!"#$#%#&$'()*'+,*-.+./'0&.*1+.234*1+3(+..2(+3*

5.26*7**8987*

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SOLA 4951/SOLA9451

RESEARCH THESIS A

"#$%%!&'(#$&#!)*#$+,-!.....V
0'(#$&#!)*#$+,-!$()!&'(-1,#$#+'(!#+2*-!%'3!&'13-*!&'(4*('3!.....V
0'(#$&#!)*#$+,-!$()!&'(-1,#$#+'(!#+2*-!%'3!$))+#+'($,!,*&#13*3-5)*2'(-#3$#'3-5,$6!-#$%%!.....V
728'3#$(#!,+(9-!.....V
0'13-*!)*#$+,-!.....V
03*)+#!8'+(#-!.....V
0'(#$&#!:'13-!.....!;
"122$3<!$()!=+2-!'%!#:*!&'13-*!.....!;
"#1)*(#!,*$3(+(>!'1#&'2*-!.....!;
?@!AB'(-C!$()!DE!D3'>3$2!F*$3(+(>!G1#&'2*-!.....!;
0'13-*!F*$3(+(>!G1#&'2*-!A2$88*)!#'!?@!D3'>3$2!$()!DE!F*$3(+(>!G1#&'2*-!6*,'HC!I
J*$&:+(>!-#3$#*>+*-!.....!I
0'13-*!-&:*)1,*!.....K
=--*--2*(#!.....L
=--*--2*(#!'4*34+*H!.....L
J:*-+-!=!A"GF=IMKN5"GF=MIKNC!=--*--2*(#!.....D
D3*-*(#$#+'(!.....M
"162+--+'(!.....M
P$39+(>!.....NQ
@R$2+($#+'(-!.....NQ
"8*&+$,!&'(-+)*3$#+'(!$()!-188,*2*(#$3<!$--*--2*(#!.....NQ
J:*-+-!S+#:)3H,T!"1-8*(-+'(T!$()!J+2*!@R#*(-+'(!U!.....NQ
@R8*&#*)!3*-'13&*-!%'3!-#1)*(#-!.....NN
0'13-*!*4$,1$#+'(!$()!)*4*,'82*(#!.....N/
D3+V*-!.....N/
B*$,#:!$()!"$%*#<!.....N/
=&$)*2+&!:'(*-#<!$()!8,$>+$3+-2!.....N;
=)2+(+-#3$#+4*!2$##*3-!$()!,+(9-!.....N;
=88*()+R!=W!@(>+(**3-!=1-#3$,+$!A@=C!0'28*#*(&+*-!.....NK
!

J : *3*! $3*! ('! % '3 2 $,! ,*&#13* -! % '3! # : + -! & '13- *.! "#1) * (#-! - : '1,) ! -#$<! + (! & ' (#$&#! H+# : ! # : *+3! (' 2+($#*) ! -18*34+- '3!# : 3 '1> : '1#!# : *!# : 3**!# : * -+-!#*3 2 -T!8*3 : $8-!$#!$!83*` '3>$(+-*) !H**9,<! 2 **#+(>!#+2 *.!7#!+-!4*3<!+28 '3#$(#!+(!# : *!*$3,<!-#$>* -! '%!< '13!83 'd*&#!# '!6*!+(!& ' (#$&#!H+# : !< '13! -18*34+- '3!# '!* (-13*!# : $#!< '1! : $4*!$!&,*$3!1 ( ) *3-#$ ( ) + (>! '%!# : *!# '8+&T!H : $#!+-!3*_1+3*) T!$ ( ) !# '! & : *&9!# : $#!H : $#!< '1!$3*!) '+(>!+-!$)) 3* - -+(>!# : *!$+2 -! '%!# : *!83 'd*&#.!7%!$!-#1) * (#!H '1,) !,+9*!# '! & ' (#$&#! # : *+3! -18*34+- '3! '1#-+) *! '%! $! 83*` '3>$(+-*) ! H**9,<! 2 **#+(>T! * 2 $+,! +-! # : *! 83*%*33*) ! 2 *# : ') ! '%!& ' (#$&#.!

J : *!J : * -+-!D3 'd*&#!+-!&$33+*) ! '1#!+(!# : *!,$-#!# : 3**!#*3 2 -! '%!# : *!-#1) * (#-!

K.! Z('H,*)>*!'%!*(>+(**3+(>!)*-+>(!83$&#+&*!$()!&'(#*R#1$,!%$&#'3-!+28$&#+(>!#:*!
*(>+(**3+(>!)+-&+8,+(*.!

