EXPLORING LEAN TO ADDRESS UNIVERSITY PARKING PROBLEMS

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ABSTRACT

Parking services represents a key problem in many contexts. Given that lean manufacturing is applicable in services – shown to increase performance and customer satisfaction – the parking system should benefit from the application of lean principles. This study investigates the applicability of lean in a university parking system.

Keywords: Lean Manufacturing, University parking, Lean principles

1. INTRODUCTION

Car parking is a significant issue in local and regional strategic planning (Young 2000). Many urban areas in USA and other countries experience the problem of insufficient parking facilities (Batabyal and Nijkamp, 2008). Today, many cities are searching for solutions to their parking problems (Dieussaert et al. 2009). However, parking services is an under-researched area of transport (Ison and Rye 2006).

Large universities resemble small cities, and similarly have substantial transportation problems (Shoup, 2008). "Problems with parking is a nearly universal phenomenon in higher education" (Bauerly and Thistlethwaite, 1997, p.1). In addition to faculty and staff, the number of students is increasing with every year, creating shortage of parking spots (Batabyal and Nijkamp, 2008). Student parking is one of the key unresolved problems, faced by the higher education's administrators (Bauerly and Thistlethwaite, 1997). Some of the proposed solutions are adoption of two campus parking policies: political relying on the regulations and economical relying on the market price (Shoup, 2008). On the other hand, Litman (2006) proposed appropriately applied parking management, resulting in reduced number of parking spaces required in each situation in addition to the economic, social and environmental benefits.

Another very effective management system, achieving better results while using less of everything: half the human effort, half the manufacturing space, half the engineering hours, decreased labor cost, etc. is the lean manufacturing (Dibia and Onuh 2010; Sohal and Egglestone, 1994). According to recent research, lean is applicable in a variety of business contexts (Hong et. al., 2010). Womak et al. (1990) are convinced that the lean production principles are applicable in every industry and that transformation to lean will result in positive outcome to the human society. Furthermore, lean has started in manufacturing environment, but has been implemented in a service context (Bortolotti et al .2010) and many of its tools are developed in the service industries (Swank 2003). According to Bortolotti et al. (2010) lean management is one of the most effective methodologies for improvement of the business processes. Ahlstrom (2004) concluded that lean production is applicable to the service operations, but the applicability is contingent on the type of service and its characteristics, even in some cases lean is more applicable to the services than to manufacturing. Parking system is classified by Schmenner (2004) as a service factory, consequently it should benefit from the application of lean manufacturing.

The purpose of this study is to identify lean practices that are applicable to improve the satisfaction with parking service. Moreover, the relationship between the key lean practices, parking performance, waste reduction and parking satisfaction will be determined. Specifically this study will inform two research questions related to the university's parking system:

RQ1: Which lean practices are applicable in parking services?

RQ2: How do lean principles affect parking performance, waste reduction, and parking satisfaction?

2. LITERATURE REVIEW

2.1 Parking and parking problems

Parking management refers to various policies and programs, resulting in more efficient use of the parking resources (Llitman 2006). Some of the parking management principles assisting the parking management are: "consumer choice, user information, sharing, and efficient utilization of the parking facilities." (Gurram and Rakha 2010; p.1). Car parking is a very significant issue in the strategic planning (Young 2000).

Insufficient parking facilities are a problem experienced by many urban areas in US and other countries (Batabyal and Nijkamp, 2008). Consequently, searching for a solution to their parking problems is important tasks for many cities (Dieussaert et al. 2009). Litman, (2006) divided the parking problems in two categories: 1. resulting from supply deficiency, or resulting from inefficient parking management or inappropriate strategy (Brown-West 1996). These parking problems are observed by drivers at the moment they start searching for a parking place (Zwerts and Nuyts, 2005). Space and time are important factors in parking congestion (Shoup, 2006).

