visual boards and representations on the elevator site to communicate clearly with the employees.	1	2	3	4	5
30	I will organize regular meetings to discuss the processes and solve problems.	1	2	3	4	5