L.! b()*3-#$()+(>!'%!#:*!-&'8*T!83+(&+8,*-T!('32-T!$&&'1(#$6+,+#+*-!$()!6'1()-!'%!
-1-#$+($6,*!*(>+(**3+(>!83$&#+&*!+(!#:*!-8*&+%+&!)+-&+8,+(*.!

O.! =88,+&$#+'(!'%!*-#$6,+-:*)!*(>+(**3+(>!2*#:')-!#'!&'28,*R!*(>+(**3+(>!83'6,*2!
-',4+(>.!

g.! ^,1*(#!$88,+&$#+'(!'%!*(>+(**3+(>!#*&:(+_1*-T!#'',-!$()!3*-'13&*-.!

M.! =88,+&$#+'(!'%!-<-#*2$#+&!*(>+(**3+(>!-<(#:*-+-!$()!)*-+>(!83'&*--*-.!

NQ.!=88,+&$#+'(!'%!-<-#*2$#+&!$883'$&:*-!#'!#:*!&'()1&#!$()!2$($>*2*(#!'%!*(>+(**3+(>!
83'd*&#-.!

NN.!@#:+&$,!&'()1&#!$()!83'%*--+'($,!$&&'1(#$6+,+#<.!

N/.!@%%*&#+4*!'3$,!$()!H3+##*(!&'221(+&$#+'(!+(!83'%*--+'($,!$()!,$<!)'2$+(-.!

N;.!03*$#+4*T!+((' 4$#+4*!$()!83'`$&#+4*!)*2*$('13.!

NI.!D3'%*--+'($,!1-*!$()!2$($>*2*(#!'%!+('32$#+'(.!

NK.!G3)*3,<!2$($>*2*(#!'%!-*,%T!$()!83'%*--+'($,!&'()1&#.!

NL.!@%%*&#+4*!#*$2!2*26*3-:+8!$()!#*$2!,*$)*3-:+8.!

J:+-!&'13-*!+-!)*-+>(*)!#'!$))3*--!#:*!,*$3(+(>!'1#&'2*-!6*,'H!$()!#:*!&'33*-8'()+(>!
@(>+(**3-!=1-#3$,+$!"#$>*!N!0'28*#*(&<!"#$()$3)-!%'3!D3'%*--+'($,!@(>+(**3-!$-!-:'H(.!
J:*!%1,,!,+-#!'%!"#$>*!N!0'28*#*(&<!"#$()$3)-!2$<!6*!%'1()!+(!=88*()+R!=.!
!
=%#*3!-1&&*--%1,,<!&'28,*#+(>!#:+-!&'13-*T!<'1!-:'1,)!6*!$6,*!#'W!

=#!#:*!&'(&,1-+'(!'%!%!#:+-!&'13-*T!-#1)*(#-!-:'1,)!6*!$6,*!#'W!

N.! Y*4*,'8!$!)*-+>(!'3!$!83'&*--!'3!+(4*-#+>$#*!$!:<8'#:*-+-!%',,'H+(>!+()1-#3<!$()!
83'%*--+'($,!*(>+(**3+(>!-#$()$3)-.!AOT!gT!MT!NQC!

/.! 03+#+&$,,<!3*%,*&#!'(!$!-8*&+$,+-#!6')<!'%!9('H,*)>*!3*,$#*)!#'!#:*+3!#:*-+-!#'8+&.!A;C!

;.! =88,<!-&+*(#+%+&!$()!*(>+(**3+(>!2*#:')-!#'!-',4*!$(!*(>+(**3+(>!83'6,*2.!AOC

6*!&'28,*#*)!$()!-162+##*)!#'!P*3,+()*!Z$<!$()!18,'$)*)!#'!#:*!"GF=!IMKN5MIKN!

A

7#!+-!+(#*()*)!#:$#!J:*-+-!=!&'4*3!#:*!-&'8+(>T!8,$((+(>T!$()!&'28,*#+(>!
83*8$3$#+'(-!%'3!#:*!83'd*&#.!

N.! D3'd*&#!D,$(!i!#:+-!H+,,!&'283+-*!$!N`/!8$>*!)'&12*(#!*R8,$+(+(>!#:*!d1-#+%+&$#+'(!%'3!
#:*+3!83'd*&#T!$!3'1>:!,$<'1#!'%!$!8,$(!''%!H'39!#:3'1>:'1#!#:*!83'd*&#T!+(&,1)+(>!$(<!

	/.! "*2+($3! D3*-*(#$#+'(! ;.! D3'>3*--!a*8'3#! !	O! ! NQ!	NQ j ! ! K j !	"18*34+-'35=--*--'3!AKQ5KQC! ! "18*34+-'3!