Similar to the small cities, the large universities have significant transportation problems. (Shoup, 2008). Parking problems are a universal phenomenon in many universities, because an increasing number of students creates a shortage of parking spots (Batabyal and Nijkamp, 2008; Bauerly and Thistlethwaite, 1997). Moreover, parking management faces difficult planning for two reasons: 1. uncertainty in the parking demand and 2. parking demand exceeding the available supply (Batabyal, A. Nijkamp, 2008).

Many universities have adopted two main approaches related to campus parking policy: political and economical (Shoup, 2008). Political relies on rules and regulations while the economical relies on market prices (Shoup, 2008). On the other hand appropriately applied parking management is resulting in reduced number of parking spaces required (Litman, 2006). Another solution to the university parking shortage is using the price to balance supply and demand (Shoup, 2008).

2.2 Proposed parking solutions

Researchers have proposed different types of tools to address parking system problems. Advanced parking management systems are introduced by Intelligent transportation system effort and utilizes variable message signs providing to the drivers up to date information on the availability of parking at alternative lots and number of open spaces in congested parking environments, it is a driver decision where to park (Holton and Fisher 1998; Hester et al. 2002)

A wireless sensor network announcing which of the parking spaces are available at any moment is used for a parking management in San Francisco. Moreover the system allows drivers to see real time information displayed on street signs or on the screen of their cell phones (Markoff, 2008). Tang et al. (2006) clarified that wireless network system is applicable to various environments and many industrial and academic companies are interested in it.

Idris et al. (2009) proposed a smart parking system based on web and GIS systems able to disseminate information to the users via internet, mobile phones and or PDA. Vehicle occupancy is detected by detection sensors at entrances and exits, the traffic information is gathered and displayed to the drivers (Idris et al. 2009). Similarly Ganchev (2007) proposed InfoStation as a solution to the University parking problems. With InfoStation the registered users have instant information for the available on the campus parking spots. Gurram and Rakha (2010) developed web based interactive system informing visitors for the empty parking spots and their location.

2.3 Lean Services

The lean management is one of the most effective methodologies for improvement of the business processes (Bortolotti et al. (2010) and delivering better outcomes for the key stakeholders (Emiliani, 2004). Core principles in lean include swift and even flow, pull, waste

reduction, and standardization, among others in manufacturing and service operations (Lewis, 2000).

Lean production principles are applicable in many industries, resulting in positive outcomes for society (Womak et al., 1990). Although the lean began as a manufacturing approach, service enterprises can also benefit from the lean advantages (Abos, 2002). In addition, many lean tools are developed in the service industries (Swank, 2003). Lean production is applicable to the service operations, but the applicability is contingent on the type of service and its characteristics, even in some cases lean is more applicable to the services than to manufacturing (Ahlstrom, 2004)

During the past decades, the service industries have experienced a significant growth and currently they are significant portion of the world's economic (Su et al. 2006). In order to be competitive, the service companies need to provide service and quality meeting the customer's expectation, goals achievable trough lean implementation (Allway and Corbett 2002).

Application of lean manufacturing to the service businesses results in significant improvement in the quality and cost (Piercy and Rich, 2009). Service companies taking the lean approach achieve control of their key processes and improve them, resulting in a cost benefits for the organization and generated substantial benefits for customers (Allway and Corbett, 2002).

Service processes are different than the manufacturing because in the services the customer actively participates into the delivery process, the service is intangible and the service cannot be stored (Fitzsimmons et al., 1994; Abos, 2002). Lean is a tool which successful utilization depends on the "efforts surrounding its use" (Dickson et al. 2009).

2.4. Benefits of lean

Researchers suggest that lean is successfully applied in variety of services. When lean approach is applied to the Human resources management, it results in better quality and increased customer service focus (Bowen and Youngdahl. 1998). Swank (2003) proved that when lean is applied to the financial service, the same lean principles applicable to manufacturing are pushing the financial service performance to new heights. When lean is applied in service companies as Taco Bell, Southwest Airlines, and Shouldice Hospital trough implementation of the lean principles, the service businesses have become apparent, highly praised, service role models. (Bowen and Youngdahl. 1998) On the other hand, if lean is implemented in the hospitals according Dickson et al.(2009) the result is increased patients' satisfaction, reduced length of stay in the hospital, significant reduction in the process cycle time of patient's transportation and treatment and minimized mortality rate (Shah et al., 2008). The results of applying the lean principles and practices to a graduate business school course are higher level of student satisfaction, clear expectations, standard format for assignments, better management of students' time and better satisfaction. (Emiliani 2004). According Comm and Marhisel (2005) each

college and university is a good candidate for lean, especially on the operation and administrative site.

2.5 Lean in parking management

JIT is a key element of the lean production (Hines (1996), defined as delivery of the parts in the right quantity at the right time (Sanchez and Perez, 2001). According to recent researches, JIT is successfully utilized not only in manufacturing, but in the service businesses (Duclos et al., 1995). Consequently JIT should be applicable to the parking services and could be defined as finding a parking spot at the right time at the right location. JIT is supported through *Kanban*, a system of visual tools, used to synchronize and provide instruction to the customers and suppliers (Dennis, 2007; Melton, 2005). Signs providing to the drivers, information on the available parking spaces (Holton and Fisher 1998; Hester et al. 2002) may be thought of as Kanban applied to the parking services.

Visual management is used to coordinate the system and make the production conditions transparent to everyone (Dennis, 2007). Visual management refers to simple signals providing immediate and apparent understanding of a situation (Kilpatrick, 2003) with a goal creating a self-directing, self-explaining, and self-improving visual workplace (Hogan, 2009). According to recent researchers, the most utilized lean tool in the parking services is visual management. Up to date information on the availability of parking at specific lots and number of open spaces, is provided on message signs (Holton and Fisher 1998: Hester et al. 2002). A real time parking information displayed on street sighs or on the screen of the smart phones (Markoff, 2008). A smart parking system is disseminating information via internet or mobile phones (Idris et al., 2009). InfoStation, providing instant information for the available on the campus parking spots (Ganchev, 2007).

5S's is the extent to which the workplace is organized and standardized (Dennis, 2007; Liker, 2004). In a *lean* transformation, 5S is the first implemented tool providing immediate return on investments and applicable to every function in the organization (Kilpatrick, 2003). As example, 5S's is universally applicable achieving self-explaining, self-ordering and self-improving visual work place (Dennis, 2007).

Hedjunka refers to distributing production volume and mix evenly over time, with purpose of minimizing peaks and valleys in the work load (Dennis, 2007). An example of hedjunka is alleviating peak hours parking utilization through peak spreading' demand management strategy: scheduling classes in a less concentrated manner (Bustillos et al., 2011). Another example is leveling the parking demand between closest and distant from the buildings parking lots.

Jidoka refers to automation; the different processes require different levels of automation (Harris and Harris, 2008). Jidoka is supported through Poke-yoke detection method, referring to sensor technology. Non contact methods are used to detect disturbance in photo electronic beams as photo electronic devices, or metal passage detectors (Dennis, 2007). Vehicle occupancy, detected

by detection sensors at entrances and exits (Idris et al. 2009) is an example of poke-yoke devices applicable in parking service. Another example of Jidoka in the parking system is a free bus – shuttle transporting the students to their buildings, referring to automated transportation.

Muda is defined as the extent to which the activity or the process is not value added (Dennis, 2007). Muda found in the parking services: 1. Over processing: the car is parked for longer than required. 2. Correction/scrap muda: Illegal parking, paying tickets, late for classes, missed classes. 3. Conveyance muda: walking from a distant parking lot. 4. Waiting muda: waiting for somebody to take his/her car and empty the parking space. Motion muda: driving around from parking lot to parking lot when looking for a space.
From the literature review is obvious that visual management is the most used tool in the parking systems.