J:*-+-!0! N.! ^+($,!a*8'3#!
/.! D$3#+&+8$#+'(!
;.! D3*-*(#$#+'(!
'%!H'39

If he e i a ignifican diffe ence be een he ma k fo he li e a e and og e e ie

?*,'H!$3*!#:+(>-!#'!&'(-+)*3!H:*(!81##+(>!#'>*#:*3!#:*!,+#*3$#13*!$()!83'>3*--!3*4+*H!
)'&12*(#!

F+#*3$#13*!a*4+*H! !	*(W a , a a ?)* ! ?3+*%!6$&9>3'1()!#'!83'd*&#! ! "122$3<!'%!,+#*3$#13*!3*,*4$(#!#'!83'd*&#! ! 7)*(#+%+&$#+'(!'%!I>$8-m!+(!#:*!,+#*3$#13*! ! D3'6,*2!"#$#*2*(#!A+(%'32*)!6<!>$8-!+(!#:*! ,+#*3$#13*C! ! B<8'#:*-+-!$()!$+2-!	KQ j !	N/`NK!
D3'd*&#!D,$(!	A*H a a a a a ?) ! ! D3'8'-*)!"',1#+'(5@R8*3+2*(#$,!P*#:')','><! ! J:*-+-!#+2*,+(*!i!%'3!(*R#!#H'!#*32-! o! n1-#+%+&$#+'(!'%!#+2*!$,,'&$#+'(!%'3!*$&:! #$-9! ! =4$+,$6,*!3*-'13&*-!+)*(#+%+*)! ! a*_1+3*)!#3$+(+(>!$()!18-9+,,+(>!+)*(#+%+*)!	/Q j !	;`K!
D3'd*&#! Y*8*()*(#! D3*8$3$#+'(-!	*(Ca a a ? W a a a a a ?)* D3'd*&#!-8*&+%+&T!61#!2$<!+(&,1)*! ! @4+)*(&*!'%!#3$+(+(>!'(!-8*&+%+&!*_1+82*(#! ! @4+)*(&*!'%!-'2*!18-9+,,+(>!+(!(*H! -'%#H$3*52*#:')-! ! D3*,+2+($3<!3*-1,#-! ! D3*,+2+($3<!-9*#&:*-! ! 0'28'(*(#-58$3#-!'3)*3*)!		

.

J : *!,$#*!8* ($,#<!+-!$88,+*)!8*3!&$,*()$3!)$<!A+(&,1)+(>!H**9*()-!$()!816,+&!:',+)$<-C!#:$#!
#:*!$--*--2*(#!+-!'4*3)1*.!J:*3*!+-!('!83'`3$#$!'%!#:*!,$#*!8*($,#<!%'3!-162+--+'(-!2$)*!
8$3#!H$<!#:3'1>:!$!)$<.!
!
Ma
P$39+(>!>1+)*,+(*-!%'3!$--+>(2*(#!-162+--+'(-!H+,,!6*!83'4+)*)!$#!#:*!-$2*!#+2*!$-!
$--+>(2*(#!)*#$+,-!#'!$--+-#!H+#:!2**#+(>!$--*--$6,*!3*_1+3*2*(#-.!"162+--+'(-!H+,,!6*!
2$39*)!$&&'3)+(>!#'!#:*!2$39+(>!>1+)*,+(*-!83'4+)*).!

!
J : *3*!+-!('!*R$2!%'3!#:+-!&'13-*.!

!
7%!<'1!:$4*!*R8*3+*(&*)!$(!+,,(*--!'3!2+-$)4*(#13*!6*<'()!<'13!&'(#3',!#:$#!H+,,!+(#*3%*3*!H+#:!
<'13!$--*--2*(#!8*3%'32$(&*T!<'1!$3*!*,+>+6,*!#'!$88,<!%'3!"8*&+$,!0'(-+)*3$#+'(!83+'3!#'!
-162+##+(>!$(!$--*--2*(#!'3!-+##+(>!$(!*R$2.!!
!
!#:$#!bX"S!('H!:$-!$!^+#!#''!"+#!5!"162+#!31,*T!H:+&:!2*$(-!#:$#!%!<'1!-+#!$(!*R$2!
'3!-162+#!$!8+*&*!'%!$--*--2*(#T!<'1!$3*!)*&,$3+(>!<'13-*,%!%+#!*('1>:!#'!)'!-'!$()!&$(('#!
,$#*3!$88,<!%'3!"8*&+$,!0'(-+)*3$#+'(.!
!
^'3!)*#$+,-!'%!$88,<+(>!%'3!"8*&+$,!0'(-+)*3$#+'(!$()!&'()+#+'(-!%'3!#:*!$H$3)!'%!
-188,*2*(#$3<!$--*--2*(#T!8,*$-*!-**!#:*!+(%'32$#+'(!''(!bX"Sf-!"8*&+$,!0'(-+)*3$#+'(!
8$>*.!