Table 1: Lean applied to parking service

Lean Tool	**Lean tool definition**	**Parking Management**	**Literature References**
JIT	delivery in the right quantity at the right time (Hines, 1996)	Parking at the right parking lot at the right time	Detty and Yingling, 2000
Kanban	a system of visual tools, used to synchronize and provide instruction to the customers and suppliers (Dennis, 2007)	Signs, providing to the drivers up to date information on the availability of available parking spots	Holton and Fisher 1998: Hester et al. 2002
5S's	the extent to which the workplace is organized and standardized (Dennis, 2007)	Universally applicable	Dennis, 2007
Visual management	Simple signals that provide an immediate and readily apparent understanding of a condition or situation. (Kilpatrick, 2003)	Advanced parking management: utilizes variable message signs providing to the drivers up to date information on the availability of parking at alternative lots and number of open spaces in congested parking environments	Holton and Fisher, 1998; Hester et al., 2002
		Real time information displayed on street signs or on the screen of the smart phones	Markoff, 2008

		GIS systems, disseminating information to the users via internet, mobile phones and or PDA	Idris et al., 2009
		Instant information for the available on the campus parking spots	Ganchev, 2007
		Web based interactive system informing visitors for the empty parking spots and their location.	Gurram and Rakha , 2010
Hedjunka	distributing the production volume and mix evenly over time (Dennis, 2007)	Pick hours parking utilization is alleviated through using "'peak spreading' demand management strategy: scheduling classes in a less concentrated manner	Bustillos et al., 2011
Jidoka (Poka-yoke)	autonomous monitoring for defects detection method using sensor technology (Haak 2006; Dennis, 2007)	A wireless sensor network announcing which of the parking spaces are available	Markoff, 2008
Muda	the extent to which the activity or the process is not value added (Dennis, 2007)	parking for longer than required, llegal parking, paying tickets, late for classes, missed classes, walking from a distant parking lot, waiting for somebody to take his/her car and empty the parking space, driving around from parking lot to parking lot when looking for a space	

3. THEORY DEVELOPMENT AND HYPOTHESES

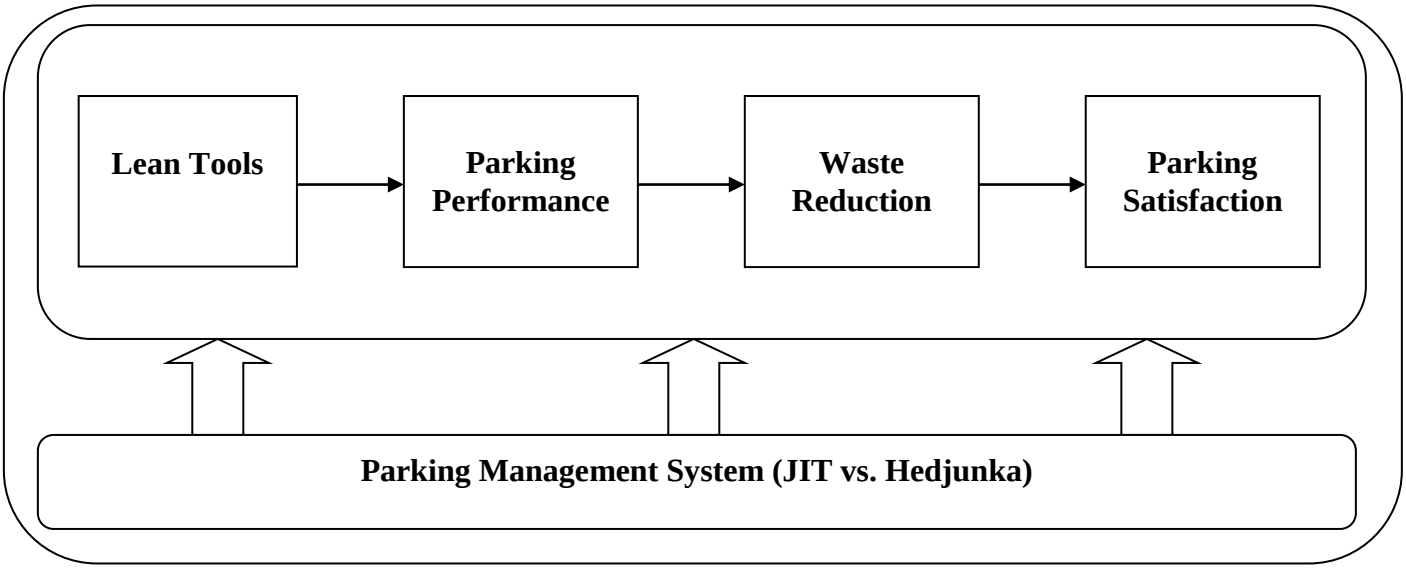
3.1 Contingency Theory

Contingency theory states that there is no one best way of organizing, and an organizational style successful in one situation may not be useful in another (Fiedler, 1964). Moreover, there is no single structure equally appropriate for all environmental circumstances (Ruekert et al., 1985). "One size does not fit all", because the different projects have a wide range of variations (Shenhar, 2001). An organization will perform well if its context and structure fit together (Drazin and Ven, 1985). "Contingency theory assumes that the better the 'fit' among contingency variables (e.g., between technology and organizational structure), the better the performance of the organization" (Weill and Olson, 1989, p. 61). Higher performing organizations have strong relationship between structure and context (Drazin and Ven, 1985).

3.2 Lean Manufacturing

Lean is doing more with less, using the *least* amount of effort, energy, equipment, time, facility space, materials, and capital – while giving customers *exactly* what they want (Womak 1996). The literature review suggests that lean manufacturing is applicable in variety of services businesses (Hong et. al., 2010), effectively improving their business processes (Bortolotti et al., 2010). Parking system is classified by Schmenner (2004) as a factory service business; consequently, the lean manufacturing can be applicable to the parking system. The lean practices will need customization to the organizations circumstances, there is not a "best approach" appropriate for all organizations. Generally speaking, the use of lean tools should improve the performance of the parking system, reducing waste for the users of the system, and improving user satisfaction. The specific lean tools used to achieve improved parking performance are contingent upon the type of parking management system employed. See figure 1.

Figure 1: Theoretical Model



One approach to parking management can be conceptualized as a *just in time parking management model (JITPMM),* which refers to finding a parking spot at the right time at the right location. In the university setting, JITPMM is suitable for students who prefer parking close to the buildings. Just in Time uses the minimum necessary resources to deliver the right quantity at the right time (Sanchez and Perez, 2001; Haak, 2006; Detty and Yingling, 2000, Kasul and Motwani, 1997). The other name of Just in Time is "pull system" because placing an actual order triggers the manufacturing of the product (Haaster et al., 2010; Dennis, 2007). Matching production with demand is the purpose of pull production (Detty and Yingling, 2000; Kilpatrick, 2003). Some of its benefits are lower inventory, space, cost and response time (Beard

and Butler, 2000; Haak, 2006; Haaster et al., 2010; Billesbach and Hayen, 1994). Because the different industries have different manufacturing process, JIT is not equally applicable to all of them (Beard and Butler, 2000). JIT is supported trough Kanban, a visual control signal, pulling production through the manufacturing process (Melton, 2005). In cases when pure flow is not possible because of different cycle time between processes or another reason, Kanban system is the next choice (Liker, 2004).

The success of *lean* is contingent on the organization environment context; consequently, the *lean* practices will need customization to the organizations environment (Browning and Heath, 2009). There is not a "best approach" appropriate for all organizations and building a theory of *lean* have to take into account the moderating factor of contextual variables, because the *lean* success is contingent on the organization environmental context (Browning and Heath, 2009). For successful *lean* implementation is very important to know, which of the *lean* tools to which specific environment relevant are (Corbett, 2007).