, , **E**

!
a*_1*-#-!%'3!#:*-+-!H+#:)3H,T!-1-8*(-+'(!'3!*R#*(-+'(!--:'1,)!6*!2$)*!+(!H3+#+(>!#'!#:*!
J:*-+-!0''3)+($#'3.!J:*!%',,'H+(>!83'&*)13*-!$()!31,*-!H+,,!6*!$88,+*)!H:*(!$!-#1)*(#!H+-:*-!
#'!H+#:)3$H!%3'2T!'3!-1-8*()!"GF=IMKN5"GF=MIKN.!J:*-*!31,*-!-188,*2*(#!#:*!bX"S!
)*$),+(*-T!&'()+#+'(-T!$()!83'&*)13*-!%'3!H+#:)3$H+(>!%3'2!$!&'13-*.!!!
DF@="@!XGJ@W! !
!
N.! 7(!*4*3<!&$-*!H:*3*!$!-#1)*(#!H+-:*-!#'!8'-#8'(*!&'28,*#+'(!''!%!#:*!#:*-+-T!+.*.!#'!
-1-8*()!H'39!$()!&'28,*#*!#:*!#:*-+-!+(!$!,$#*3!--*--+'(T!H3+##*(!$883'4$,!'%!#:*!
-18*34+-'3!21-#!%+3-#!6*!'6#$+(*)!6*%'3*!-162+##+(>!$!H3+##*(!3*_1*-#!'!#:*!J:*-+-!0'`
'3)+($#'3.!
!
J:*!-18*34+-'3!2$<!3*%1-*!$883'4$,!%'3!$!4$3+*#<!'%!3*$-'(-T!*.>.!#:$#!#:*!(*&*--$3<!

/.! =!-#1)*(#!H:'!+-!8*32+##*)!#'!H+#:)3$H!H+#:'1#!%$+,13*!%3'2!-16d*&#!"GF=IMKN5MIKN!
-:'1,)!3*`*(3',!+(!#:*!%',,'H+(>!-*--+'(!H+#:!$!J:*-+-!X'2+($#+'(!^'32.!X'#*!#:$#!
1()*3!('32$,!&+3&12-#$(&*-!)+-&'(#+(1$#+'(!H+#:'1#!%$+,13*!'3!%+($(&+$,!8*($,#<!+-!
8'--+6,*!'(,<!18!#'!#:*!0*(-1-!Y$#*.!

;.! S:*(!$!-#1)*(#!+->3$(#*)!$(!*R#*(-+'(!#:*3*!2$<!6*!$!8*($,#<!3*-1,#+(>!+(!$!3*)1&#+'(!
'%!#:*!#:*-+-!2$39.!J:+-!H+,,!6*!+28'-*)!$&&'3)+(>!#'!31,*-!$883'4*)!6<!#:*!J:*-+-!

'#:*3H+-*! '6#$+(!$! a+-9! =--*--2*(#!%'3! $883'4$,! 6<!#:*+3! -18*34+-'3!$()! 6<!#:*! "8$&*!
P$($>*3!+(!H:'-*!-8$&*!#:*!H'39!+-!#'!6*!)'(*.!
!
a+-9!=--*--2*(#!#*28,$#*-!%'3!"D=0@"T!@sb7DP@XJ!$()!DaG0@Yba@"!$3*!4+,$6,*!'(!
#:*! 2'')*,*! -+#*.! a+-9! =--*--2*(#-! $()! *R$28,*-! $3*! $,3*$)<! 4+,$6,*T! #:3'1>:! <'13!
-18*34+-'3!%'3!2$(<!$&#+4+#+*-.!0'28,*#*)!'3!2')+‰+*)!4*3-+'(-!-:'1,)!6*!-162+##*)!$-!-+>(*)!
:$3)!&'8+*-!$()!P"!S'3)!*,*&#3'(+&!4*3-+'(-!#'!Z+$(!^'(>!0:+(!A9%.&:+([1(-H.*)1.$1C.!

A

!
bX"S!:$-!$(!''(>'+(>!&'22+#2*(#!#'!%'-#*3+(>!$!&1,#13*!'%!,*$3(+(>!+(%'32*)!6<!$&$)*2+&!
+(#*>3+#<.!=,,!bX"S!-#1)*(#-!:$4*!$!