Figure: 2 JIT parking management model

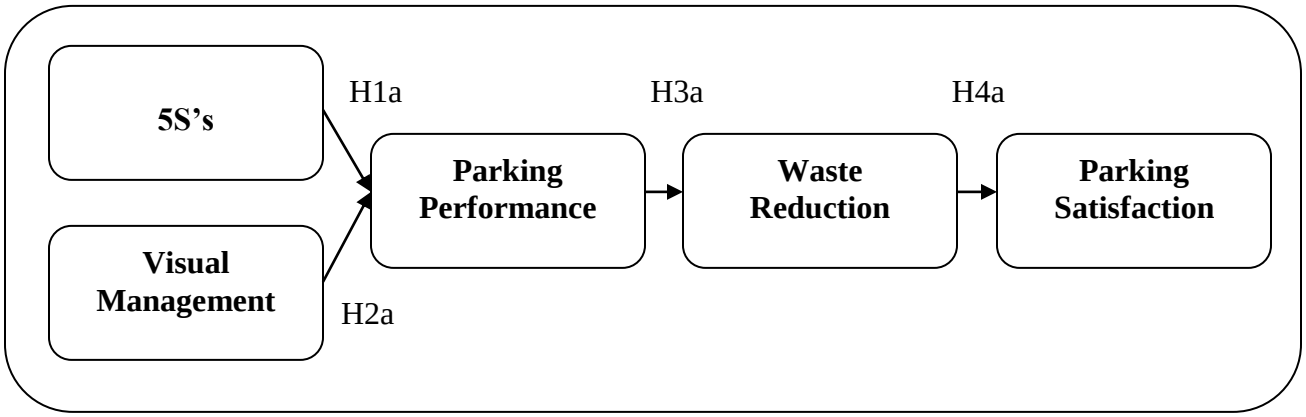


Table 2: Construct Definitions

Construct	Construct Definition	Literature
5S	the extent to which the workplace is organized and standardized	Dennis, 2007; Liker, 2004; Kilpatrick, 2003
Visual Management	the extent to which value added information is displayed to everyone	Dennis, 2007; Kilpatrick, 2003
Parking performance	the extent to which is	Litman, 2006

	measured the progress toward the objectives.	
Waste	the extent to which the process is not value added	Dennis, 2007; Liker, 2004
Satisfaction	the extent to which "one's feelings or attitudes toward a variety of factors affecting the situation" are summed	Legris et al., 2003; Bailey and Pearson, 1983

5S's is the extent to which the workplace is organized and standardized (Dennis, 2007; Liker, 2004). It is a housekeeping technique, through which the control is transformed to the shop floor (Melton, 2005). First S stands for Sort-keep only what is needed, second S stands for Straighten –create a place for everything, third S stands for Shine-cleaning so abnormal and pre-failure conditions are exposable, forth S: Standardize, stands for create rules to maintain and monitor the first 3s, fifth S stands for sustain, create a self discipline for continuous improvement (Liker, 2004). In a *lean* transformation, 5S is the first implemented tool providing immediate return on investments and applicable to every function in the organization (Kilpatrick, 2003).
Thus, the present study hypothesizes:

Hypothesis 1A: 5S's is positively associated with parking performance

With visual management **a** value added information is displayed to everyone (Hogan, 2009; Dennis, 2007) and the problems are apparent to all (Hogan, 2009). Kilpatrick (2003) defined visual management as simple signals providing immediate and obvious understanding of a situation within a short period of time. Moreover, visual management is a communication aid, a tool driving real time operations and processes (Parry and Turnerz, 2006). With visual management, the problems are apparent to all because the production operations status is displayed to all workers. According to recent researchers (Holton and Fisher 1998: Hester et al. 2002; Markoff, 2008; Idris et al., 2009; Ganchev, 2007) the most utilized lean tool in the parking services is visual management, consequently this study hypothesizes:

Hypothesis 2A: Visual management is positively associated with parking performance

Muda (waste) refers to not value added processes or activities (Dennis, 2007). Researchers have identified eight types of muda, but not all of them are found in the parking services. Type of wastes expected to be found when parking close to the building: Over processing muda refers to processing the items more than is customer's requirement (Dennis, 2007; Liker, 2004). Correction/scrap muda refers to reworked or corrected parts (Liker, 2004). Waiting muda refers to workers waiting for material or for the next processing steps, part, etc. (Dennis, 2007; Liker,

2004). Unused employees creativity refers to lost improvement and learning opportunity (Liker, 2004)

Hypothesis 3A: JIT parking performance is positively associated with the waste reduction

Satisfaction is the sum of "one's feelings or attitudes toward a variety of factors affecting the situation" (Legris et al., 2003, p.192; Bailey and Pearson, 1983, p.531). Cheney (1986) identified three variables measuring the satisfaction: uncontrollable, partly controllable and fully controllable. The satisfaction is a critical factor determining success or failure of the system implementation (Doll and Torkzadeh, 1988: Bailey and Pearson, 1983).

Hypothesis 4A: JIT waste reduction is positively associated with parking satisfaction

3.4 Hedjunka parking management model

Hedjunka parking management model *(HPMM)* refers to leveling the parking demand between closest and distant to the buildings parking lots. HPMM is suitable for students who prefer to park at distant parking lots. Hedjunka refers to leveled production aiming constant flow of mixed parts without picks and valleys in the workload (Furmans, 2005., Haaster et al., 2010, Adler et al., 1997; Coleman and Vaghefi, 1994; Deif, 2011; Hampson, 1999; Huttmeir et al., 2009). Moreover hedjunka is a manufacturing strategy eliminating the overproduction and synchronizing all production operations to match customer's demand (Deif, 2011, Detty and Yingling, 2000). Production leveling aim to smooth the product line utilization, to level the work load, and to set up standardized processes (Průša and Schacherl, 2007). Consequently, even work distribution results in stabile and even output, and create a continuous flow which is required for *lean* manufacturing (Haaster et al., 2010).

Figure 3: Hedjunka parking management model

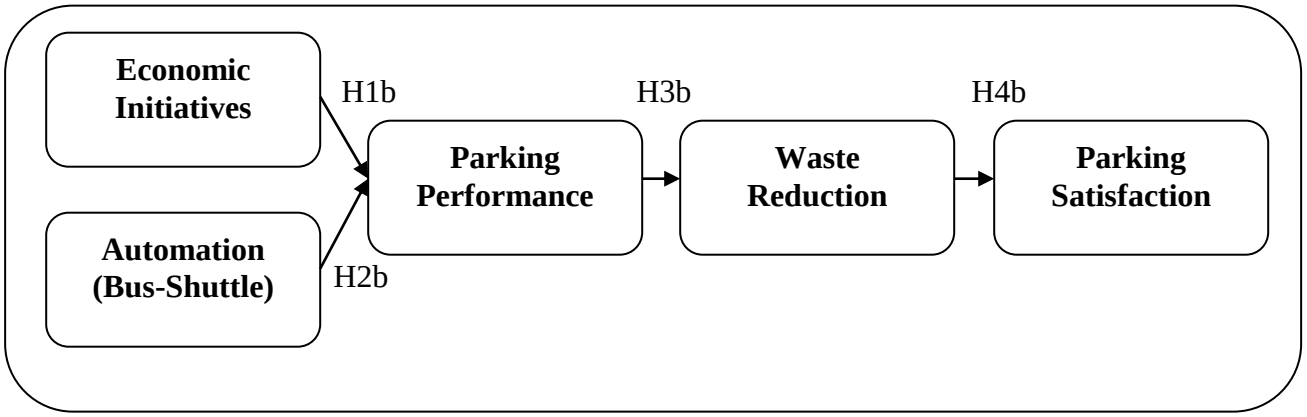


Table 3: Construct Definitions

Construct	Construct Definition	Literature
Economic Initiatives	the extent to which the parking prices are used to balance supply and demand	Shoup 2008
Automation	the extent to which is implemented the appropriate level of automation	Sandberg, 2007

Specific lean tool: Economic Initiatives. Defined by Toyota *lean* tools are solving similar to Toyota's problems, but for specific organization's problems, specific tools have to be designed and implemented (Lander and Liker 2007). One of the parking management principles is pricing (Litman, 2006). Shoup (2008) proposed using the parking prices to balance supply and demand: if many spaces are vacant indicates that the price is too high, on the other hand if no spaces are vacant indicates that the price is too low. Not vacant spaces in the parking lots close to the building indicate that the price for those parking lots is too low; on the other hand the many vacant spaces on distant parking lots indicate that the parking price is too high. This study hypothesizes that

Hypothesis 1B: Economic Incentives are positively associated with parking performance

Automation is an effective lean tool in high production volume, because eliminate waste and reduce production lead time (Morey, 2008). A key is not the automation of simple manual labor, but how to plan and implement the appropriate level of automation to fit with the other objective of the organization (Sandberg, 2007; p.431). The lean manufacturing companies using automation have achieved faster production development, lower inventory level, simplified management process, increased inventory turnover rates and improved quality. (Orr 1997). Automation increases quality and efficiency while reduces waste. (Morey, 2008), but its level varies with each manufacturer (Sandberg, 2007). When applied to the parking system, automation refers to bus shuttle transporting the students from distant parking lot to the buildings. Free bus shuttle is an acceptable solution in cases of distant parking facility (Litman,

2006). This study hypothesizes that

Hypothesis 2B: Automation (Bus transportation) is positively associated with parking performance.

Type of wastes expected to be found when parking at distant parking lots: Excess inventory muda, which refers to unnecessary raw materials, parts, and WIP, generating production imbalance, late delivery from suppliers, long set up times or equipment downtime, etc. (Liker, 2004). Conveyance muda refers to moving parts between processes (Dennis, 2007; Liker, 2004). Motion muda refers to unnecessary motion (Dennis, 2007; Liker, 2004). Unused employees creativity refers to lost improvement and learning opportunity (Liker, 2004)

Hypothesis 3B: Hedjunka parking performance is positively associated with the waste reduction

Hypothesis 4B: Hedjunka waste reduction is positively associated with parking satisfaction

4. Proposed method

A descriptive quantitative research design will be employed for the study. Survey Questions will be used to collect information about the lean principles in parking management, parking performance, waste resulting from parking system and parking satisfaction. The survey will be created with Lime Survey and will be distributed to the participants electronically. The population for the study is all students using the EMU parking lots. The appropriate sampling technique is simple random sampling: "the sample is chosen by simple random selection, whereby every member of the population has an equal chance of being selected" (Leedy & Ormrod, 2005, p. 201). The sample is one thousand five hundred students currently using the EMU parking system.

5. Anticipated findings and future research extending the present study

Similarly to small cities, the big universities have big transportation problems (Shoup, 2008). Parking problem is a universal problem in higher education (Bauerly and Thistlethwaite, 1997, p.1), because is one of the key problems faced by administrators (Bauerly and Thistlethwaite, 1997). This study will identify the lean practices applicable to the university parking services, and will determine the relationship between the key lean practices, parking performance, waste reduction and parking satisfaction.

Parking services is an under-researched area of transport (Ison and Rye 2006). Applicability of lean to the parking system is not determined. Extension to this study will investigate the

applicability of the lean practices to another type of university parking problems. Moreover, will investigate how the lean practices affect the parking performance and parking satisfaction.

6. Limitations

First, this study uses survey for data collection, the limitation of the survey research is that it captures a fleeting moment in time and relies on self reported data (Leedy and Ormrod, 2005). Second this study will explore how both types of parking management models: JIT and Hedjunka effect parking performance and satisfaction. As discussed, both models are applicable to universities with enough parking spaces, but not equally distributed around the buildings parking lots.

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